Australian guideline for the prevention, diagnosis and management of acute rheumatic fever and rheumatic heart disease (Edition 3.4)

October 2026

menzies SCHOOL OF HEALTH RESEARCH

Heart Foundation

Editors: Professor Anna Ralph, Professor Bart Currie, Dr James Marangou

Cultural Editor: Associate Professor Aunty Vicki Wade

Production Editor: Ms Sara Noonan

Writers and reviewers: Ms Christine Barclay, Prof Asha Bowen, Ms Beth Chidlow, Ms Cathy Doidge, Ms Erin Ferguson, Assoc Prof Josh Francis, Dr Deborah Hall, Dr Ari Horton, Dr Min-Ho Jung, Prof Judith Katzenellenbogen, Assoc Prof Laurens Manning, Ms Melanie Middleton, Ms Gabrielle Mullen, Dr Joshua Osowicki, Ms Ingrid Stacey, Ms Jenny Thomlinson, Dr Geri Vaughan, Assoc Prof Vicki Wade Ms Ann Weaver, Dr Rachel Webb, Dr Gavin Wheaton, Ms Jacqui Williamson.

Contributions to past editions not listed above: Dr Jason Agostino, Ms Mellise Anderson, Dr Peter Azzopardi, Dr Dylan Barth, Assoc Prof Jayme Bennetts, Ms Hilary Bloomfield, Ms Claire Boardman, Ms Linda Bootle, Mr Karl Briscoe, Prof Alex Brown, Dr Allan Brown, Dr Jeffrey Cannon, Prof Jonathan Carapetis, Dr Marilyn Clarke, Dr Samantha Colquhoun, Ms Cia Connell; Dr Ben Costello; Ms Jennifer Cottrell, Ms Elle Crighton, Mr Michael Cusaro; Dr Margaret Danchin, Dr Jessica de Dassel; Dr Nicolette de Zoete, Ms Karrina Demasi; Ms Ellen Donnan, Dr Keith Edwards, Dr Daniel Engelman, Ms Stephanie Enkel, Dr Dana Fitzsimmons, Ms Therese Gordon, Dr Clive Hadfield, Ms Catherine Halkon, Dr Robert Hand, Dr Christopher Handbury, Dr Kate Hardie, Mr Mark Haste, Mr John Havnen, Dr Richard Heazlewood, Mr Adam Hort, Ms Erin Howell, Dr Marcus Ilton, Dr Susan Jack, Dr Mohan Kandasamy, Dr John Kelly, Dr Charles Kilburn, Prof Diana Lennon, Prof Graeme Maguire, Dr Jaye Martin, Prof Malcolm McDonald, Dr Claire McLintock, Dr Jacki Mein, Dr Alice Mitchell, Dr Nikki Moreland, Ms Diana Mosca, Prof Robyn North, Dr Jane Oliver, Ms Bhavini Patel, Prof Michael Peek, Ms Jennifer Pringle, Ms Lynette Purton, Dr Simon Quilty, Dr James Ramsay, Dr Ben Reeves, Dr Boglarka Reményi, Dr Marc Rémond, Dr Ross Roberts-Thomson, Mr Stewart Roper, Dr Alan Ruben, Mr Sean Rung, Dr Rosalie Schultz, Dr Timothy Senior, Dr David Simon, Dr Ajay Sinhal, Ms Rebecca Slade, Prof Elizabeth Sullivan, Assoc Prof Robert Tam, Dr Adrian Tarca, Mr Dale Thompson, Assoc Prof Steve Tong, Ms Kylie Tune, Dr Warren Walsh, Prof Barry Walters, Ms Samantha Welke, Dr Miriam Wheeler, Ms Desley Williams, Assoc Prof Nigel Wilson, Ms April Roberts-Witteveen, Dr Daniel Yeoh.

Conflicts of interest: None declared

Endorsing organisations
Australian Indigenous Doctors' Association (AIDA)
Australasian Society for Infectious Diseases (ASID)
Australasian Society for Ultrasound in Medicine (ASUM)
Australasian Sonographers Association (ASA)
Australian and New Zealand Society of Cardiac and Thoracic Surgeons (ANZSCTS)
Cardiac Society of Australia and New Zealand (CSANZ)
Council of Remote Area Nurses (CRANAplus)
Heart Foundation Australia
HeartKids
Murdoch Children's Research Institute (MCRI)
National Association of Aboriginal and Torres Strait Islander Health Workers and Practitioners (NAATSIHWP)
National Aboriginal Community Controlled Health Organisation (NACCHO)
Royal Australasian College of Physicians (RACP)
Royal Australian & NZ College of Obstetricians and Gynaecologists (RANZCOG)
Sydney Infectious Diseases Institute (Sydney ID)
The Kids Research Institute

Copyright
Copyright © 2025 Menzies School of Health Research

This work is copyright. You may download, display, print and reproduce this material in unaltered form only (retaining this notice) for personal, non-commercial use or use within your organisation. Apart from any use as permitted under the Copyright Act 1968 (Commonwealth), all other rights are reserved. Enquiries concerning reproduction and rights should be addressed to rhdguidelines@menzies.edu.au.

Suggested citation
Menzies School of Health Research (ARF/RHD writing group). Australian guideline for the prevention, diagnosis and management of acute rheumatic fever and rheumatic heart disease (Edition 3.4) October 2026

ISBN
978-1-922770-11-0 (online)

Disclaimer
This publication was funded by the National Heart Foundation of Australia (Heart Foundation). The views expressed are those of the authors and do not necessarily reflect those of the Heart Foundation. The Heart Foundation does not warrant or represent that the information contained in this publication is accurate, current or complete. To the extent permitted by law, the National Heart Foundation of Australia does not accept any legal liability or responsibility for any loss, damages, costs or expenses incurred by the use of, or reliance on, or interpretation of, the information contained in this publication.

This document has been produced by Menzies School of Health Research for the information of health professionals. The statements and recommendations it contains are based on independent review of the available evidence. The guidelines are designed to provide information to assist decision-making and are based on the best evidence available at the time of development. Interpretation of this document by those without appropriate medical and/or clinical training is not recommended, other than at the request of, or in consultation with, a relevant health professional. While care has been taken in preparing the content of this material, to the extent permitted by law the Menzies School of Health Research and its employees do not accept any liability, including for any loss or damage, resulting from the reliance on the content, or for its accuracy, currency and completeness. The information is obtained and developed from a variety of sources including, but not limited to, collaborations with third parties and information provided by third parties. It is not an endorsement of any organisation, product or service. This material may be found in third parties' programs or materials (including, but not limited to, show bags or advertising kits). This does not imply an endorsement or recommendation by the Menzies School of Health Research for such third parties' organisations, products or services, including their materials or information. Any use of the Menzies School of Health Research including Menzies School of Health Research materials or information by another person or organisation is at the user's own risk. The entire contents of this material are subject to copyright protection.

Contents

1

Introduction 2

Foreword 2
Summary of important changes in this edition 3
Classifications of acute rheumatic fever and rheumatic heart disease used in this guideline 5
Levels of evidence for GRADE recommendations 6
Points of difference between WHO 2024 and Australia 2025 7
References 9

2

Culture and Workforce 11

Overview 11
Key information 11
Discussion 12
- Centrality of culture 12
- The importance of workforce 12
- First Nations health workforce capacity 13
- Socio-ecological model 13
- Patient journey mapping 13

Conclusion 14
References 15

3

Burden of acute rheumatic fever and rheumatic heart disease 17

Important changes in this chapter 17
Key information 17
Introduction 18
- The global burden of ARF and RHD 18
- Historical changes in the burden of ARF and RHD 19
- Estimating the burden of ARF and RHD 19

Burden of ARF and RHD in Australia 21
- demographic distribution of ARF and RHD 21
- Registrations by jurisdiction and ethnicity 23
- Comparison of disease between First Nations and non-Indigenous Australians 25
- Patterns of disease among First Nations peoples 26
  - » Incidence and prevalence of ARF and RHD by age and sex 26
  - » Trends in First Nations registration 27
- Progression and complications of disease 28
  - » Progression of ARF to RHD 28
  - » Complications of RHD 29
- Death rates 30
- Burden of RHD in Disability-Adjusted Life Years 31
- Real world and projected costs of treating ARF and RHD 32

References 34

4 Primordial prevention and social determinants of acute rheumatic fever 37
Important changes in this chapter 37
Key information 37
Discussion 39
Healthy living practice 1 – washing people 41
Healthy living practice 2 – washing clothes and bedding 42
Healthy living practice 3 – removing wastewater safely 44
Healthy living practice 4 – improving nutrition, the ability to store, prepare and cook food 44
Healthy living practice 5 – reducing the negative impacts of overcrowding 44
Healthy living practice 6 – reducing the negative effects of animals, insects and vermin 46
Healthy living practice 7 – reducing the health impacts of dust 47
Healthy living practice 8 – controlling the temperature of the living environment 47
Healthy living practice 9 – reducing minor trauma 47
Case study 48
References 49

5 Primary prevention 53
Important changes in this chapter 53
Key information 53
Discussion 56
Strep A throat infections 58
» Colonisation (carriage) 58
» Infection (tonsillitis or sore throat) 58
» Symptoms and signs 58
» Clinical scoring of sore throats 59
» The challenges of treating sore throats 59
Strep A skin infections 60
» Skin sores or impetigo 60
» Antibiotic treatment of skin sores (impetigo) 61
Strep A rapid diagnostics 61
The role of non-A strains of streptococci 61
Case studies 62
» Treatment of Strep A tonsillitis to prevent ARF 62
» Skin control programs 62
» Population-based sore throat management 62
References 63

6 Diagnosis of acute rheumatic fever 66
Important changes in this chapter 66
Key information 66
Discussion 70
Difficulties with ARF diagnosis 70
Indication for hospitalisation 70
Evolution of the Jones criteria and unifying American and Australian guidelines 71
ARF categorised as definite (confirmed), probable (highly suspected) or possible (uncertain) 73
Important points about ARF diagnosis in difficult cases 73

6

Clinical features of ARF: major manifestations 74
- Overview 74
- Arthritis 74
- Sydenham chorea 75
- Carditis 76
- Subcutaneous nodules 77
- Erythema marginatum 78

Clinical features of ARF: minor manifestations 80
- Arthralgia 80
- Fever 80
- Elevated acute-phase reactants 80
- Prolonged P-R interval and other rhythm abnormalities 81

Other less common features of ARF 82

Evidence of Streptococcal A infection 83

Streptococcus A rapid diagnostics 84

Differential diagnosis 84

Syndromes that may be confused with ARF 85
- Post-streptococcal reactive arthritis 85
- Paediatric autoimmune neuropsychiatric disorders associated with Strep A infections 85

Echocardiography and ARF 86
- Echocardiography in ARF recurrences 88
- Left ventricular size and function 88
- Three-dimensional echocardiography 88
- Evidence of subclinical rheumatic valve damage 88

Case study 89

References 90

7

Management of acute rheumatic fever 95

Important changes in this chapter 95

Key information 95

Discussion 98
- Pre-hospital management of ARF 98
- Decision-making regarding hospitalisation 99
- Hospital management of ARF 99
  - » Five priorities during hospitalisation 101
  - » Education 103
  - » Management of possible and probable ARF 103
  - » Management according to priority classification 104
- Antibiotic treatment 104
- Treatment of arthritis and arthralgia 106
  - » Naproxen and Ibuprofen 106
  - » Aspirin 106
- Treatment of fever 107
- Treatment of carditis and heart failure 107
  - » Corticosteroids for carditis 107
  - » Role of surgery for ARF 109
  - » Bed rest 109
- Treatment of Sydenham chorea 109
  - » Grading the severity of chorea 109

7

» Differential diagnoses of chorea 111
» Anti-convulsant agents 111
» Neuroleptic agents 111
» Corticosteroids for chorea 111
» Other immunomodulatory agents for Sydenham chorea 111
» Monitoring response of Sydenham chorea symptoms to therapy 112
Monitoring and progress of ARF 112
» Frequency of laboratory tests 112
» Discharge from hospital 112
Commencement of long-term preventative measures 113
» Secondary prevention 113
» Immunisations 113
References 114

8

Diagnosis of rheumatic heart disease 117
Important changes in this chapter 117
Key information 117
Discussion 123
Natural history of RHD 126
Diagnostic aspects of RHD 126
Clinical assessment of RHD 126
Clinical features of specific valve lesions 127
» Mitral valve disease 127
» Aortic valve disease 129
» Tricuspid valve disease 130
Echocardiography and RHD diagnosis 130
» Distinguishing RHD from other valve pathology 131
Specific valve features on echocardiography 131
» Mitral valve disease 131
» Aortic valve disease 132
» Right-sided valve disease 132
Adjunctive investigations in RHD diagnosis 133
» Transoesophageal echocardiography 133
» Exercise stress testing and stress echocardiography 133
» Angiography and right heart catheterisation 133
New echocardiography technology and its role in diagnosis 134
References 135

9

Screening for rheumatic heart disease 138
Important changes in this chapter 138
Key information 138
Discussion 140
General principles of screening 140
Brief history of RHD screening 141
World Heart Federation diagnostic criteria for RHD 141
Natural history of screen detected RHD 142
Potential approaches to implementation of RHD screening with echocardiography 142

9

Target population 142
Non-technical considerations 143
Different models of screening 143
» Personnel 143
» Equipment 143
» Screening protocols 146
» Diagnostic confirmation 146
Recommendations for management of echocardiogram screening detected RHD 147
Potential benefits of screening 148
» Benefits at an individual level 148
» Benefits at a community level 148
» Benefits at a health-system level 148
Potential risks of screening 148
» Risks to the individual 148
» Risks to the health system 148
Case studies 149
References 150

10

Secondary prophylaxis 153
Important changes in this chapter 153
Key information 153
Discussion 158
Overview 158
Pharmacological therapy 158
» Recommended secondary prophylaxis dosage 158
» Pharmacokinetics 159
» Frequency of injections 159
» Duration of secondary prophylaxis after ARF 159
» Rationale for revision of secondary prophylaxis duration 160
» Ascertaining whether cardiac involvement is present 160
» Duration of secondary prophylaxis after RHD diagnosis 160
» Long-acting penicillin supply interruptions 161
» Oral versus intramuscular secondary prophylaxis 161
» Monitoring oral prophylaxis 161
» Injection sites and techniques 162
» Injection sites for BPG 162
» Ventrogluteal site 163
» Dorsogluteal site 163
» Vastus lateralis site 163
Technique for administering BPG injections 164
» Managing injection pain and distress 164
» Non-pharmacological strategies 165
» Pharmacological strategies: analgesia 166
» Administering BPG injection with lidocaine (lignocaine) 166
» Pharmacological strategies: sedation 168
» Penicillin allergy and reactions 170
» Non-allergic reactions 170
» Vasovagal syncope (fainting) 171

10

» Special considerations 173
» Pregnancy and breastfeeding 173
» Following heart valve surgery 173
» Bleeding disorders 173
Multidisciplinary patient-centred care 174
» Patient education 174
» Adolescent care 174
» Measuring BPG injection adherence 175
» Recall for injection 175
» Patient and family support strategies 175
» RHD program oversight 177
Unsuccessful secondary prophylaxis delivery 177
Case study 178
References 179

11

Management of rheumatic heart disease 183
Important changes in this chapter 183
Key information 183
Discussion 189
Access to care 189
» Access to specialist physician, paediatrician or cardiologist 189
» Access to comprehensive cardiac services 189
» Accessible care for First Nations adolescents 189
Transition from paediatric to adult cardiology services and care providers 190
Secondary prevention with penicillin prophylaxis 191
Management of valvular heart disease 192
Medical management of valve disease 192
Surgical management of valve disease 192
Australian experience in valvular intervention for RHD 193
Patient resources and education 194
Mitral regurgitation 195
» Medical management 195
» Indications for surgery 195
Mitral valve repair 195
» Bioprosthetic mitral valve replacement 196
» Mechanical mitral valve replacement 196
Mitral stenosis 197
» Medical management 197
» Indications for intervention 197
» Percutaneous balloon mitral valvuloplasty 197
» Surgical management 198
Aortic regurgitation 199
» Medical management 199
» Indications for surgery 199
» Choice of operation 199
» Mechanical valve replacement 199
» Bioprosthetic valve replacement 199
» Aortic valve repair 200
» Homograft valve replacement 200
» Ross procedure 200

11

Aortic stenosis 201
» Medical management 201
» Indications for intervention 201
» Choice of intervention 201
» Aortic valvuloplasty 201
Tricuspid valve disease 202
» Medical management 202
» Surgical management 202
Mixed and multi-valvular disease 203
Monitoring following valve surgery 204
Management of thromboembolic risk and anticoagulation 204
» Atrial fibrillation and atrial flutter 204
» Mitral stenosis 204
» Prosthetic valve replacement 205
» Monitoring anticoagulation 205
Management of RHD complications 206
» Heart failure 206
» Pulmonary hypertension 206
» Atrial fibrillation 207
» Prosthetic valve thrombosis 207
Prevention of infective endocarditis 207
» Antibiotic prophylaxis to reduce endocarditis risk 209
» Oral health and RHD 210
» Common dental pathologies and pre-surgical assessment 210
» Access to dental care 210
Case study 211
References 218

12

Women and girls with rheumatic heart disease 225
Important changes in this chapter 225
Key information 225
Discussion 230
Overview 230
Transitional care 231
» Transition to adult reproductive health and preconception care 231
» Transition to adult cardiovascular care 231
Pre-pregnancy 231
» Contraception and reproductive health 231
» Preconception care and planning 232
» Medication considerations pre-pregnancy 232
» Pregnancy planning and risk 232
During pregnancy 233
» Antenatal care 233
» General principles of care and access to services 233
» Continuity of care 234
» Cardiovascular physiology during pregnancy 234
» Screening and new diagnosis in pregnancy 234
» Cardiac risk assessment 235
» Termination of pregnancy 236

12

Specific cardiac valve lesions and complications 237
» Mitral or aortic regurgitation 237
» Mitral stenosis 237
» Atrial fibrillation in mitral stenosis 237
» Aortic stenosis 237
» Tricuspid regurgitation 238
» Left ventricular systolic dysfunction 238
» Heart failure medications 238
» Pulmonary hypertension 238
» Other cardiac risk 238
Prosthetic heart valve considerations 238
Anticoagulation therapy 239
» Fetal risk with warfarin 239
» Use of low molecular weight heparin 239
» Aspirin 239
» Clinical recommendations for anticoagulation in pregnancy 240
» Mechanical valve thrombosis 241
Cardiac surgery during pregnancy 241
Other drugs in pregnancy and lactation 241
Labour, birth and the post-partum period 241
» Method of birth 241
» Infective endocarditis prophylaxis 242
» Medications to treat post-partum haemorrhage 242
Pre-discharge 242
» Discharge plan 242
» Conception planning 242
» RHD Register and secondary prophylaxis 242
Post-discharge 242
Australian classification for medicines in pregnancy 246
Case studies 247
References 251

13

Rheumatic heart disease control programs 257
Important changes in this chapter 257
Key information 257
Discussion 258
Program model 258
Registers and recall systems 258
» RHD control programs in Australian 259
» Legislated notification of ARF and RHD 260
» ARF and RHD surveillance 262
» Evaluating RHD control 262
» Key performance indicators 263
References 264

14 New technologies 266
Important changes in this chapter 266
Key information 266
Penicillin delivery 266
Strep A vaccine development 268
Biomarkers for diagnosis of ARF 269
References 270

Acronyms and abbreviations 273

Tables

Table 1.1.	GRADE evidence grade	6
Table 1.2.	GRADE strength of recommendations	6
Table 1.3.	Points of difference between WHO (2024) and Australian (2025) guidelines	7
Table 3.1.	Percentage of people experiencing complication(s) at various times after first uncomplicated RHD diagnosis (<35-year-olds in SA, NT, WA Qld and NSW 2010-2018)	30
Table 4.1.	Healthy Living Practices and their association with reducing Strep A infections, ARF and RHD	38
Table 4.2.	Potential strategies to increase washing of hands and bodies	41
Table 4.3.	Strategies for effective parasite removal from clothes and bedding	43
Table 4.4.	Strategies to address household crowding	45
Table 4.5.	Strategies to reduce the negative effects of animals, insects and vermin	46
Table 4.6.	Strategies to maintain tidy home environments to minimise risk of minor trauma	47
Table 5.1.	Summary of recommendations with GRADE Level of Evidence	54
Table 5.2.	Risk groups for primary prevention of ARF	54
Table 5.3.	Recommended antibiotic treatment for Strep A sore throat / tonsillitis	54
Table 5.4.	Recommended antibiotic treatment for Strep A skin sores	55
Table 5.5.	Symptoms and signs of a sore throat / tonsillitis	58
Table 6.1.	Summary of recommendations with GRADE Level of Evidence	67
Table 6.2.	Risk groups for ARF	67
Table 6.3.	Australian criteria for ARF diagnosis	68
Table 6.4.	Suggested upper limits of normal (ULN) for serum streptococcal antibody titres in children and adults	69
Table 6.5.	Upper limits of normal for P-R interval	69
Table 6.6.	Evolution of diagnostic criteria for ARF since 1992	72
Table 6.7.	Key points in identifying major manifestations of ARF	79
Table 6.8.	Key points in identifying minor manifestations of ARF	82
Table 6.9.	Differential diagnoses of common major presentations of ARF	84
Table 6.10.	Uses of echocardiography in ARF	87
Table 6.11.	Minimal echocardiographic criteria to allow a diagnosis of pathological valvular regurgitation	87
Table 7.1.	Medications used for acute rheumatic fever	96
Table 7.2.	Priorities in managing ARF in the acute setting	100
Table 7.3.	Testing and monitoring of ARF in the acute setting	102
Table 7.4.	Priority classification and recommended follow-up (updated 2025)	105
Table 7.5.	Prevention of opportunistic infections in immunosuppressed individuals	108
Table 7.6.	Summary of Sydenham chorea management strategies	110
Table 8.1.	Summary of recommendations with GRADE Level of Evidence	118
Table 8.2.	Clinical features of common valve lesions	119
Table 8.3.	Echocardiographic features of RHD	120
Table 8.4.	Role of cardiac investigations in the diagnosis of RHD	121
Table 8.5.	Diagnostic morphological features of RHD (based on WHF 2023 guidelines)	122

Table 8.6.	Criteria for pathological valve dysfunction (based on WHF 2023 guidelines)	123
Table 8.7.	Staging of RHD as detected by echocardiography based on WHF 2023 guidelines	124
Table 8.8	Screening criteria using had carried ultrasound for the echocardiographic detection of RHD in individuals ≤20 years old (based on the 2023 WHF guidelines)	134
Table 9.1.	Summary of recommendations with GRADE Level of Evidence	139
Table 9.2.	Suitability of early RHD for screening	140
Table 9.3.	Considerations for screening	144
Table 9.4.	Models of echocardiographic screening	145
Table 9.5.	General specifications and functionality of different categories of echocardiogram machines	146
Table 10.1.	Summary of recommendations with GRADE Level of Evidence	154
Table 10.2.	Recommended antibiotic regimens for secondary prophylaxis	155
Table 10.3.	Recommended duration of secondary prophylaxis, updated 2025	156
Table 10.4.	Considerations for using lidocaine (lignocaine)	168
Table 10.5.	Clonidine use for BPG injection	169
Table 10.6.	Strategies to improve the delivery of secondary prophylaxis	176
Table 11.1.	Summary of recommendations with GRADE Level of Evidence	184
Table 11.2.	Priority classification and recommended follow-up (updated 2025)	187
Table 11.3.	Summary of medical and surgical management options for specific advanced valve disease	188
Table 11.4.	Standards for quality healthcare for adolescents	191
Table 11.5.	The CHA_2DS_2VA score is used to determine thromboembolic risk and guide use of anticoagulation in patients with non-valvular atrial fibrillation	205
Table 11.6.	Cardiac conditions and procedures for which infective endocarditis prophylaxis is recommended	208
Table 11.7.	Antibiotics for infective endocarditis prophylaxis	209
Table 11.8.	Patient surgery journey	212
Table 12.1.	Summary – Care pathways for women and girls with RHD	226
Table 12.2.	Medications in pregnancy and lactation	243
Table 13.1.	Evolution of ARF and RHD notification and RHD program establishment in Australia	261
Table 13.2.	Processes for notification and inclusion on registers, April 2025	261
Table 13.3.	Key reporting indicators	263

Figures

Figure 2.1. Socio-ecological model underpinning the guidelines 14

Figure 3.1. Change in global age-standardised prevalence of RHD, 1990-2013, and global number of prevalent cases of RHD, 2013 18

Figure 3.2. Model for assessing the burden of RHD 20

Figure 3.3. Number of people aged 4 to 74 with ARF and/or RHD identified from hospital and register data sources by population group in SA, NT, WA and Qld 2001-2017 20

Figure 3.4. ARF and/or RHD diagnoses among First Nations people, by region of management, 31 December 2022 21

Figure 3.5. All hospital admissions for ARF and RHD by Indigenous status, 2011-2012 22

Figure 3.6. People on ARF/RHD Registers, by age group at earliest diagnosis (ARF or RHD) and risk groups, 31 December 2022 24

Figure 3.7. Number and crude rates of new ARF diagnoses recorded on RHD registers among Australians living in the NT, SA, WA and QLD, by year 2013–2022 25

Figure 3.8. Age-standardised rates of people with first-ever ARF (<45 years) or new RHD diagnoses (<55 years) from ARF/RHD registers and/or hospital records in SA, NT, WA Qld and NSW 2015-2017 25

Figure 3.9. ARF incidence and RHD prevalence among First Nations Australians, by age group and sex in SA, NT, WA Qld and NSW 2015-2017 26

Figure 3.10. Prevalence of ARF and RHD, stratified by age and severity, among First Nations Australians in SA, NT, WA Qld and NSW 2015-2017 27

Figure 3.11. Incidence (new and recurrent) of ARF in the Northern Territory, First Nations Australians by age group, 2006 to 2015 27

Figure 3.12. ARF recurrence by time since initial ARF diagnosis 28

Figure 3.13. Progression of ARF to RHD and RHD to severe RHD, Northern Territory 1997-2013 29

Figure 3.14. Outcomes after uncomplicated RHD diagnosis in young Australians in SA, NT, WA Qld and NSW 2010-2018 29

Figure 3.15. Trends in age specific RHD mortality rates and mortality rate ratios for people with a history of RHD aged <65 years in SA, NT, WA Qld and NSW: 1997 to 2005 vs 2013 to 2017 30

Figure 3.16. Cause of death for people with a history of RHD aged <65 years in SA, NT, WA Qld and NSW, 2013-2017 31

Figure 3.17. Cardiovascular diseases age-standardised DALY rates (per 1000 people) by disease and Indigenous status, 2011 32

Figure 3.18. Total paediatric and adult costs ($ million) for treating ARF, RHD and associated complications in hospital in SA, NT, WA Qld and NSW for 2012/13 to 2016/17 33

Figure 5.1. Pathway for ARF and RHD with immune priming 56

Figure 5.2. Strep A infection of the throat 58

Figure 5.3. Assessment of sore throat 59

Figure 5.4. Progression of impetigo from purulent, inflamed and crusted (left), to crusted (middle) to flat and dry (right) 60

Figure 5.5. Strep A infections of the foot and leg 60

Figure 6.1. Redness and swelling of right ankle associated with arthritis. 74

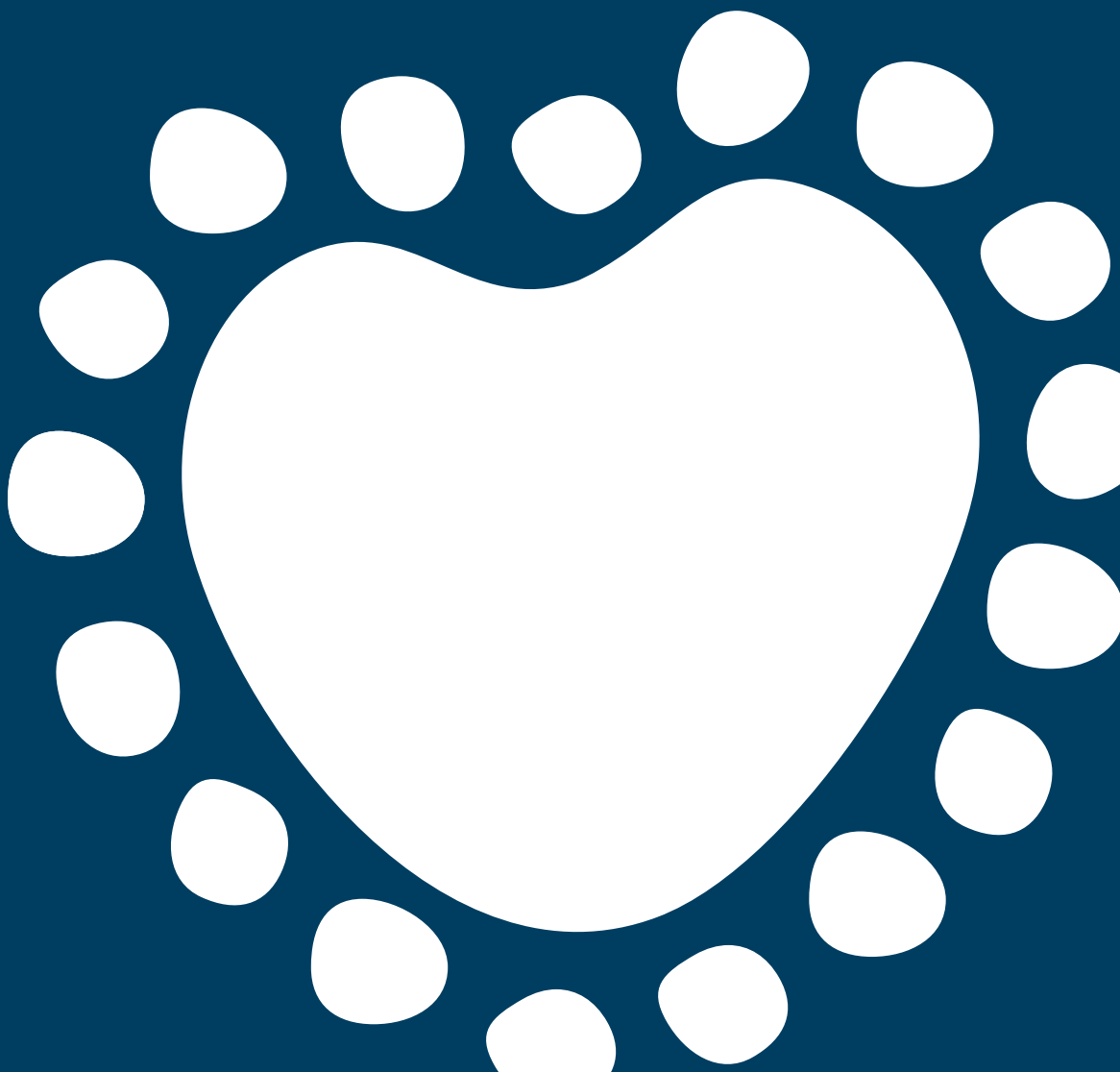
Figure 6.2. Polyarthritis of the fingers in ARF demonstrating inter-phalangeal joint swelling 75

Figure 6.3. Example of subcutaneous nodules on the inner aspect of the wrist 77

Figure 6.4. Example of subcutaneous nodules on the knee 77
Figure 6.5 Erythema marginatum on the back 78
Figure 6.6. Examples of erythema marginatum 78
Figure 6.7. Normal Sinus Rhythm 81
Figure 6.8. First degree heart block 81
Figure 6.9. Second degree heart block 81
Figure 6.10. Third degree (complete) heart block 81
Figure 6.11. Accelerated junctional rhythm 81
Figure 8.1a. Rheumatic mitral valve; appearance with harmonics 'on', note anterior mitral valve thickness. Harmonics should be turned off 122
Figure 8.1b. Rheumatic mitral valve; appearance with harmonics 'off', note anterior mitral valve thickness 122
Figure 8.2. Rheumatic mitral valve; mitral regurgitant jet needs to measure at least 2 cm on colour Doppler (if patient weighs over 30 kg) to meet RHD diagnostic criteria for pathological regurgitation (red arrow) 123
Figure 8.3. Rheumatic mitral valve; thickened and restricted posterior leaflet (red arrow), thickened anterior leaflet tip with diastolic doming (yellow arrow) resulting in stenosis 128
Figure 8.4. Rheumatic mitral valve; restricted posterior leaflet with loss of coaptation (red arrow) leads to eccentric posteriorly directed regurgitation 128
Figure 8.5. Rheumatic mitral valve; significant bileaflet thickening and calcification (yellow arrow) with fused commissure (red arrow) resulting in reduced orifice area 128
Figure 8.6. Rheumatic mitral valve; mitral regurgitation due to RHD is commonly eccentric with a posteriorly directed jet seen on colour Doppler (red arrows) 128
Figure 8.7. Rheumatic mitral valve; severe eccentric mitral regurgitation demonstrated with colour Doppler. The regurgitation follows the posterior wall and fills multiple pulmonary veins (red arrow) 128
Figure 8.8. Mixed rheumatic valve disease; aortic cusp thickening and rolled edges (yellow arrow), thickened anterior mitral valve leaflet (red arrow) 129
Figure 8.9. Rheumatic aortic valve; cusp thickening and restriction (red arrow) 129
Figure 8.10. Rheumatic aortic valve; restricted cusp with rolled edges (red arrow) 129
Figure 8.11. Rheumatic aortic valve with colour Duppler demonstrating regurgitation (red arrow) 129
Figure 9.1. Screening pathway 147
Figure 10.1. Strategies for injection managing pain, fear and distress 165
Figure 11.1. Rheumatic mitral regurgitation: indications for intervention 196
Figure 11.2. Rheumatic mitral stenosis: indications for intervention 198
Figure 11.3. Rheumatic aortic regurgitation: indications for intervention 200
Figure 11.4. Rheumatic aortic stenosis: indications for intervention 202
Figure 11.5. Tricuspid regurgitation in the setting of RHD: indication for intervention 203
Figure 12.1. Care pathways and referral algorithm for pregnant women with RHD 229
Figure 12.2. Anticoagulation pathways for pregnant women on Vitamin K antagonist (VKA) regimen 240

CHAPTER 1

Introduction



Introduction

FOREWORD

This edition of the Australian guideline for the prevention, diagnosis and management of acute rheumatic fever (ARF) and rheumatic heart disease (RHD) has a new focus which places people with ARF and RHD, and their families and communities, at the centre of care. To achieve a value-based healthcare system that breaks down the complex and hierarchical structures based on Western ideologies, we must look at whose values are represented.

There are many cultural and structural barriers for First Nations peoples requiring evidence-based care. Most, however, are poorly understood. If guidelines are to be successful, we need to move beyond the 'evidence base' – what is known and understood – to what we do not know. We need to understand the complex relationships between the social, cultural, political and economic situations in which people live.

Despite advances in medical treatment and management of ARF and RHD, the associated health benefits at population and community level have not been as evident for First Nations peoples as they have for non-Indigenous Australians. These challenges are more than biomedical and are driven by the social, cultural and environmental determinants of health. The Australian Institute of Health and Welfare reported that in 2022, Indigenous Australians represented almost 80% of all new RHD cases. The report also indicated that only 14% of First Nations peoples with ARF and RHD received all prescribed secondary prophylaxis injections. The healthcare system must respond to these disparities and refocus on people with this disease; acknowledging their unique culture, and the social, economic and environmental circumstances in which they live.

There is a growing interest in ethnomedicine where traditional biomedical healthcare methods are guided by Indigenous cultural beliefs and practices. Within each chapter of this guideline, the medical problems and solutions have been viewed within a socio-cultural context, with the aim of reducing the evidence-practice gap. This guideline identifies the systemic factors that drive disparities in best-practice care delivery and offers solutions. We have come a long way from the first edition, and this journey has culminated in an important balance between cultural and clinical competence.

Assoc Professor Vicki Wade
First Nations Senior Research Fellow
Menzies School of Health Research
April 2025

SUMMARY OF IMPORTANT CHANGES IN THIS EDITION

OCTOBER 2026 UPDATES

Definitions added for acute rheumatic fever, rheumatic heart disease, and secondary prophylaxis (page 5)

Footnote added to Table 5.4 Recommended antibiotic treatment for Strep A skin sores to caution against use of cotrimoxazole in pregnancy

Clarity provided on secondary prophylaxis use for post-streptococcal reactive arthritis in high and low risk groups (page 85)

Footnote edited in Table 10.3 Recommended duration of secondary prophylaxis to clarify need for specialist review prior to ceasing secondary prophylaxis

Checklist added to highlight steps required prior to ceasing secondary prophylaxis (page 160)

2025 UPDATES

Culture and Workforce

None

Burden of acute rheumatic fever and rheumatic heart disease

Figure 3.1. Change in global age-standardised prevalence of RHD, 1990-2013, and global number of prevalent cases of RHD, 2013

Figure 3.3. Number of people aged 4 to 74 with ARF and/or RHD identified from hospital and register data sources by population group in SA, NT, WA and Qld 2001-2017

Figure 3.4. ARF and/or RHD diagnoses among First Nations people, by region of management, 31 December 2022

Figure 3.6. People on ARF/RHD Registers, by age group at earliest diagnosis (ARF or RHD) and risk groups, 31 December 2022

Figure 3.7. Number and crude rates of new ARF diagnoses recorded on RHD registers among Australians living in the NT, SA, WA and QLD, by year 2013–2022

Figure 3.8. Age-standardised rates of people with first-ever ARF (<45 years) or new RHD diagnoses (<55 years) from ARF/RHD registers and/or hospital records in SA, NT, WA Qld and NSW 2015-2017

Figure 3.9. ARF incidence and RHD prevalence among First Nations Australians, by age group and sex in SA, NT, WA Qld and NSW 2015-2017

Figure 3.10. Prevalence of ARF and RHD, stratified by age and severity, among First Nations Australians in SA, NT, WA Qld and NSW 2015-2017

Figure 3.12. ARF recurrence by time since initial ARF diagnosis

Figure 3.14. Outcomes after uncomplicated RHD diagnosis in young Australians in SA, NT, WA Qld and NSW 2010-2018

Table 3.1. Percentage of people experiencing complication(s) at various times after first uncomplicated RHD diagnosis (<35-year-olds in SA, NT, WA Qld and NSW 2010-2018)

Figure 3.15. Trends in age specific RHD mortality rates and mortality rate ratios for people with a history of RHD aged <65 years in SA, NT, WA Qld and NSW: 1997 to 2005 vs 2013 to 2017

Figure 3.16. Cause of death for people with a history of RHD aged <65 years in SA, NT, WA Qld and NSW, 2013-2017

Figure 3.18. Total paediatric and adult costs ($ million) for treating ARF, RHD and associated complications in hospital in SA, NT, WA Qld and NSW for 2012/13 to 2016/17

Primordial prevention and social determinants of acute rheumatic fever

None

Primary prevention

Addition of Summary of Recommendations with GRADE Level of Evidence (Table 5.1)

Oral options have been expanded to include a choice of four antibiotics for treatment of sore throat (Table 5.3) (Updated August 2025)

Progress of molecular point of care tools for identifying Strep A throat infections

Recommendation to use phenoxymethylpenicillin (oral penicillin) as first line treatment for sore throat during periods of rationing premix Benzylpenicillin G (Table 5.3)

Clarity that antibiotic treatment is indicated for all people (not just children) with one or more skin lesions with pus or thick crust (Table 5.4)

Diagnosis of acute rheumatic fever

Addition of Summary of Recommendations with GRADE Level of Evidence (Table 6.1)

Clarification of who may be initially managed in the community with suspected ARF (on medical specialist advice)

Addition of "advanced conduction abnormalities" on ECG as a minor manifestation of ARF

Dengue, chikungunya and malaria added to the differential diagnosis of polyarthritis and fever

Section Echocardiography and ARF updated in line with 2023 World Heart Federations RHD diagnosis guidelines

- Discussion related to valvulitis: minimal echocardiographic criteria diagnosis of acute rheumatic fever for pathological regurgitation removed
- Discussion related to morphological changes associated with rheumatic carditis removed

Clarification that echocardiography cannot accurately determine the timing or duration of rheumatic valve changes

Management of acute rheumatic fever

Updated medications used for acute rheumatic fever with GRADE Level of Evidence (Table 7.1)

Removal of tramadol from management of severe pain while awaiting diagnostic confirmation

New emphasis on potential disease-modifying treatment (corticosteroid) in the management of Sydenham chorea (Table 7.1)

Integration of management recommendations for all stages of RHD based on 2023 World Heart Federation guidelines, Table 7.4. Priority classification and recommended follow-up (updated 2025)

Updated Sydenham chorea management strategies (Table 7.6)

Removal of the discussion about tramadol from the text (updated August 2025)

Correction of Priority 1 and Priority 2 RHD Stage definitions in Table 7.4 (updated August 2025)

Diagnosis of rheumatic heart disease

Addition of Summary of Recommendations with GRADE Level of Evidence (Table 8.1)

Integration of the 2023 World Heart Federation (WHF) diagnostic morphological features for RHD (Table 8.5)

Integration of the 2023 WHF guidelines for pathological valvular regurgitation and stenosis (Table 8.6)

Integration of the 2023 WHF guidelines staging criteria (with removal of definite and borderline definitions) (Table 8.7)

Updated reference for 2023 WHF guidelines and explanation of the staging criteria

Addition of 2023 WHF echocardiographic screening criteria (Table 8.8)

Screening for rheumatic heart disease

Addition of Summary of Recommendations with GRADE Level of Evidence (Table 9.1)

Integration of the WHF 2023 echocardiographic diagnosis of rheumatic heart disease (RHD) guidelines including screening and confirmatory criteria

Integration of new evidence including randomised controlled trial data on prophylaxis of early echocardiography detected RHD

Secondary prophylaxis

Addition of Summary of Recommendations with GRADE Level of Evidence (Table 10.1)

Updated recommendations for duration of secondary prophylaxis (Table 10.3)

Addition of guidance for managing long-acting penicillin supply interruptions

Addition of technique for administering benzathine benzylpenicillin injections

Updated strategies to manage injection pain (Figure 10.1)

Guidance for benzathine benzylpenicillin administration in people who may be at high risk of vasovagal syncope (fainting)

Consideration of oral antibiotic prophylaxis rather than intramuscular injections for the small subset of people who may be at high risk of vasovagal syncope (fainting)

Recommendation for clinical discretion for duration of antibiotic prophylaxis after surgery in people aged over 40 years

Addition of calculation for days at risk

Updated priority definitions in Table 10.3 to align with definitions in Table 7.4 and Table 11.2 (Updated August 2025)

Management of rheumatic heart disease

Addition of Summary of Recommendations with GRADE Level of Evidence (Table 11.1)

Integration of management recommendations for all stages of RHD based on 2023 World Heart Federation guidelines, Table 11.2. Priority classification and recommended follow-up (updated 2025)

Integrated evidence from the INVICTUS trial regarding anticoagulation in AF and advanced MS (no change to recommendations)

No change to the management of each individual valve lesion or indications for referral to surgery/heart team. These appear in line with ESC and AHA/ACC valvular heart disease guidelines

Correction of Priority 1 and Priority 2 RHD Stage definitions in Table 11.2 (updated August 2025)

Addition of reference to Therapeutic Guidelines advice on dental procedures for dentists, available September 2025 (updated August 2025)

Women and girls with rheumatic heart disease

Emerging importance of early access to echocardiography for pregnant women in high-risk populations

Statement about Birthing on Country under Key Information (updated August 2025)

Updated information for metoprolol, labetalol, bisoprolol and diltiazem in Table 12.2 (updated August 2025)

Rheumatic heart disease control programs

Updated status of RHD control programs in the Australian context

Addition of notifiable conditions (Table 13.1)

Updated notification process and consent requirements (Table 13.2)

Updated key performance targets and metrics for RHD Control Programs (Table 13.3)

New technologies

Introduction to the SubCutaneous Infusions of high dose benzathine benzylpenicillin G (SCIP) trial

Updated discussion on Strep A vaccine development

DEFINITIONS AND CLASSIFICATIONS OF ACUTE RHEUMATIC FEVER AND RHEUMATIC HEART DISEASE USED IN THIS GUIDELINE

Definitions

Acute rheumatic fever is an autoimmune illness following a streptococcal infection.

Rheumatic heart disease is damage to one or more heart valves resulting from acute rheumatic fever.

Secondary prophylaxis is the regular administration of antibiotics to prevent recurrent ARF resulting from Strep A infections.

Classification of ARF

Definite ARF: acute presentation which fulfils Jones diagnostic criteria for ARF.

Probable ARF: acute presentation which does not fulfil Jones diagnostic criteria for ARF, missing one major or one minor criterion or lacking evidence of preceding streptococcal infection, but ARF is still considered the most likely diagnosis.

Possible ARF: acute presentation which does not fulfil Jones diagnostic criteria for ARF, missing one major or one minor criterion or lacking evidence of preceding streptococcal infection, and ARF is considered uncertain but cannot be ruled out.

Classification of RHD

Stage A: Minimum echocardiographic criteria for RHD, may be at risk for valvular heart disease progression.

Stage B: Mild RHD, at risk for developing clinical symptoms of valvular heart disease.

Stage C: Advanced RHD, at high risk of developing clinical complications of disease.

Stage D: Advanced RHD, already has clinical complications of disease.

RHD in pregnancy risk levels

Level I: low risk of maternal mortality, low to moderate risk of morbidity (e.g. mild RHD with no mitral stenosis).

Level II: elevated risk of maternal mortality or moderately increased risk of morbidity (e.g. bioprosthetic valve or mild mitral stenosis).

Level III: further elevated risk of maternal mortality or severe morbidity (e.g. mechanical heart valve, severe asymptomatic mitral / aortic regurgitation or severe asymptomatic aortic stenosis or moderate mitral stenosis.

Level IV: extremely high risk of maternal mortality or severe morbidity (e.g. severe mitral stenosis or valve disease with pulmonary hypertension).

Types of penicillin used in ARF

Benzathine benzylpenicillin G: long-acting intramuscular formulation of penicillin.

Phenoxymethylpenicillin: short-acting oral formulation of penicillin.

LEVELS OF EVIDENCE FOR GRADE RECOMMENDATIONS

Grading of Recommendations Assessment, Development and Evaluation (GRADE)[1] is used in this document where the level of evidence of a recommendation requires grading. The GRADE approach is an internationally recognised system for grading quality of evidence and strength of recommendations. The GRADE approach rates evidence across studies for specific clinical outcomes to link evidence-quality evaluations to recommendations in clinical guidelines.

Table 1.1. GRADE evidence grade

CODE	QUALITY OF EVIDENCE	DEFINITION
A	High	We are very confident that the true effect lies close to that of the estimate of the effect
B	Moderate	We are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
C	Low	Our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect
D	Very low	We have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect

Table 1.2. GRADE strength of recommendations

CODE	STRENGTH OF RECOMMENDATION	IMPLICATIONS WHEN COMBINED WITH EVIDENCE GRADE
1	Strong	1A: Strong recommendation, applies to most patients without reservation. Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present 1B: Strong recommendation, applies to most patients. Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present 1C: Strong recommendation, applies to most patients. Some of the evidence base supporting the recommendation is, however, of low quality
2	Weak	2A: Weak recommendation. The best action may differ depending on circumstances of patients or societal values 2B: Weak recommendation. Alternative approaches likely to be better for some patients under some circumstances 2C: Very weak recommendation. Other alternatives may be equally reasonable 2D: No evidence available; expert consensus judgement

POINTS OF DIFFERENCE BETWEEN WHO 2024 AND AUSTRALIA 2025

The Australian Guidelines Writing Group acknowledges several points of difference between recommendations in the Australian Guidelines, and World Health Organization (WHO) guidelines[2] which were released in November 2024. The WHO considers randomised, controlled trial evidence only, and produces recommendations to guide wide international settings including low-resource settings. The WHO guideline is *"not intended to encompass all aspects of the prevention, detection and clinical care of the disease in affected populations and subpopulations. Readers are encouraged to identify high-quality, evidence-informed national and local guidance to complement this guideline."*

According to the WHO: "*Member States are expected to adapt the recommendations to their setting, taking into account feasibility, resource availability and other considerations at the national and subnational level."*

Table 1.3. Points of difference between WHO (2024) and Australian (2025) guidelines

WHO 2024	AUSTRALIA 2025
Risk for rheumatic fever/rheumatic heart disease	
Populations with **low risk** are considered as having a RF incidence <2 per 100,000 children (5 to 14 years of age) per year, or an all-age prevalence of RHD of ≤100 per 100,000 population per year.	The definition of **high risk** is ARF incidence >30/100,000 per year in 5-14-year-olds or RHD all-age prevalence >2/1000 (i.e. >200/100,000).
Diagnosis and treatment of skin and skin structure infections	
No recommendation: the WHO was unable to make a recommendation either for or against antibiotic treatment of skin and skin structure infection(s) (SSSIs), whether laboratory confirmed or clinically diagnosed, for the specific purpose of preventing rheumatic fever (RF) or rheumatic heart disease (RHD). **Remarks:** Health workers should treat SSSIs as indicated, based on the signs and symptoms and on relevant laboratory findings. The absence of evidence on the effectiveness of treatment of confirmed or suspected GAS SSSIs to prevent progression to RF/RHD should not affect decision-making when patients with SSSIs present in the clinical setting, to prevent other complications from SSSIs.	Skin infections trigger ARF. In Australia, Strep A has been shown to be associated with most impetigo episodes.[3] Strep A impetigo is very common among First Nations children living in remote areas, with almost one in two affected at any one time.[4] Timely treatment of skin infections in high risk groups before the body mounts an immune response is a crucial component of ARF prevention.
Treatment of group A streptococcal pharyngitis	
Recommendation 1: Children, adolescents and adults with sore throat and a positive diagnostic test (either POC testing or microbial confirmation) for GAS pharyngitis should be treated with antibiotics to prevent RF/RHD. **Remarks:** There is evidence that a treat-all strategy for children and adolescents presenting with a sore throat reduces the incidence of RF/RHD, especially in moderate/high risk populations. However, there are harms associated with such an approach, including cost, adverse effects from antibiotics, risk of antimicrobial resistance and burden on the health care system. The GDG felt that these harms outweigh the benefits of a treat-all strategy for sore throat, including among populations at high risk for RF/ RHD. Therefore, children and adolescents presenting with a sore throat should not receive antibiotic prophylaxis unless GAS pharyngitis is confirmed or clinically suspected in areas with moderate/high risk of RF and RHD.	Timely treatment of Strep A sore throats should prevent ARF, however, only some sore throats are caused by Strep A. Antibiotic treatment of all episodes of clinical tonsillitis would expose a significant proportion of patients to unnecessary medication. Depending on the setting, it is likely that only 20–40% of tonsillitis episodes are caused by Strep A.[5,6] Given the high transmission of Strep A infections in many high risk communities and the high risk of ARF, empirical antibiotic treatment of all high risk young people presenting with sore throat is recommended.

Table 1.3. Points of difference between WHO (2024) and Australian (2025) guidelines (continued)

WHO 2024	AUSTRALIA 2025
Diagnosis of rheumatic fever	
Temperature • ≥38.5°C for high risk groups **Monoarthritis** • Minor manifestation for high risk groups **Monoarthralgia** • Not included	**Temperature** • ≥38°C for high risk groups **Monoarthritis** • Major manifestation for high risk groups • Minor manifestation for low risk groups **Monoarthralgia** • Minor manifestation for high risk groups
Echocardiography in the diagnosis of rheumatic fever and rheumatic heart disease	
Recommendation 1: Among children, adolescents and adults with suspected RF or RHD in settings where standard echocardiography is not available, hand-held echocardiography can be used for diagnosis of RF-carditis and RHD.	The Guidelines Writing Group acknowledges the growing role of task-sharing and use of hand-held echocardiography, particularly for the screening of RHD. However, there is limited data to support its use in the diagnosis or follow-up on RF-carditis or RHD. ARF can be difficult to diagnose, particularly in rural and remote settings, and presenting symptoms may be subtle. It is therefore strongly recommended that all patients with suspected ARF have a comprehensive echocardiogram to identify valvulitis, assess cardiac function, determine the presence of pericarditis, and exclude other forms of cardiac murmur.
Anti-inflammatory agents for the treatment of rheumatic fever	
No Recommendation: The WHO does not recommend either for or against the use of anti-inflammatory agents for children, adolescents and adults diagnosed with RF to prevent the progression to RHD. These agents include aspirin, non-steroidal anti-inflammatory drugs (NSAIDs), intravenous immunoglobulin and corticosteroids. **Rationale:** It is currently unknown whether the addition of anti-inflammatory agents to antibiotics is beneficial in children, adolescents and adults diagnosed with RF with regard to progression to RHD, or severity of carditis or valvular lesions. Based on low and very low certainty evidence, aspirin, NSAIDs, IVIG and corticosteroids were neither more beneficial nor more harmful than placebo in children, adolescents and adults diagnosed with RF.	The Guidelines Writing Group agrees with the lack of evidence in relation to anti-inflammatory medications preventing progression to RHD. However, analgesic medications should not be withheld since effective management of pain is a crucial part of rheumatic fever care. A small study of intravenous immunoglobulin (IVIg) suggested more rapid recovery from chorea than placebo.[7] A systematic review of IVIg8 identified two randomised, controlled trials with 38 participants.[9,10] Compared with other immunomodulatory therapies (steroids and plasma exchange), short-term benefit was seen with IVIg, and the side-effect profile is favourable. The authors concluded that use of a single 2 g/ kg dose of IVIg in children with moderate-severe chorea associated with significant impairment, is reasonable. Expert advice also describes the use of IVIg 1 g/kg daily for 2 days or 400 mg/ kg for 5 days as alternative dosing regimens. In addition to these trials there are also case reports of successful IVIg use in severe chorea.[8]

REFERENCES

1 Schünemann H, Brożek J, Guyatt G, Oxman A. GRADE Handbook. Updated October 2013.

2 World Health Organization 2024 WHO guideline on the prevention and diagnosis of rheumatic fever and rheumatic heart disease. Geneva: World Health Organization; 2024. Licence: CC BY-NC-SA 3.0 IGO.

3 Bowen AC, Tong SY, Chatfield MD, Carapetis JR. The microbiology of impetigo in indigenous children: associations between Streptococcus pyogenes, Staphylococcus aureus, scabies, and nasal carriage. BMC Infect Dis. 2014;14:727.

4 Bowen AC, Mahé A, Hay RJ, et al. The Global Epidemiology of Impetigo: A Systematic Review of the Population Prevalence of Impetigo and Pyoderma. PLOS One. 2015;10(8):e0136789.

5 Oliver J, Malliya Wadu E, Pierse N, et al. Group A Streptococcus pharyngitis and pharyngeal carriage: A meta-analysis. PLOS Neglected Tropical Diseases. 2018;12(3):e0006335.

6 Bisno A, Gerber MA, Jr. GJ, Kaplan EL, Schwartz RH. Practice guidelines for the diagnosis and management of group A streptococcal pharyngitis. Clinical Infectious Diseases. 2002;35(2):113-125.

7 Voss L, Wilson NJ, Neutzew JM, et al. Intravenous immunoglobulin in acute rheumatic fever: a randomized controlled trial. Circulation. 2001;103(3):401-406.

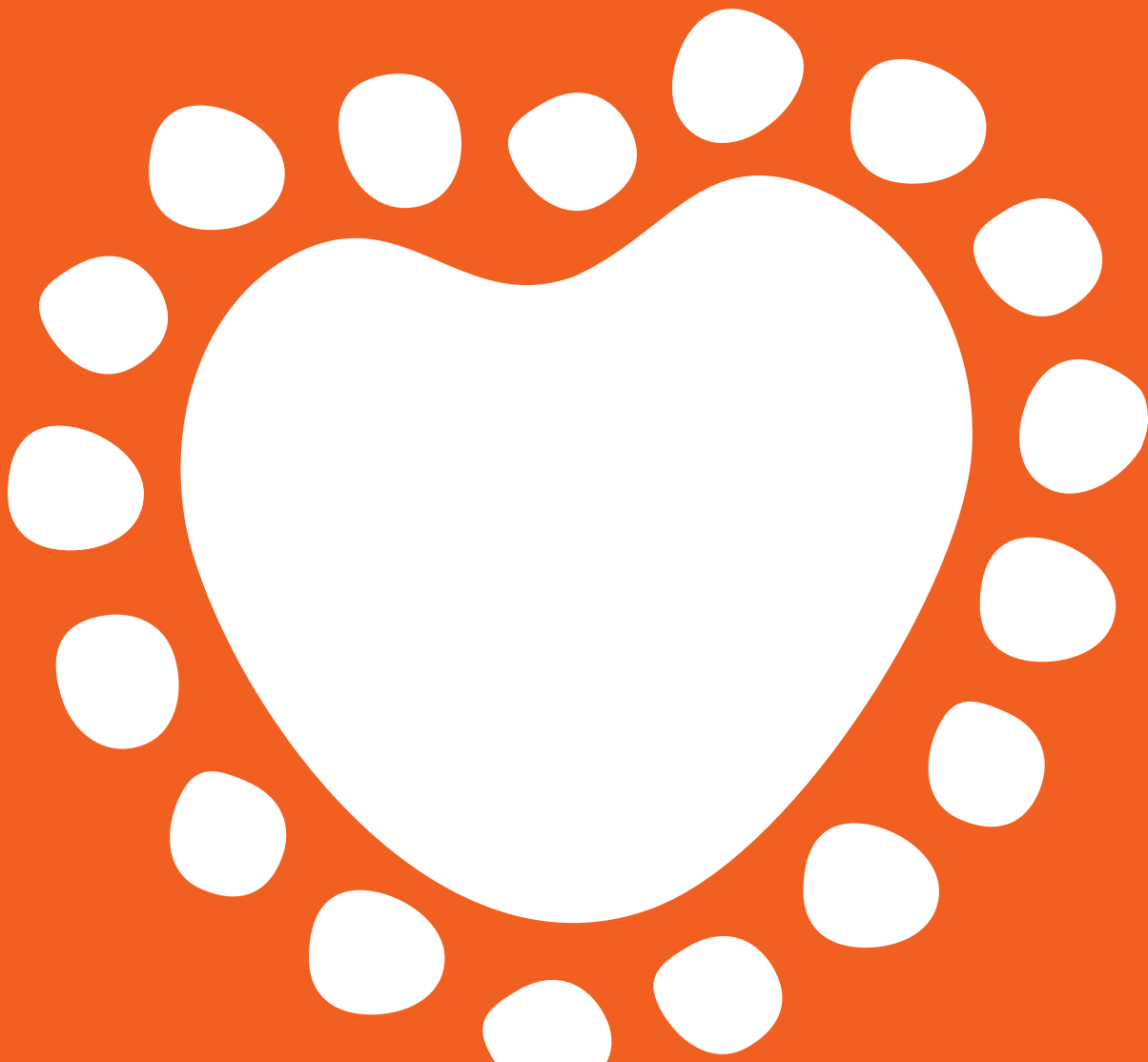
8 Mohammad SS, Nosadini M, Grattan-Smith P, Dale RC. Intravenous immunoglobulin in acute Sydenham's chorea: A systematic review. Journal of Paediatrics and Child Health. 2015;51(12):1235-1238.

9 Garvey MA, Snider LA, Leitman SF, et al. Treatment of Sydenham's chorea with intravenous immunoglobulin, plasma exchange, or prednisone. Journal of Child Neurology. 2005;20:424-429

10 Walker K, Brink A, Lawrenson J, Mathiassen W, Wilmshurst JM. Treatment of Sydenham chorea with intravenous Immunoglobulin. Journal of Child Neurology. 2012;27:147-155.

CHAPTER 2

Culture and Workforce



Culture and Workforce

OVERVIEW

There is often a mismatch between the ethnicity of populations bearing the greatest burdens of ARF and RHD, and the healthcare providers tasked with managing these conditions. In Australia, the vast majority of ARF and RHD diagnoses occur in First Nations peoples. This chapter seeks to highlight the importance of cultural safety as the underpinning requirement for the safe and effective delivery of healthcare for First Nations peoples affected by ARF and/or RHD.

Workforce and cultural issues have been identified and highlighted throughout the following chapters. Healthcare must move beyond cultural competence to structural competence, and to explore how systems respond to the needs of people.[1] Moving from cultural competence to structural competence to address the cultural and social determinants of ill-health, and the structures that perpetuate disparities, have been woven throughout this guideline in highlighted boxes and case studies.

Cultural awareness is different to cultural safety.

Cultural awareness is awareness of one's own biases. It is a single event while cultural safety is the ongoing critical reflection of health practitioner knowledge, skills, attitudes, practising behaviours and power differentials in delivering safe, accessible and responsive healthcare free of racism and harm. The effect of cultural safety is judged by the person receiving care.

KEY INFORMATION

- Centrality of culture is the core component of these guidelines.
- Cultural and structural competencies in healthcare are necessary to close the evidence-practice gap.
- An ethnomedical framework (respecting and incorporating traditional Indigenous medical practices) should be used to inform guideline development.
- A socioecological model (understanding the personal and environmental factors - interpersonal, community, organisational and environmental – that determine health behaviours) can highlight the complex relationships that exist for First Nations peoples.
- An adequately trained and supported First Nations workforce is the key driver for successful health programs.

DISCUSSION

"The systematic neglect of culture in health is the single biggest barrier to advancing the highest attainable standards of health worldwide".[2] Healthcare providers must be prepared to 'translate' care delivery to patients with diverse cultural backgrounds, expectations, and needs.

It is necessary to acknowledge the ongoing impact of trauma that colonisation has on the health and well-being of First Nations peoples. Many First Nations peoples continue to experience discrimination and social disadvantage today, and this has a significant impact on health.[3]

It is well known that patient's perceptions and definitions of health can conflict with the priorities set out in clinical guidelines and standards, and this can significantly affect health outcomes. Everyone receiving healthcare must feel culturally safe, and healthcare providers have an obligation to deliver culturally safe care. Skilled clinical care, culturally safe practice, and reflection, can substantially improve care experiences and outcomes for First Nations peoples.[4]

First Nations peoples in Australia belong to the oldest living civilisation in the world, dating back more than 65,000 years. First Nations peoples' cultures are complex and diverse, with more than 500 language and kinship groups in Australia. The kinship system puts everybody in a specific relationship to each other, the water, and the land, based on their clan or kin. It is important that Australian healthcare providers acknowledge and understand the unique First Nations cultures, to collaborate effectively with all communities.

First Nations peoples have a holistic view of health that is not adequately met by the biomedical model of healthcare; health is not just the physical well-being of an individual, but refers to the social, emotional and cultural well-being of the whole community.

The Cultural Respect Framework for Aboriginal and Torres Strait Islander Health[5] commits the Commonwealth government and all States and Territories to embed cultural respect principles into their health systems; developing policy and legislation, how organisations are structured and managed, and planning and delivery of services. The Cultural Respect Framework guides and underpins the delivery of culturally safe, responsive, and quality healthcare for all First Nations peoples.

In 2015, the Aboriginal and Torres Strait Islander Health Curriculum Framework was completed. Its implementation will provide a benchmark towards national consistency for the minimum level of capability required by graduates to effectively deliver culturally safe and responsive healthcare to First Nations peoples.[6]

We know that policies alone are not enough to bring about change, as these frameworks must be adapted into clinical practice, including into guideline development. Social justice and the right to quality healthcare are basic human rights. Translation of these values to tangible policies and reforms is paramount to closing the gap between First Nations peoples and non-Indigenous peoples; and putting people and their culture at the centre of healthcare.

Centrality of culture

Throughout this guideline, there is an emphasis on the person who is receiving care, their family, community and their culture. This includes:

- Respect for cultural diversity, rights, views, values and expectations of First Nations peoples.
- First Nations health workforce participation at health worker, nursing and medical level an essential element within all health workforce initiatives, settings and strategies.
- Effective, comprehensive and culturally safe and responsive approaches to service delivery that have the flexibility to reflect the local context and the diversity of First Nations communities.
- Workforce initiatives and processes within the wider health system that embed, acknowledge and respect First Nations holistic views of health that includes attention to physical, spiritual, cultural, emotional and social well-being, community capacity and governance.
- Cultural knowledge, expertise and skills of First Nations health professionals reflected in health services models and practice.

The importance of workforce

First Nations peoples have the right to feel confident and safe in accessing the Australian healthcare system. The system responsible for the delivery of quality healthcare to First Nations peoples must be culturally appropriate and clinically sound.[7] The health workforce must therefore be adequately resourced and supported, with considerations for the complex needs of First Nations peoples, especially those living in remote areas.[8] It is equally important that we identify the barriers and enablers within the current workforce that prevent uptake of the recommendations in this guideline, so we can identify areas for improvement.

The 2021–2031 National Aboriginal and Torres Strait Islander Health Workforce Strategic Framework and Implementation Plan[9] has a vision that *"Aboriginal and Torres Strait Islander peoples enjoy long, healthy lives centred in culture, with access to services that are prevention-focused, culturally safe and responsive, equitable and free of racism"*.

The principles enshrined in the Framework have been integrated into the guideline's subsequent chapters.

First Nations health workforce capacity

Workplaces must be free of racism, culturally safe and supportive, and attractive to the First Nations health workforce. The First Nations health workforce has unique insight into the lived experiences of families and communities, support by their knowledge of cultural beliefs, practices, and protocols with First Nations peoples. Health workers possess a cultural intellect that cannot be replicated by mainstream.

Supporting and expanding the skills and knowledge of the First Nations health workforce is critical. The presence and integration of First Nations staff across the entire care system is essential for effective care.

This needs to occur predominately at a primary care level, acknowledging that admission to hospital and transfer back into the community is also important. The roles of First Nations staff are often undervalued within the multidisciplinary team. Scope of practice is often poorly understood, resulting in their expertise being underused.

First Nations Health Workers and Health Practitioners and nurses provide an important service in primary care centres and hospitals, and support members of their local community to navigate the health systems. Appropriate, ongoing professional development and training that is recognised, supported and resourced is essential to achieving this. They must be well supported, with opportunities for mentoring and career advancement to ensure success, best practice and staff retention.

A well-resourced First Nations Community Controlled Health Service is well-placed to provide holistic care for First Nations peoples with ARF and or RHD. This care considers the social and economic context of the patient, and involves social and emotional well-being, trauma informed care, cultural care, legal and family care, and is provided in a culturally safe way. A strengths-based approach has been applied throughout this guideline, which provides case studies and evidence that can be turned into action.[10]

Socio-ecological model

The socio-ecological (or social ecological) model is a framework developed to describe the factors that interact to determine health behaviours of individuals or societies. We have adapted this to depict a socio-ecological model for ARF and RHD (Figure 2.1) which reflects the complex and dynamic interrelationships between systems, people and the guidelines areas. In this model, the individual is central, surrounded by culture, family and the wider community. This has a direct influence on how quality evidence-based care is received and adopted. The social-ecological model:

- Demonstrates that various factors influence health-seeking behaviour patterns.
- Demonstrates the complexities and importance of the relationships and partnerships of the various parts of the health system and community.
- Can help health professionals understand how layers of influence intersect to shape the First Nations person, family and communities in choices about relevant elements of care.

The importance of partnerships between the health system and the community to engage with and implement the recommendations in this guideline is critical and requires ongoing education and training across multiple levels.

Patient journey mapping

Patient journey mapping has been used to highlight the complexities of navigating the health system for First Nations peoples, especially for those living in remote areas who access centralised health services. It has also allowed gaps in care to be identified from a cultural and clinical perspective.[11] The Managing Two Worlds Together mapping tool[12] was used during development of this guideline to identify existing evidence-practice gaps in relation to culture and workforce. Barriers, enablers and solutions to best practice care for people on a journey with ARF or RHD were also reviewed from a cultural and workforce perspective.

CONCLUSION

Clinical practice guidelines should focus on supporting safe and efficient healthcare. It is clear that judgments and decision-making processes during guideline development are central to producing information to support high-quality care.[13] However, guidelines do not always come with high adoptability of recommendations. Only an estimated one-third of the evidence informing guidelines tends to be routinely adhered to,[14] and this is especially true where recommendations are directed to priority groups.

Clinical expertise is important but equally important is the understanding and underpinning of cultural knowledge and workforce issues embedded within guideline development and recommendations.

The Cultural and Workforce Working Group provided First Nations cultural input, and highlighted workforce issues and contextual factors that are critical to the successful implementation of this guideline.

Figure 2.1. Socio-ecological model underpinning the guidelines

Adapted from the Centers for Disease Control and Prevention (CDC), The Social Ecological Model: A Framework for Prevention.[15]

REFERENCES

1 Hansen H, Braslow J, Rohubaugh RM. From Cultural to Structural Competency-Training Psychiatry Residents to Act on Social Determinants of Health and Institutional Racism. Journal American Medical Association Psychiatry. 2018;75(2):117-178.

2 Napier AD, Ancarno C, Butler B, et al. Culture and health. The Lancet. 2014;384(9954):1607-1639.

3 Wyber R, Ralph AP, Bowen AC, et al. Improving primary care for Aboriginal and Torres Strait Islander people with rheumatic heart disease: What can I do? Aust J Gen Pract. 2022;51(12):959-94.

4 Bastos JL, Harios CE, Paradies YC. Health care barriers, racism, and intersectionality in Australia. Social Science and Medicine. 2018;199:209-218.

5 Australian Health Ministers' Advisory Council. Cultural Respect Framework 2016-2026 For Aboriginal and Torres Strait Islander Health. A National Approach to Building a Culturally Respectful Health System. 2016.

6 Commonwealth of Australia Department of Health. National Aboriginal and Torres Strait Islander Health Curriculum Framework. Canberra, 2014.

7 South Australian Health and Medical Research Institute. National Safety and Quality Health Service Standards user guide for Aboriginal and Torres Strait Islander health. Sydney, 2017.

8 Hays R, Gupta TS. Developing a general practice workforce for the future. Australian Journal of General Practice. 2018;47(8):502-505.

9 Australian Health Ministers' Advisory Council. National Aboriginal and Torres Strait Islander Health Workforce Strategic Framework and Implementation Plan 2021–2031. 2022.

10 National Aboriginal Community Controlled Health Organisation. Aboriginal Community Controlled Health Services are more than just another health service — they put Aboriginal health in Aboriginal hands.

11 Kelly J, Dwyer J, MacKeon T, et al. Coproducing Aboriginal patient journey mapping tools for improved quality and coordination of care. Australian Journal of Primary Health. 2016;23(6):536-542.

12 Kelly J, Dwyer J, Pekarsky B, et al. Managing two worlds together: Stage 2 - patient journey mapping tools. Melbourne: Lowitja Institute, 2012.

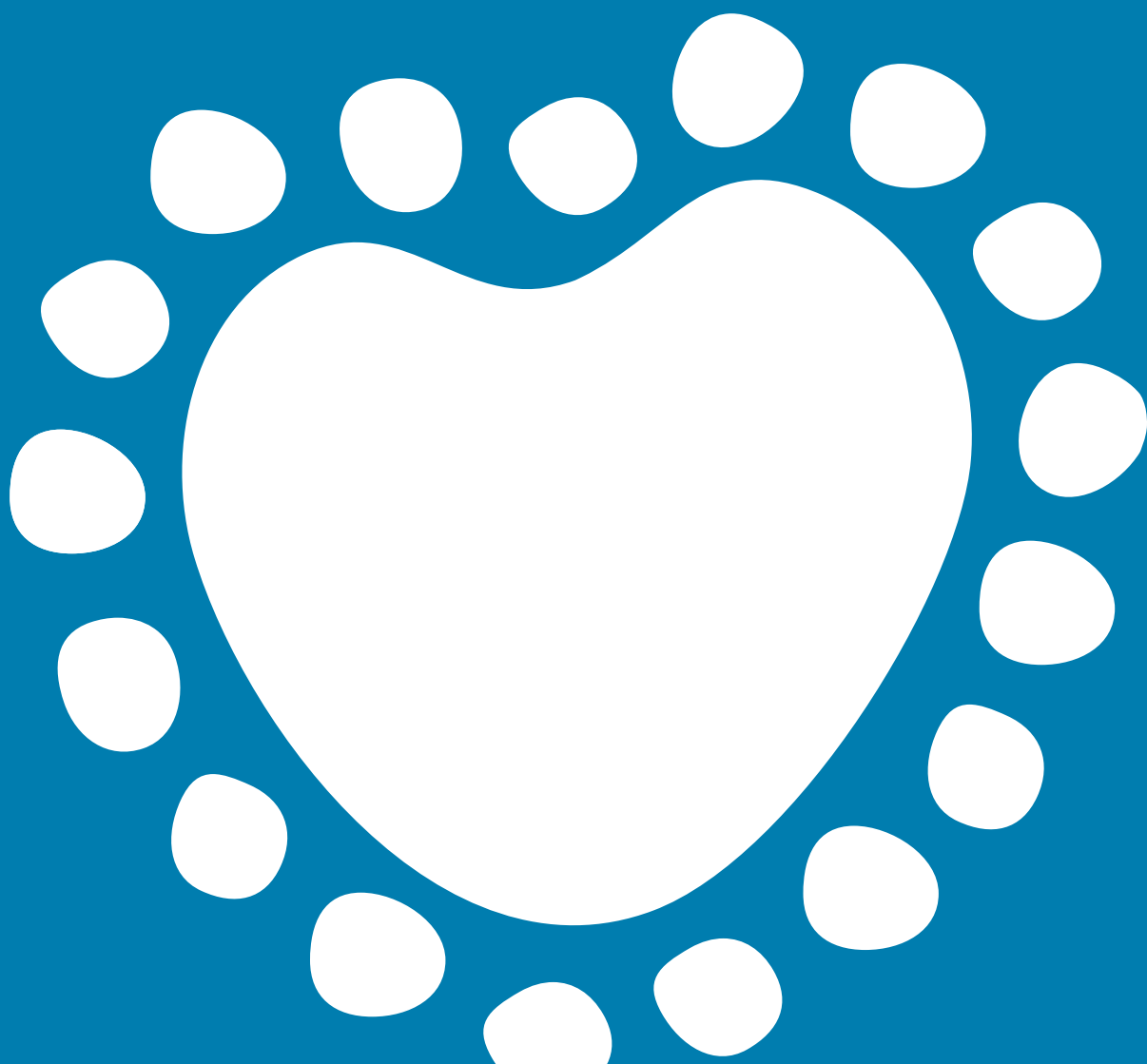
13 Lau R, Stevenson F, Ong BN, et al. Achieving change in primary care-causes of the evidence practice gap: systematic reviews of reviews. Implementation Science. 2016;11:40.

14 Mickan S, Burls A, Glasziou P. Patterns of 'leakage' in the utilisation of clinical guidelines: a systematic review. Postgraduate Medical Journal. 2011;87(1032):670-679.

15 Centers for Disease Control and Prevention. The Social Ecological Model: A Framework for Prevention. 2022.

CHAPTER 3

Burden of acute rheumatic fever and rheumatic heart disease



Burden of acute rheumatic fever and rheumatic heart disease

IMPORTANT CHANGES IN THIS CHAPTER

The following figures and tables and accompanying text have been added or updated from a range of sources:

Figure 3.1. Change in global age-standardised prevalence of RHD, 1990-2013

Figure 3.3. Number of people aged 4 to 74 with ARF and/or RHD identified from hospital and register data sources by population group in SA, NT, WA and Qld 2001-2017

Figures 3.4. ARF and/or RHD diagnoses among First Nations people, by region of management, 31 December 2022

Figure 3.6. People on ARF/RHD Registers, by age group at earliest diagnosis (ARF or RHD) and risk groups, 31 December 2022

Figure 3.7. Number and crude rates of new ARF diagnoses recorded on RHD registers among Australians living in the NT, SA, WA and QLD, by year 2013–2022

Figure 3.8. Age-standardised rates of people with first-ever ARF (<45 years) or new RHD diagnoses (<55 years) from ARF/RHD registers and/or hospital records in SA, NT, WA Qld and NSW 2015-2017

Figure 3.9. ARF incidence and RHD prevalence among First Nations Australians, by age group and sex in SA, NT, WA Qld and NSW 2015-2017

Figure 3.10. Prevalence of ARF and RHD, stratified by age and severity, among First Nations Australians in SA, NT, WA Qld and NSW 2015-2017

Figure 3.12. ARF recurrence by time since initial ARF diagnosis

Figure 3.14. Outcomes after uncomplicated RHD diagnosis in young Australians in SA, NT, WA Qld and NSW 2010-2018

Table 3.1. Percentage of people experiencing complication(s) at various times after first uncomplicated RHD diagnosis (<35-year-olds in SA, NT, WA Qld and NSW 2010-2018)

Figure 3.15. Trends in age specific RHD mortality rates and mortality rate ratios for people with a history of RHD aged <65 years in SA, NT, WA Qld and NSW: 1997 to 2005 vs 2013 to 2017

Figure 3.16. Cause of death for people with a history of RHD aged <65 years in SA, NT, WA Qld and NSW, 2013-2017

Figure 3.18. Total paediatric and adult costs for treating ARF, RHD and associated complications in hospital in SA, NT, WA Qld and NSW for 2012/13 to 2016/17

KEY INFORMATION

- Since the early 1990s, acute rheumatic fever (ARF) in Australia has occurred almost exclusively in young First Nations peoples, particularly in the 5-14-year-old age group.
- During the same period, rheumatic heart disease (RHD) has predominately affected young to middle-aged First Nations peoples as a consequence of the current era of endemic ARF among this population. Older non-Indigenous people with RHD were affected during a past era of endemic ARF.
- After accounting for age difference between populations, the rate of new diagnoses among First Nations peoples in 2015-2017 was 98.7 times higher for ARF and 49.0 times higher for RHD compared with the non-Indigenous population.
- Females are more likely to be diagnosed with ARF and RHD than males.
- The number of First Nations peoples with ARF and RHD is increasing.
- Over a quarter of people diagnosed with ARF or RHD are not recorded on Australian registers. In high-risk areas, many people with RHD are only diagnosed during screening activities.
- The burden of disease often spans the majority of a person's lifetime, starting with ARF in childhood, where ongoing active engagement with the healthcare system is needed for many years and progressing in many cases to RHD and associated heart conditions during adulthood.
- People who have had ARF are more likely to have a recurrence, with one in five people having a recurrent episode of ARF within 10 years of their first.
- There is a high risk of rheumatic valvular damage from a recurrent or single severe episode of ARF; more than half of those with ARF progress to RHD within 10 years of their initial ARF episode, and more than one-third of these people develop severe RHD.
- Almost one quarter of young people initially diagnosed with mild or moderate RHD will progress to a complication within 8 years of diagnosis.
- First Nations peoples with RHD are more likely to die compared to non-Indigenous Australians with RHD; however, the death rates have decreased for all population groups over the past few decades.

INTRODUCTION

This chapter provides an overview of the changing global burden of ARF and RHD over the past century, the strengths and limitations in the data used to inform current estimates, and a demographic summary of the burden of ARF and RHD in Australia.

The writers acknowledge that this section is written in an epidemiological style, and that figures and other statistics represent the loss of health and human life with profound impact and sadness for people, families, community and culture. The 'numbers story' originating from this project will hopefully supplement the 'lived stories' that reflect the voices of people with RHD and their families, jointly contributing to evidence to erase suffering caused by ARF and RHD in Australia.

The global burden of ARF and RHD

The Global Burden of Disease (GBD) study estimated that in 2015, RHD contributed 10.5 million Disability-Adjusted Life Years (DALY) globally, incorporating 33.4 million cases of RHD and 319,499 deaths.[1] Global age-standardised mortality decreased by 47.8% from 1990 to 2015 but large differences were observed across regions.

The majority of ARF and RHD is seen in low- and middle-income countries where more than 80% of the world's ARF cases occur.[2] Global estimates indicate that the burden of RHD is highest among people living in poor-quality housing, followed by rural areas, and is lowest in urban areas.[3] The highest occurrence of disease has been documented in sub-Saharan Africa, where the prevalence of RHD is about 5.7 cases per 1000 children aged 5-14 years old, and in the Pacific at 3.5 cases per 1000 children aged 5-14 years old.[2,4] First Nations Australians, New Zealand Māori and Pacific Islanders are considered to experience the next highest rates of disease. While fewer reliable estimates are available from Asia, a considerable RHD prevalence has been documented, particularly in central and southeast Asian countries.[2,5,6]

The global burden of RHD (Figure 3.1) includes many premature deaths. RHD-attributable deaths usually result from conditions that develop as complications of RHD, such as infective endocarditis, arrhythmia, heart failure and stroke.[5,6] Consequently, accurate estimates for RHD-related deaths are difficult to produce; however, estimates suggest that about 1.5% of people living with RHD are thought to die each year in low-resource settings, where secondary prophylaxis programs are not delivered and management of RHD is limited.[5,6] Premature deaths from RHD are pronounced; in Australia for example, the average age at death from RHD among First Nations peoples was estimated as 44 years.[7] RHD in pregnancy is an important cause of maternal death in low- and middle-income countries,[8] and is also a cause of maternal morbidity among high-risk populations in high-income countries.

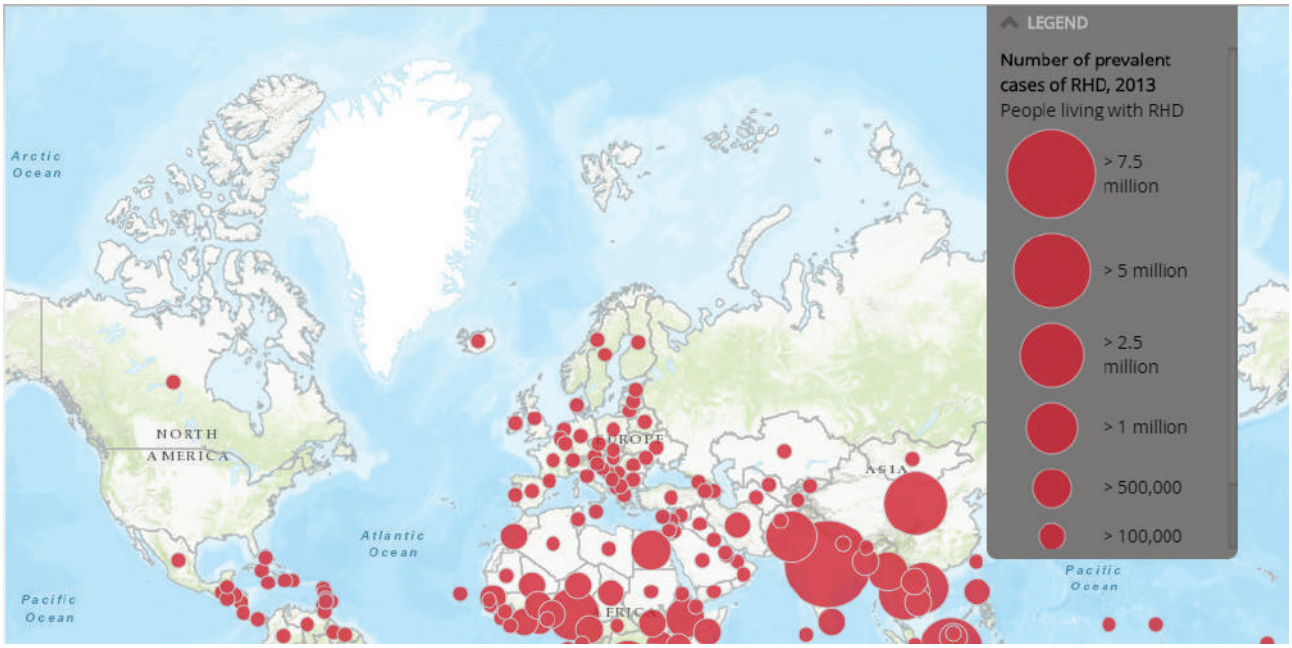


Figure 3.1. Change in global age-standardised prevalence of RHD, 1990-2013, and global number of prevalent cases of RHD, 2013

SOURCE: Carapetis JR, et al. 2016[9]

Historical changes in the burden of ARF and RHD

ARF was once common in children across Europe, North America and the Pacific.[10,11] At the start of the 20th century, ARF was the leading cause of death for people aged 5–20 years old in the USA.[11] Specialised hospital wards cared for very sick children in many high-income countries. Rates of ARF declined in most of these countries during the mid-20th century (with rates of <0.1 case per 100,000 population). The decline of ARF was associated with reductions in household crowding, improvements in socioeconomic conditions, better access to healthcare, and increasingly widespread availability of penicillin to treat streptococcal infections.[12,13] By contrast, high rates of ARF and RHD persist among young people (particularly females) across many low- and middle-income countries, where widespread poverty persists and access to quality secondary and tertiary prevention services is poor.[14]

Many high-income countries have a burden of RHD among older surviving adults who developed ARF in their youth prior to improvements in socioeconomic conditions and antibiotic treatment. Simultaneously, some Indigenous minority populations living in high-income countries continue to be affected by ARF and RHD, including children and young people. To date, Australian First Nations peoples and New Zealand Māori and Pacific Islanders have among the highest rates of ARF in the world and experience an inequitable burden of RHD. These groups experience considerable inequities across a wide range of social, educational and health outcomes compared with the general population.[15–18]

Many First Nations people live in communities that are geographically isolated from decision makers and health care services. Geographical isolation along with past government policies have impacted negatively on health and this has led to some of the highest rates of ARF and RHD of all First Nations people.

Estimating the burden of ARF and RHD

Accurate estimates of the burden of ARF and RHD are difficult to obtain. Such estimates often rely on data available from field studies, predominately echocardiographic screening studies; ARF and RHD disease registers; and general administrative databases of health services. In Figure 3.2. *Model for assessing the burden of RHD* (Zühlke & Steer 2013)[6] highlight the sources of ARF and RHD data globally, including how the burden of RHD can be assessed. The GBD study has produced the most recent global and regional estimates using two analytic tools to statistically model cause of death and prevalence estimates based on the best available published data.[1] No single source provides definitive data; each source has its limitations but contributes to understanding the burden of disease.

Countries with the poorest health services and public health infrastructure are often the worst affected by ARF and RHD. In such countries, people with disease are less likely to access healthcare, receive a diagnosis, or appear on an accessible disease register and 'be counted' within the health system. ARF is often undiagnosed due to the lack of a diagnostic test, and ARF and RHD can go unnoticed, particularly when not causing symptoms.[2] Screening for RHD requires a significant health resource investment, which is not always available.[19,20] Even in countries with well-developed public health infrastructure and record keeping, cases may still be under counted if diagnoses are missed. The widely used International Classification of Diseases, 10th revision, (ICD-10) includes valvular disease of unspecified origin in some of its classifications related to, but not specific for RHD, making such classifications (and medical records coded as such) non-specific to RHD.[21] Consequently, different sources of epidemiological data (both within and between countries) are used to provide indications of the local and global burden of disease – none of which are necessarily complete or accurate.[2]

Hospital admission and death data are regularly used in government reports to estimate ARF/RHD admission and death rates.[22,23] However, these reports use data that are not person-linked (i.e. they do not have a mechanism to identify records that belong to the same individual).

Such hospital data which are not linked within and across the various systems cannot provide accurate information on incidence, prevalence and outcome estimates because longitudinal analyses are not possible.[24] Both linked and unlinked data are affected by miscoding of cases and misdiagnosis.[21]

Disease registers are widely recognised to be an important mechanism to support RHD control. The World Health Organization and the World Heart Federation recommend the implementation of ARF/RHD registers in areas where there is a significant burden of disease. Registers can assist with patient management, treatment delivery and collection of surveillance information.[25–27] RHD control programs, with disease registers, exist in five Australian jurisdictions; however, legislated notification of ARF and RHD is inconsistent (Table 13.1) and under-notification is a known issue.

In Australia, various methods are used to collect and report data on ARF and RHD, including hospital admission and death datasets, disease notification systems, ARF/RHD registers, cardiology clinics and echocardiographic screening studies.

Data analysis is usually conducted within each source and jurisdiction separately, and each system has limitations. For example, hospital and death data are not linked within and between sources, and disease registers may not capture all cases. As a result, data analysis provides a partial picture of the true burden of ARF/RHD within a jurisdiction and nationally. The End Rheumatic Heart Disease in Australia Study of Epidemiology (ERASE) project identified that 31% of Indigenous and 76% of non-Indigenous Australians aged less than 75 years with ARF and/or RHD were not on registers (Figure 3.3).[28]

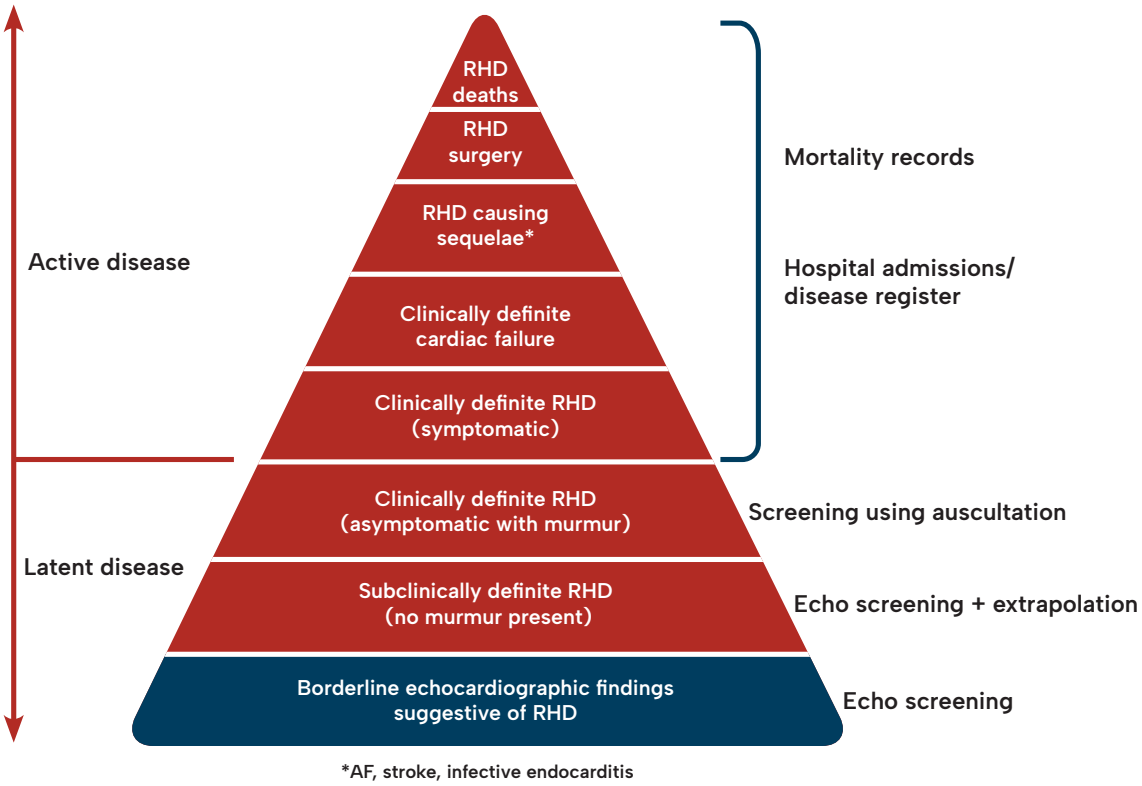


Figure 3.2. Model for assessing the burden of RHD

Adapted from Zühlke et al. 2013[6]

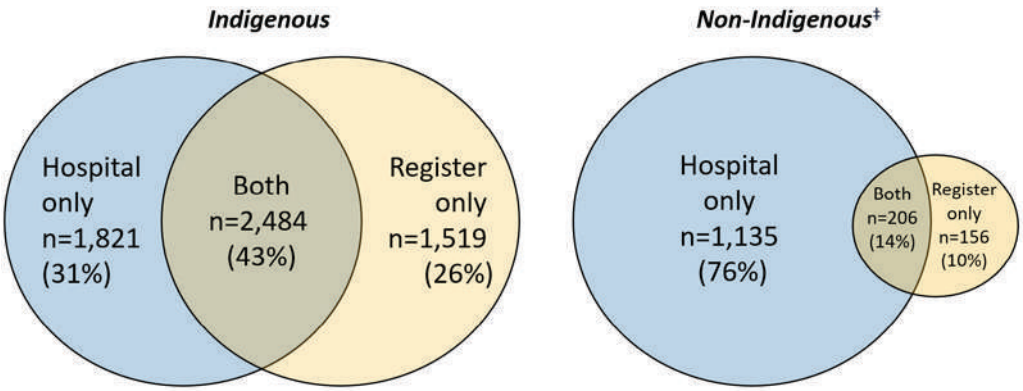


Figure 3.3. Number of people aged 4 to 74 with ARF and/or RHD identified from hospital and register data sources by population group in SA, NT, WA and Qld 2001–2017

‡ This group includes migrants

SOURCE: Agenson T, et al. 2020[29]

BURDEN OF ARF AND RHD IN AUSTRALIA

The following sections include summaries of several different Australian data sources from different time periods that best demonstrate the burden of ARF and RHD in the Australian population, with respect to the size of the problem, age distribution, sub-populations most affected, and significant differences at the population level.

In the past, producing accurate national burden of disease estimates was difficult due to a lack of standardisation in public health surveillance data. The different registers now provide a standard minimum dataset to the Australian Institute of Health and Welfare (AIHW), which allows Australian ARF and RHD data to be comparable between the jurisdictions, and over time, recognising that registers do not capture all cases.[30] Figure 3.4 shows how crude rates of registered ARF and/or RHD are distributed in different regions of five jurisdictions with registers, with the highest rates in the NT, SA, and Northern QLD.

Demographic distribution of ARF and RHD

- Since the early 1990s, ARF has occurred almost exclusively in young First Nations peoples, particularly in the 5-14-year-old age group.
- During the same period, RHD has predominately affected young to middle-aged First Nations peoples because of the current era of endemic ARF among this population, and it has affected older non-Indigenous people due to a past era of endemic ARF.
- Females are more likely to be diagnosed with ARF than males.

Multiple data sources are needed to measure ARF and RHD because data collection systems usually operate independently and are managed by different custodians; they capture different populations, and the type of data collected are based on their differing intended purposes. Record linkage across different datasets increases the utility and comprehensiveness of data related to RHD.[28] This has important implications for future policy regarding the nature of national data management in Australia.

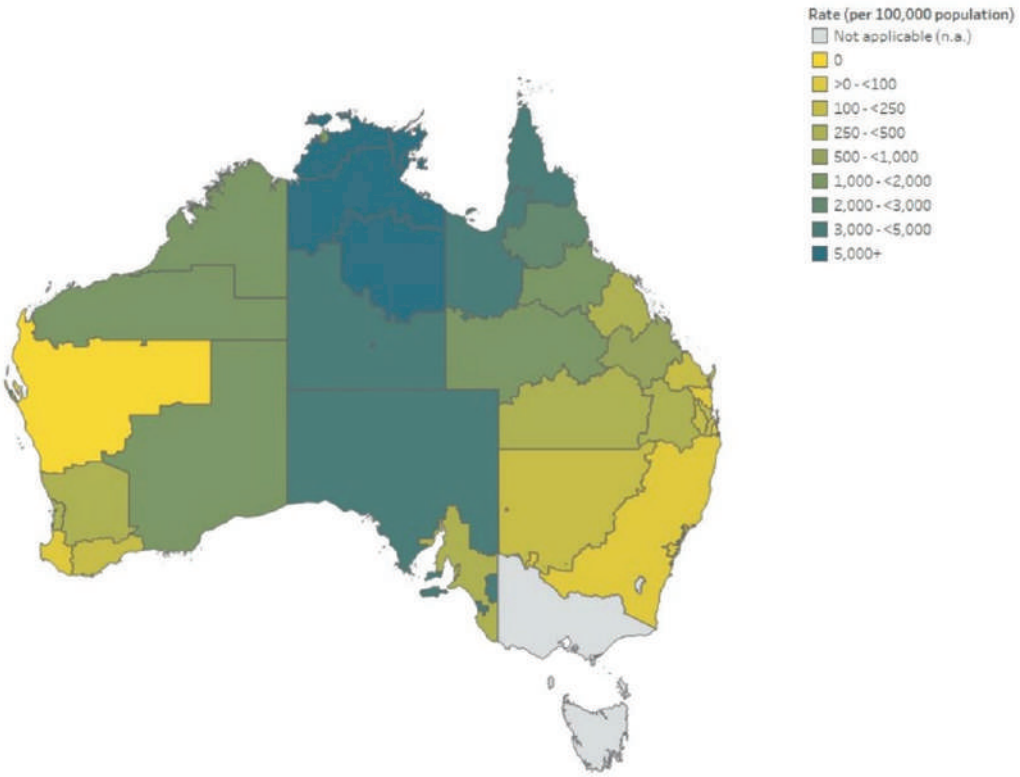


Figure 3.4. ARF and/or RHD diagnoses among First Nations people, by region of management, 31 December 2022

SOURCE: Australia Institute of Health and Welfare, 2024[30]

The following section uses Australian hospital admissions data to illustrate demographic details. This includes Australian data where ARF or RHD was the principal diagnosis recorded for admission (i.e. the main reason for hospitalisation). The numbers reflect the number of admissions, not the number of people. Some people could have been admitted more than once in the time period.

The age distributions for ARF and RHD hospital admissions are very different for First Nations and non-Indigenous people. Points to highlight include:

- High rates of hospital admission for ARF and RHD in the younger First Nations population reflects the ongoing epidemic affecting this population group (Figure 3.5).
- In 2011–2012, First Nations peoples represented 3% of the Australian population but accounted for 16.3% of all admissions for ARF or RHD; they contributed 74.1% of all ARF admissions in Australia, and 8.3% of all RHD admissions;
- The majority (79%) of all admissions for First Nations peoples were in people younger than 35 years, compared with only 7% of non-Indigenous admissions in this age group. In contrast, 78% of non-Indigenous admissions were in people aged over 55 years.
- The high concentration of RHD admissions among First Nations peoples aged under 45 years compared to the relatively low concentration in this age group among non-Indigenous people (Figure 3.5) indicates that:
    - The First Nations population experiences declining survival with RHD into older age, and/or
    - The First Nations population is currently experiencing endemic ARF.
- The age-standardised rate per 1000 hospitalisations for ARF or RHD was 7.2 times higher in First Nations peoples compared with the non-Indigenous population (data not shown), with the highest disparity being in the NT.[31] This finding considers the difference in age distribution between the two populations.

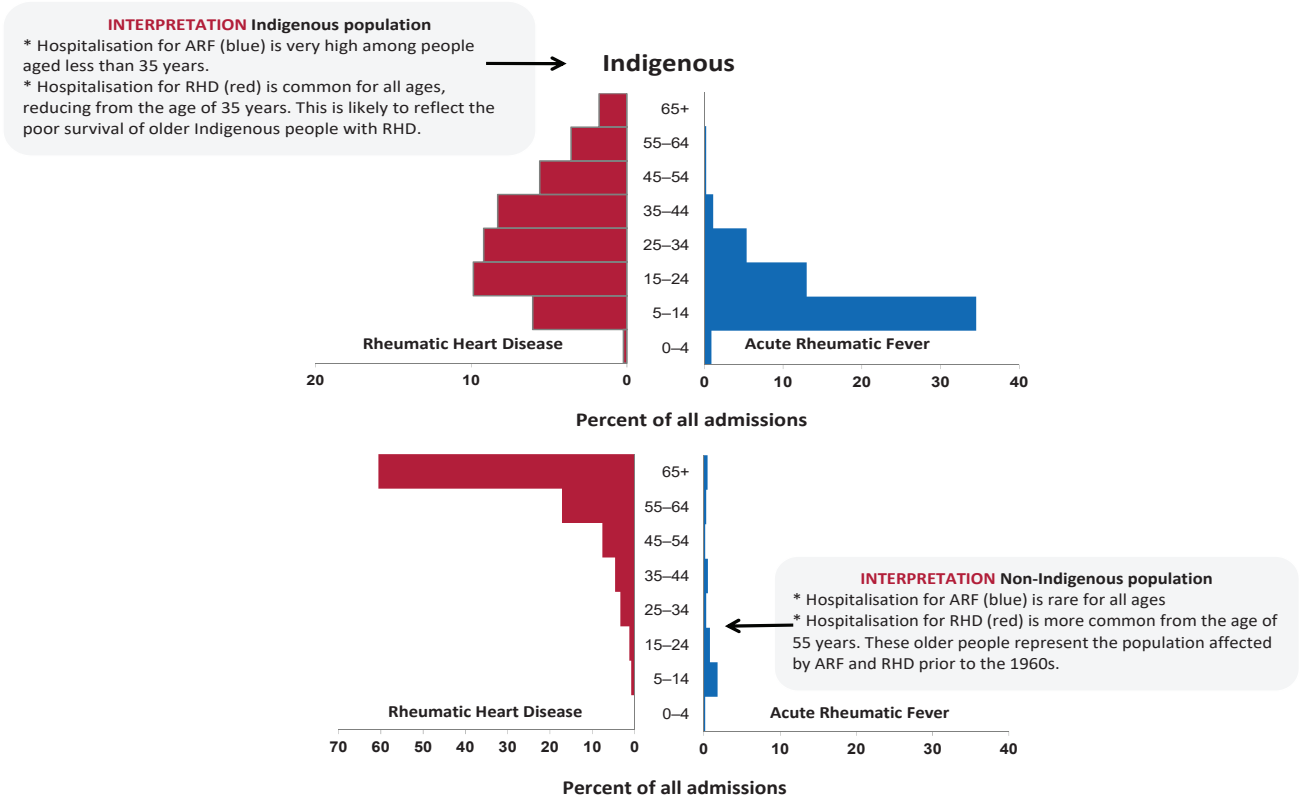


Figure 3.5. All hospital admissions for ARF and RHD by Indigenous status, 2011–2012

SOURCE: Unit record data provided by the Australia Institute of Health and Welfare in 2016.[31]
Graphic created by Dr Judith Katzenellenbogen

Registrations by jurisdiction and ethnicity

On 31 December 2022, there were more than 10,300 people recorded on registers in NSW, NT, QLD, SA and WA living with a diagnosis of ARF and/or RHD.[30]

- The majority (82%) were recorded as being First Nations peoples (Figure 3.6). Of the remaining 18%:
  - 3% were Māori and other Pacific Islander peoples;
  - 3% were from other high RHD prevalence countries;
  - 2% were other non-Indigenous people.
- For all jurisdictional registers combined, the age at registration peaked in the 5-14 year group and reduced with age. This profile reflects the age at which people are first registered (most commonly children with ARF) and is similar for all five jurisdictional registers.
- Registers in the NT and QLD contained the highest number of registrants, accounting for 78% of all people registered for ARF or RHD in Australia. This reflects the high risk of the disease in these jurisdictions.
- The NSW register contained the smallest numbers of registrants, partly due to the relatively recent establishment of the register and the restricted age range for RHD notification <35 years).
- Ethnic distributions varied across the jurisdictions, reflecting the geographical distribution of populations at high risk of ARF/RHD in Australia. For example:
  - First Nations peoples were the largest group on all registers; however, they comprised 96% of NT registrants, 85% of SA registrants, and 42% of NSW registrants.
  - Māori and Pacific Islander peoples comprised 28% of those registered in NSW, reflecting the different ethnicity in NSW compared with other jurisdictions.
- Although there is no register in Victoria, a recent audit of children and adolescents admitted to hospital with ARF and RHD between 2010-2019, found that of the Victorians, the biggest group was Pacific Islanders (45%). First Nations peoples only comprised 10%.[32]

The high frequency of hospital admissions among young First Nation young people highlights the need for a health workforce with specialised skills to provide paediatric and adolescent hospital care which meets the needs of First Nations children and their families.

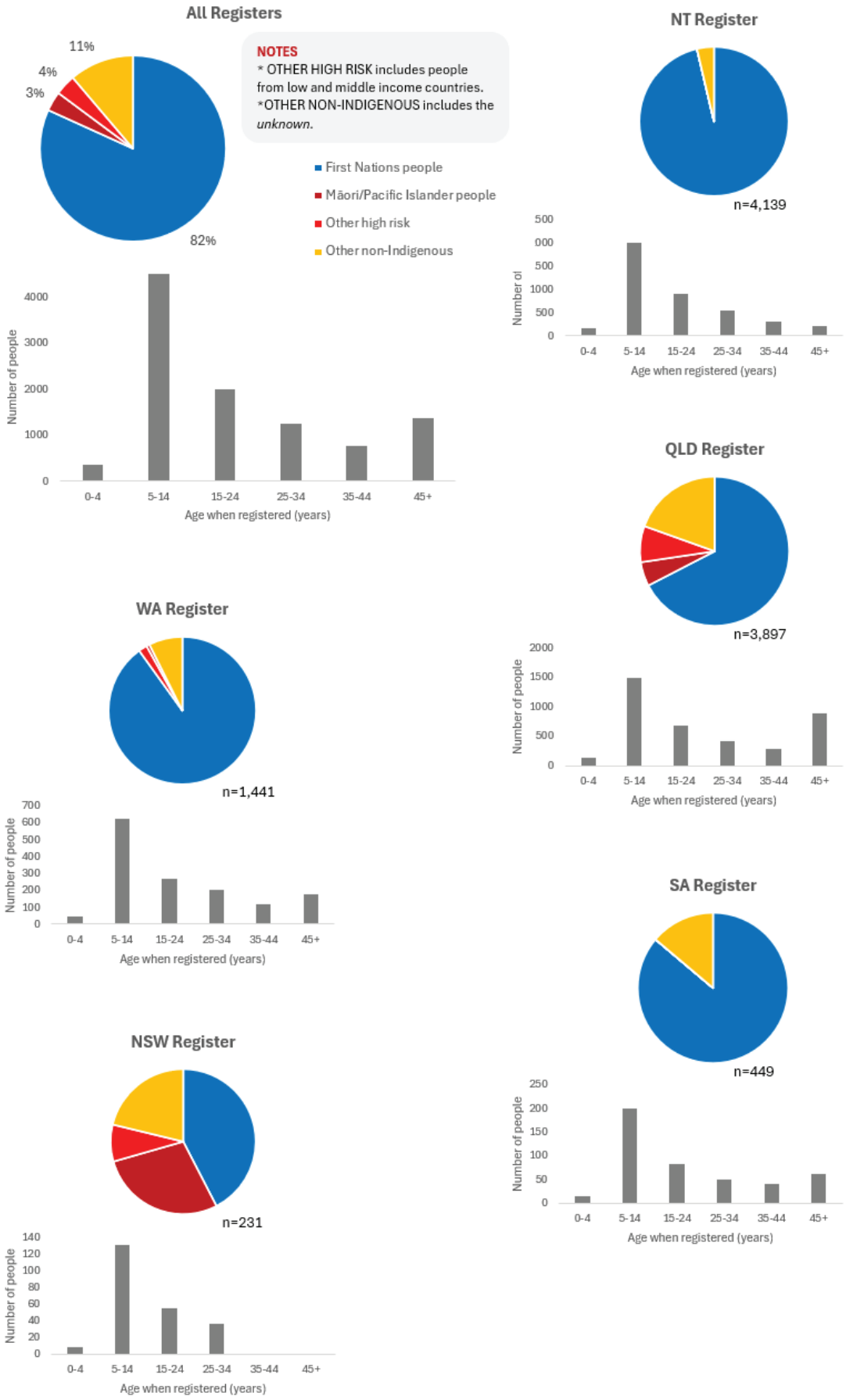


Figure 3.6. People on ARF/RHD Registers, by age group at earliest diagnosis (ARF or RHD) and risk groups, 31 December 2022

SOURCE: Unit record data provided by the Australia Institute of Health and Welfare.[30]
Graphic created by Sara Noonan and Dr Judith Katzenellenbogen

Comparison of disease between First Nations and non-Indigenous Australians

- The number of new ARF diagnoses notified to registers increased between 2013 and 2022 with a slight decrease in 2022 (Figure 3.7).[30]
- When using newly registered diagnoses to calculate rates, rates of ARF among First Nations peoples were substantially higher than non-Indigenous rates. These (crude) rates do not account for age differences between First Nations and non-Indigenous populations.
- Linked ERASE data (2015-2017) found that after accounting for age differences, Indigenous ARF rates were 98.7 times higher and RHD rates were 49.0 times higher among First Nations than among other Australians. (Figure 3.8).[33]
- The incidence of new ARF diagnoses is highest in the NT.[30,34] This likely reflects a combination of two factors: a large high-risk population and long-established processes for case ascertainment and registration (data not shown).

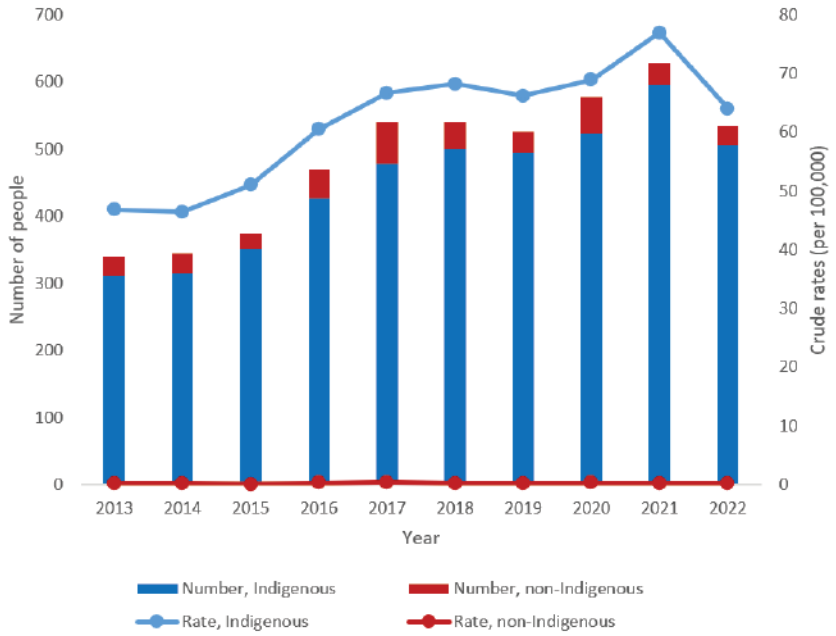


Figure 3.7. Number and crude rates of new ARF diagnoses recorded on RHD registers among Australians living in the NT, SA, WA and QLD, by year 2013–2022

SOURCE: Australian Institute of Health and Welfare. 2024[30]

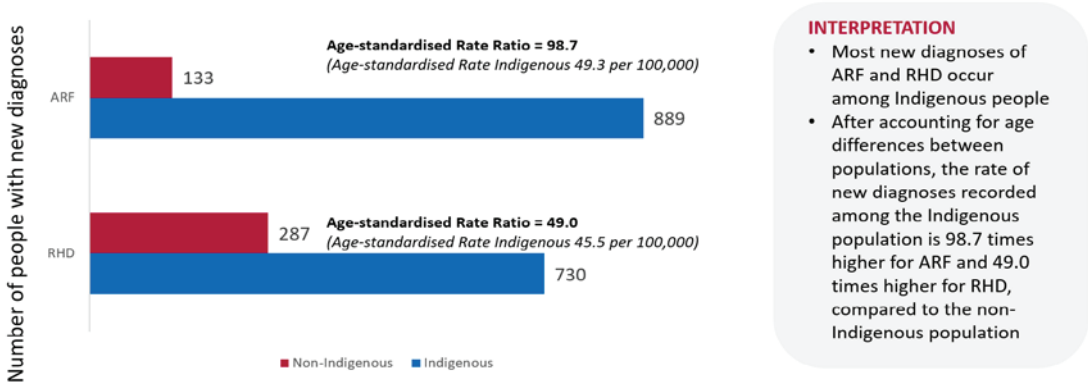


Figure 3.8. Age-standardised rates of people with first-ever ARF (<45 years) or new RHD diagnoses (<55 years) from ARF/RHD registers and/or hospital records in SA, NT, WA Qld and NSW 2015-2017

SOURCE: Katzenellenbogen JM, et al. 2020[33]

Patterns of disease among First Nations peoples

The burden of disease often spans the majority of a person's lifetime, starting with ARF in childhood, where ongoing active engagement with the healthcare system is needed for many years, and progressing in many cases to RHD and associated heart conditions during adulthood.

The number of First Nations peoples affected by ARF and RHD appears to be increasing, although increased awareness and case identification may be driving this observation rather than true increase in incidence.

Incidence and prevalence of ARF and RHD by age and sex

For some analyses in this section, not all cases on the RHD registers were included because only hospital data were used, and registration data were not linked. Therefore, numbers do not include people who were not admitted to hospital. ERASE data includes both sources.

- ARF incidence peaks at age 5–14 years and reduces after the age 15 years; it is rare at ages older than 35 years (Figure 3.9). Females experience ARF incidence at higher rates than men after adolescence.
- RHD prevalence increases steadily with age and peaks at 35–44 years. Many of the young people with severe RHD who are hospitalised do not survive to old age. Women aged over 15 years' experience a higher burden of RHD, including severe disease, than men.
- During 2015–2017, there were 5,121 First Nations peoples who had been notified to RHD registers or hospitalised for ARF or RHD across the NT, SA, QLD, NSW and WA (Figure 3.10). Over 70% with ARF were aged under 25 years old.
- This means more than 1% of the First Nations population under 65 years in these jurisdictions combined have a history of ARF or RHD. When considering only the NT and SA combined, this estimate is more than 2% of the population.
- Of all First Nations peoples aged under 64 years with RHD, 32% had severe RHD notified to a RHD register or had been hospitalised for heart failure or had a heart valve procedure.

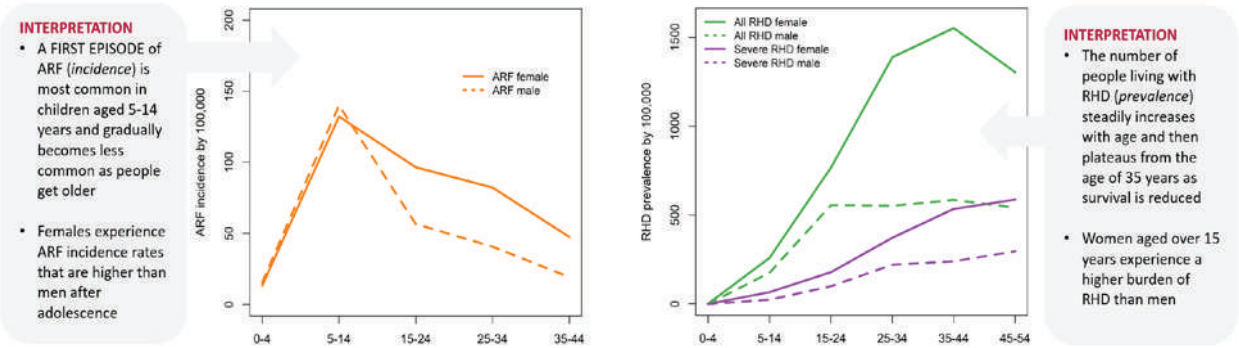


Figure 3.9. ARF incidence and RHD prevalence among First Nations Australians, by age group and sex in SA, NT, WA, Qld and NSW 2015–2017

SOURCE: Katzenellenbogen JM, et al. 2020[33]

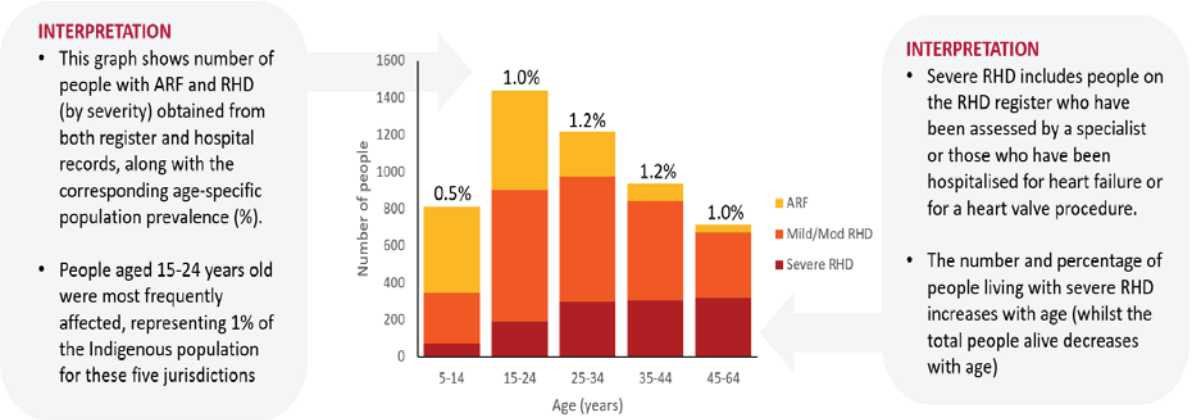


Figure 3.10. Prevalence of ARF and RHD, stratified by age and severity, among First Nations Australians in SA, NT, WA Qld and NSW 2015–2017

SOURCE Katzenellenbogen JM, et al. 2020[33]

Trends in First Nations registration

- Figure 3.11 shows how ARF incidence (new and recurrent episodes) increased in the NT among First Nations population between 2006 and 2015 overall after the 1997 establishment of the register program, with the highest increase in the 5–14-year age group.
- Since the establishment of RHD Control programs in other jurisdictions, the annual number of new notifications of ARF has increased and new RHD notifications are stable among <35-year-olds.[35] This is likely to reflect an increase in case ascertainment due to legislated notification and improved clinical awareness. True changes in rates of ARF and RHD are unlikely to be fully understood until the level of case ascertainment stabilises.

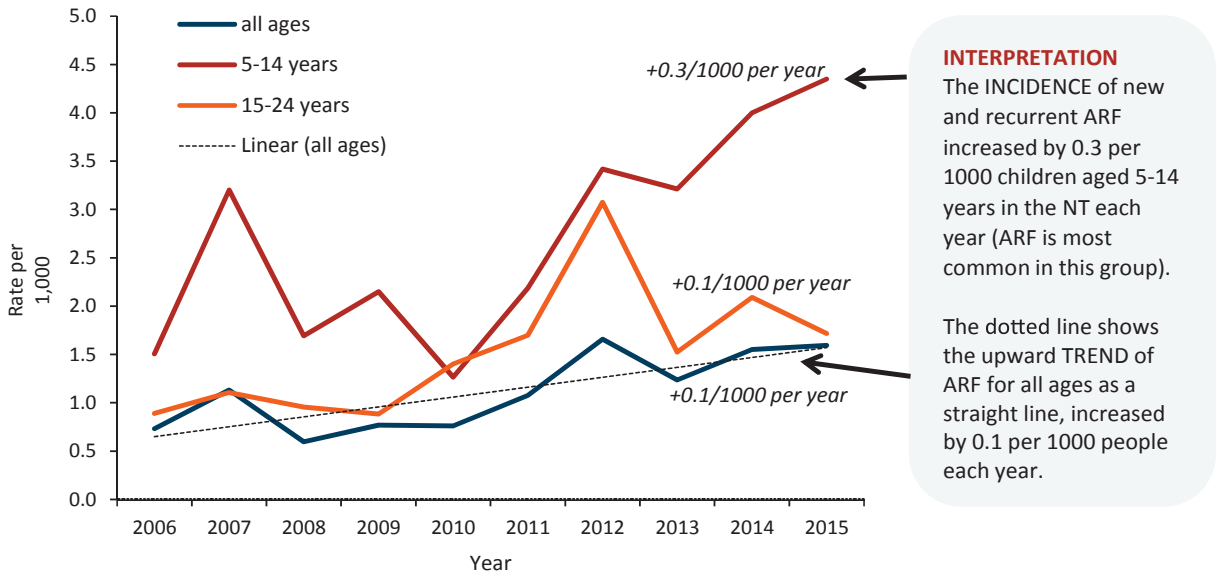


Figure 3.11. Incidence (new and recurrent) of ARF in the Northern Territory, First Nations Australians by age group, 2006 to 2015

SOURCE: Australian Institute of Health and Welfare, 2017.[31]

Progression and complications of disease

People with ARF are prone to a further episode, with one in five (20%) having a recurrent episode within 10 years of their initial ARF episode (NT data, 1997–2003).[36]

ARF recurrence rates have been stable over time, with one in ten persons experiencing recurrent ARF within 2 years of their initial ARF episode (SA, NT, WA, Qld, NSW data, 2010–2016).[35]

There is a high risk of valvular damage (RHD) from a recurrent or single severe episode of ARF; more than half of people with ARF progress to RHD within 10 years of their initial ARF episode, and more than one-third of these people develop severe RHD.[36]

Approximately 8% of young people diagnosed with uncomplicated RHD will experience heart failure resulting from RHD within 8 years of their diagnosis; 16% will require heart surgery.[37]

High recurrence of ARF highlights the need for Australia's primary health care system to strengthen partnerships with people with ARF and their families around disease education, secondary prophylaxis, and managing ongoing risk of ARF.

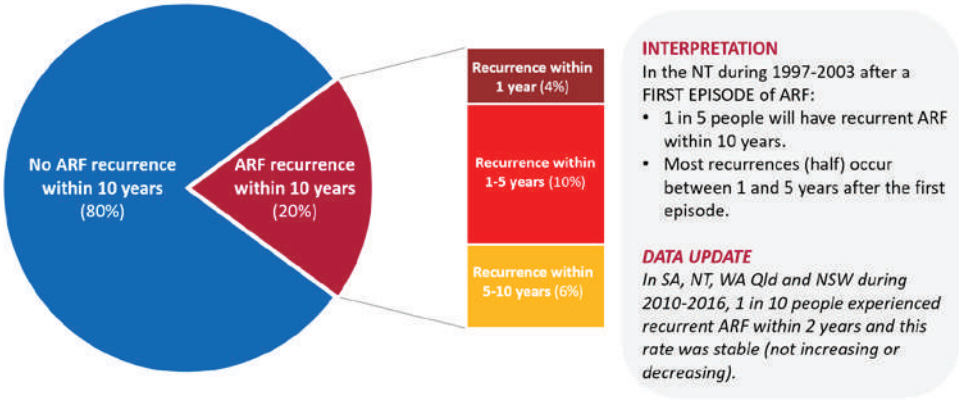


Figure 3.12. ARF recurrence by time since initial ARF diagnosis

SOURCES: 1. He VYF, et al. 2016[36], 2. Stacey I, et al. 2023[35]

Progression of ARF to RHD

- More than a quarter (27%) of people experiencing their first ARF episode in NT and free of RHD at that time developed RHD within a year of their ARF diagnosis. By five years, 44% had developed RHD. More than half (52%) had progressed to RHD within 10 years.
- Among people diagnosed with RHD in NT, 10% had severe RHD when first diagnosed. By one year after first RHD diagnosis, that figure had doubled to 20%. By 10 years, more than one-third (35%) had severe RHD.
- These findings highlight the importance of secondary prevention.

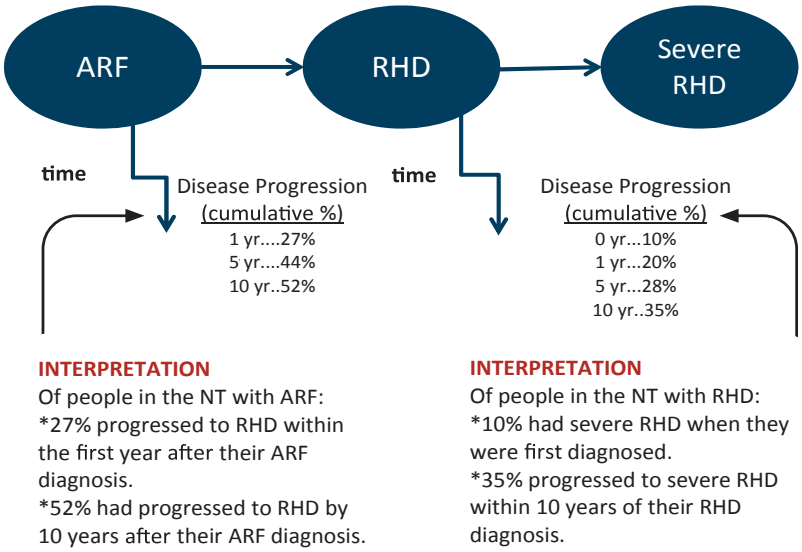


Figure 3.13. Progression of ARF to RHD and RHD to severe RHD, Northern Territory 1997–2013

SOURCES: He VYF, et al. 2016[36]

Complications of RHD

- Based on NT RHD register data linked to hospital and death records for 1997–2013, the incidence of all adverse outcomes of RHD, except death, was highest in the first year after RHD was diagnosed (Figure 3.13). Death rates increased with time after RHD diagnosis, starting from a low base at one year (0.5%) and reaching 10% by the 10-year mark (data not shown).
- In a larger study based on RHD register, hospital and death data from SA, NT, WA, Qld and NSW data for 2010–2018, one quarter of Australians aged <35 years with initially uncomplicated RHD experienced a complication within 8 years (Figure 3.14). A higher risk of complication was associated with age >15 years at first RHD diagnosis and living in a metropolitan area. Known history of ARF was associated with a lower risk of experiencing a complication of RHD.
- During the study, 3% died, 16% required valvular surgery and 8% experienced heart failure (Table 3.1).

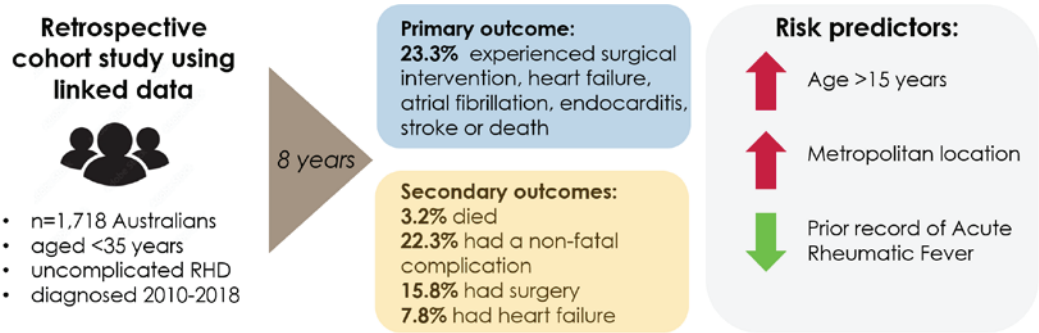


Figure 3.14. Outcomes after uncomplicated RHD diagnosis in young Australians in SA, NT, WA Qld and NSW 2010–2018

SOURCES: Stacey I, et al. 2021[37]

Table 3.1. Percentage of people experiencing complication(s) at various times after first uncomplicated RHD diagnosis (<35-year-olds in SA, NT, WA Qld and NSW 2010-2018)

	TIME AFTER DIAGNOSIS	ATRIAL FIBRILLATION, HEART FAILURE, SURGERY, STROKE OR INFECTIVE ENDOCARDITIS†	SURGERY	HEART FAILURE	DEATH
Percentage experiencing outcome‡ §	6 months	7.7% (6.5-9.1%)	5.5 % (4.5-6.7%)	2.7% (2.0-3.5%)	0.4% (0.1-0.7%)
	1 year	9.8% (8.4-11.3%)	7.2% (6.1-8.6)	3.2% (2.5-4.2%)	0.7% (0.3-1.0%)
	5 years	18.0% (16.0-20.3%)	12.9 % (11.2-14.9%)	6.2% (5.0-7.7%)	2.1 % (1.3-3.0%)
	8 years	22.3% (19.0-26.1%)	15.8% (13.3-18.7%)	7.8% (6.2-9.8%)	3.2% (1.6-4.8%)

† Composite outcome of all non-fatal complications measured.
‡ Any individual can have one or more of these outcomes.
§ Brackets reflect 95% confidence intervals. Narrower confidence intervals indicate higher certainty in the value presented, wider confidence intervals indicate less certainty in the value presented.
SOURCE: Stacey I et al. 2021[37]

Death rates

In this section, premature deaths due to RHD are measured as a rate for 2013-2017 and compared to previous estimates from 1997-2005. The cause of premature death for people previously diagnosed with RHD is also investigated.

- Premature RHD death rates among First Nations peoples have decreased over recent decades. The differential in premature RHD deaths between First Nations peoples and non-Indigenous Australians has also decreased, representing a partial "Closing of the Gap" (Figure 3.15).
- Despite this progress, young First Nations peoples still experience 18.8 times higher premature death rates due to an underlying cause of RHD than non-Indigenous Australians (Figure 3.15).
- The AIHW reported 595 deaths from any cause among people with notified RHD during 2017-2021, of which 64% were First Nations peoples.[38]
- Among persons with a previous RHD diagnosis who died during 2013-2017 before the age of 65 years, only 15% had RHD recorded as the underlying cause of death. Most people with RHD who died prematurely in this period had a non-cardiovascular cause of death (43%), highlighting the importance of also managing concomitant comorbidities in people with RHD (Figure 3.16).

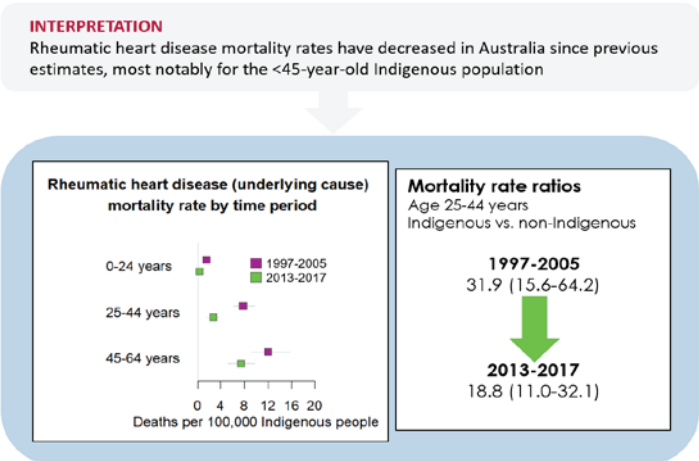
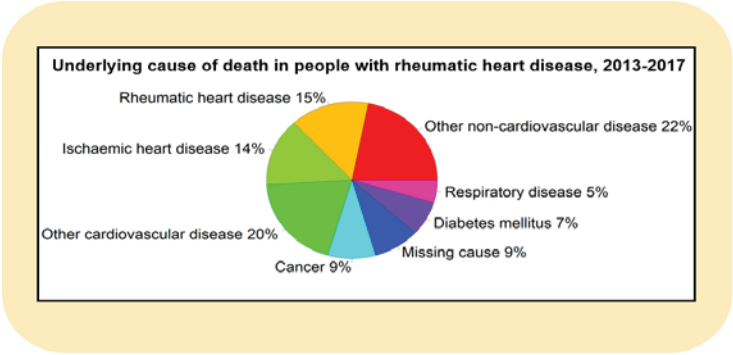


Figure 3.15. Trends in age specific RHD mortality rates and mortality rate ratios for people with a history of RHD aged <65 years in SA, NT, WA Qld and NSW: 1997 to 2005 vs 2013 to 2017

SOURCES: 1. Stacey I, et al. 2023 [1997-2005 data][39], 2. Colquhoun SM, et al. 2015[40]



INTERPRETATION
Among people with rheumatic heart disease who died between 2013-2017, 15% had rheumatic heart disease as underlying cause of death and 43% had non-cardiovascular disease cause of death

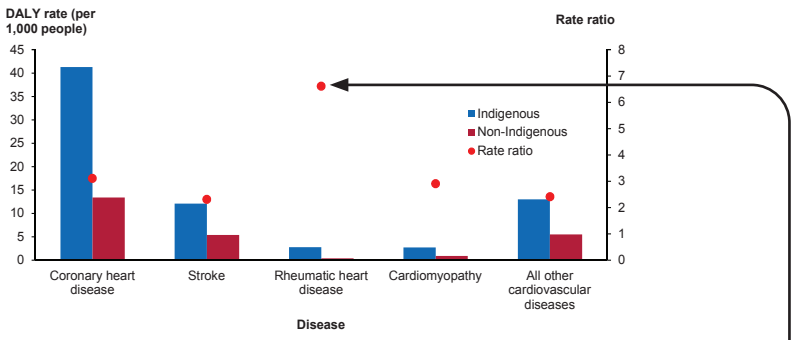
Figure 3.16 Cause of death for people with a history of RHD aged <65 years in SA, NT, WA Qld and NSW, 2013–2017
SOURCE: Stacey I, et al. 2023[39]

Burden of RHD in Disability-Adjusted Life Years

The Disability-Adjusted Life Year (DALY) is a complex measure of population health that estimates the total years of healthy life lost due to disease and injury. The DALY adds the number of years of life lost to death (YLL, fatal burden) and years of life lost to disability (YLD, non-fatal burden) that is weighted according to the disability for that condition. The Australian Burden of Disease Study[32] used hospital and death data to estimate the burden of ARF and RHD. The approach used does not differentiate between ARF and RHD, thus results reflect the combined ARF and RHD burden. Most of the results in this section focus on First Nations peoples.

- RHD makes a minor contribution to the overall cardiovascular disease burden in the Australian population, with non-rheumatic valvular heart disease making a more substantial contribution.
- The high burden of ARF and RHD in the First Nations population is over-shadowed at the national level due to this group being a small proportion of the general population. Consequently, the focus in this section is on the RHD burden in the First Nations population.
- As with other cardiovascular disease, the fatal contribution (YLL) is much higher than the non-fatal.
- RHD contributed to a small proportion of all First Nations heart disease burden (5.1%), however, unlike other forms of heart disease it is common among children and young adults.
- The RHD burden due to premature death (fatal burden, 83.6% of total RHD burden) was much greater than the burden from illness/disability (non-fatal burden), although the non-fatal proportion was still higher than that for other cardiovascular disease.
- Females contributed 61% of all RHD burden, reflecting the well-documented higher prevalence of RHD among women (data not shown).
- RHD ranked higher among women than among men as a contributor to the overall gap between First Nations and non-Indigenous Australians (data not shown).
- Once age was considered, the RHD DALY rate in First Nations peoples was 6.6 times higher than that in the non-Indigenous population. This was the highest relative gap among all cardiovascular disease and the fifth highest relative gap of all specific diseases reported (data not shown).

High rates of RHD among women highlight the need for a skilled female health workforce, including First Nations Health Workers and Health Practitioners, Practitioners, nurses, midwives and doctors.



INTERPRETATION
*The blue charts show the DALY burden rates of different cardiovascular diseases (CVD) for Indigenous Australians.
* The red charts show the rates for non-Indigenous Australians.
* RHD rates are the charts in the middle.
* The Indigenous rates are higher for all types of CVDs.

INTERPRETATION
The orange dots (rate ratios) show how many times higher the Indigenous rates are compared with non-Indigenous rates.
* Here, the Indigenous burden for RHD is 6.6 times higher than the non-Indigenous burden (taking into account age differences between the populations).

Figure 3.17. Cardiovascular diseases age-standardised DALY rates (per 1000 people) by disease and Indigenous status, 2011

SOURCE: Australian Institute of Health and Welfare, 2016.[31]

Real world and projected costs of treating ARF and RHD

Real-world hospitalisation costs were measured using ERASE data and estimated actual costs associated with treating ARF, RHD and complications during 2012-2017.

The estimations of future RHD burden and costs[41] used several stages of data analysis and were calculated based on known disease rates and trends, projections of estimated population size and distribution in 2031, knowledge about disease progression, and estimated cost of managing existing and new cases.

Real-world impact of treating ARF and RHD, and complications

- The total five-year hospitalisation costs for NT, SA, WA, Qld and NSW during the 2012/13 to 2016/17 period was $130.6m - $17.6m for paediatric admissions, and $113.0m for adult admissions (Figure 3.18).
- Over the 5-year study period, 791 children aged <16 years, and 2,761 adults aged 16-64 years, were hospitalised for ARF, RHD or complications (heart failure, atrial fibrillation, infective endocarditis, stroke or valvular surgery).
- On average there were 296 paediatric admissions per year, which increased 6.1% annually.
- On average there were 1442 adult admissions per year, which increased 1.7% annually.
- Paediatric costs were mostly for ARF-related admissions, which correlates with the peak incidence of ARF at ages 5-14 years; adult costs were mostly for admissions involving valvular surgery.
- Emergency admissions and air ambulance transfers were common, particularly for non-metropolitan residents.

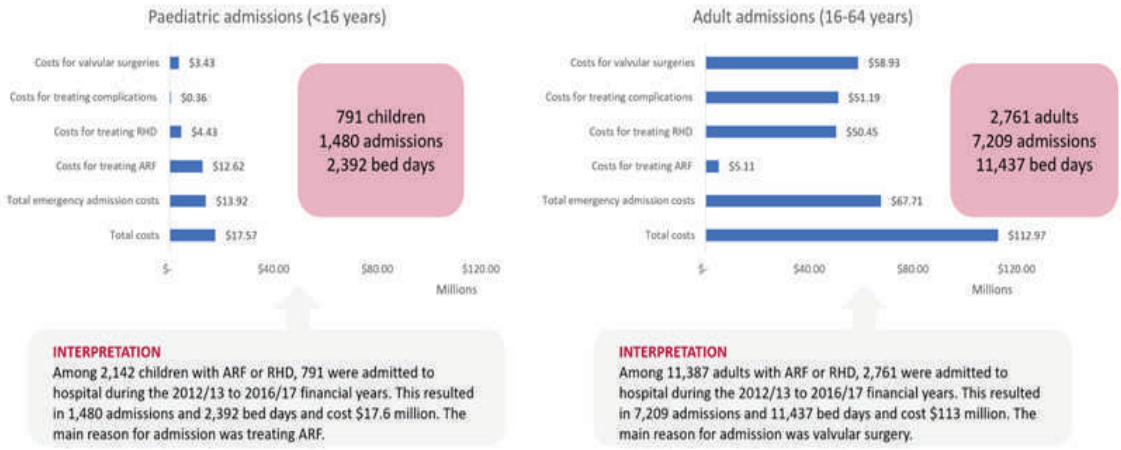


Figure 3.18. Total paediatric and adult costs ($ million) for treating ARF, RHD and associated complications in hospital in SA, NT, WA Qld and NSW for 2012/13 to 2016/17

SOURCE: Stacey I, et al. 2024.[43]

Projected medical costs of ARF and RHD for 2016–2031

- 10,211 new cases of ARF or RHD are projected to occur in the NT, SA, QLD and WA between mid-2016 and the year 2031. These cases comprise 4,885 and 5,326 people who are projected to be hospitalised with ARF or with RHD without a history of ARF, respectively.
- Of the 4,885 people projected to be diagnosed with ARF, most of whom will be children aged under 15 years, 2,535 are estimated to subsequently progress to RHD.
- 2,260 of the people who develop RHD are estimated to be diagnosed with or progress to severe RHD, which includes 1,370 people who will require valvular surgery.
- Future medical care for the 3,420 people currently with ARF or RHD under active treatment and the 10,211 people projected to develop ARF and RHD between mid-2016 and the year 2031 (considered potentially avoidable) is estimated to cost the Australian health system at least $27 million and $317 million, respectively.[42]
- Children projected to develop ARF between the ages of 5 to 14 years, including those who progress to RHD, will incur the highest medical cost.

The forecast increase of ARF and RHD in Australia highlights the importance of a skilled health workforce, including First Nations Health Workers and Health Practitioners, nurses, midwives and doctors. It also highlights the need for a well-equipped and responsive health system.

REFERENCES

1 Watkins DA, Johnson CO, Colquhoun SM, et al. Global, Regional, and National Burden of Rheumatic Heart Disease, 1990–2015. N Engl J Med. 2017;377:713-722.

2 Carapetis JR, Steer AC, Mulholland K, Weber M. The global burden of group A streptococcal diseases. The Lancet Infectious Diseases. 2005;5(11):685-694.

3 World Health Organization. The Current Evidence for the Burden of Group A Streptococcal Diseases. Geneva Switzerland, 2005.

4 Colquhoun SM, Kado JH, Reményi B, et al. Echocardiographic screening in a resource- poor setting: Borderline rheumatic heart disease could be a normal variant. International Journal of Cardiology. 2014;173(2):284-289.

5 Zühlke LJ, Beaton A, Engel ME, et al. Group A Streptococcus, Acute Rheumatic Fever and Rheumatic Heart Disease: Epidemiology and Clinical Considerations. Current Treatment Options in Cardiovascular Medicine. 2017;19(2):15.

6 Zühlke LJ, Steer AC. Estimates of the global burden of rheumatic heart disease. Global Heart. 2013;8(8):189-195.

7 Parnaby MG, Carapetis JR. Rheumatic fever in Indigenous Australian Children. Journal of Paediatrics and Child Health. 2010;46(9):527-533.

8 Sawhney H, Aggarwal N, Suri V, Vasishta K, Sharma Y, Grover A. Maternal and perinatal outcome in rheumatic heart disease. International Journal of Gynecology and Obstetrics. 2003;80(1):9-14.

9 Carapetis JR, Beaton A, Cunningham MW, et al. Acute rheumatic fever and rheumatic heart disease. Nat Rev Dis Primers. 2016;2:15084.

10 Sullivan E, Vaughan G, Li Z, et al. The high prevalence and impact of rheumatic heart disease in pregnancy in First Nations populations in a high income setting: a prospective cohort study. BJOG. 2020;127(1):47-56.

11 Hajar R. Rheumatic Fever and Rheumatic Heart Disease a Historical Perspective. Heart Views. 2016;17(3):120-126.

12 Gordis L. The virtual disappearance of rheumatic fever in the United States: lessons in the rise and fall of disease. T. Duckett Jones memorial lecture. Circulation. 1985;72(6):1155-1162.

13 Bland EF. Rheumatic fever: the way it was. Circulation. 1987;76(6):1190-1195.

14 Zühlke L, Engel ME, Karthikeyan G, et al. Characteristics, complications, and gaps in evidence-based interventions in rheumatic heart disease: The Global Rheumatic Heart Disease Registry (the REMEDY study). European Heart Journal. 2015;36(18):1115-1122a.

15 Baker M, Goodyear R, Telfar Barnard L, Howden-Chapman P. The distribution of household crowding in New Zealand: An analysis based on 1991 to 2006 Census data. Wellington NZ: He Kainga Oranga/ Housing and Health Research Programme. University of Otago; 2012.

16 Baker MG, Barnard LT, Kvalsvig A, et al. Increasing incidence of serious infectious diseases and inequalities in New Zealand: a national epidemiological study. The Lancet. 2012;379(9821):1112-1119.

17 World Health Organization. Closing the gap in a generation: health equity through action on the social determinants of health. Final Report of the Commission on Social Determinants of Health. Geneva Switzerland, 2008.

18 Carapetis JR, Zühlke L, Taubert K, Narula J. Continued challenge of rheumatic heart disease: The gap of understanding or the gap of implementation? Global Heart. 2013;8(8):185-186.

19 Grimaldi A, Ammirati E, Mirabel M, Marijon E. Challenges of using ultrasounds for subclinical rheumatic heart disease screening. International Journal of Cardiology. 2013;167(6):3061.

20 Mirabel M, Bacquelin R, Tafflet M, et al. Screening for rheumatic heart disease: evaluation of a focused cardiac ultrasound approach. Circulation Cardiovascular Imaging. 2015;8(1):e002324.

21 Katzenellenbogen JM, Nedkoff L, Canon J, et al. Low positive predictive value of ICD-10 codes in relation to rheumatic heart disease: a challenge for global surveillance. Internal Medicine Journal. 2019;49(3):400-403.

22 Australian Health Ministers' Advisory Council. Aboriginal and Torres Strait Islander Health Performance Framework 2014 Report: detailed analyses. AIHW, Canberra, 2015.

23 Australian Institute of Health and Welfare. Rheumatic heart disease and acute rheumatic fever in Australia: 1996–2012. CVD series. Cat. no. CVD 60. AIHW, Canberra, 2013.

24 Katzenellenbogen JM, Ralph AP, Wyber R, Carapetis JR. Rheumatic heart disease: infectious disease origin, chronic care approach. BMC Health Services Research. 2017;17(1):793.

25 RHDAustralia. Rheumatic Heart Disease Control Programs. 2018.

26 Reményi B, Carapetis J, Wyber R, et al. Position statement of the World Heart Federation on the prevention and control of rheumatic heart disease. Nature Reviews Cardiology. 2013;10(5):284-292.

27 Oliver J, Baker MG, Pierse N, Carapetis J. Comparison of approaches to rheumatic fever surveillance across Organisation for Economic Co-operation and Development countries. Journal of Paediatrics and Child Health. 2015;51(11):1071-1077.

28 Katzenellenbogen JM, Bond-Smith D, Cunneen R, et al. The End Rheumatic Heart Disease in Australia Study of Epidemiology (ERASE) Project: data sources, case ascertainment and cohort profile. Clinical Epidemiology. 2019;11:997-1010.

29 Agenson T, Katzenellenbogen JM, Seth R, et al. Case Ascertainment on Australian Registers for Acute Rheumatic Fever and Rheumatic Heart Disease. Int J Environ Res Public Health. 2020;17(15):5505.

30 Australian Institute of Health and Welfare. Acute rheumatic fever and rheumatic heart disease in Australia. Cat. no: CVD 100. Australian Institute of Health and Welfare, Canberra, 2024.

31 Australian Institute of Health and Welfare. Australian Burden of Disease Study: Impact and causes of illness and death in Aboriginal and Torres Strait Islander people 2011. Australian Institute of Health and Welfare, Canberra, 2016.

32 Lindholm DE, Whiteman IJ, Oliver J, et al. Acute rheumatic fever and rheumatic heart disease in children and adolescents in Victoria, Australia. J Paediatr Child Health. 2003;59:352-359.

33 Katzenellenbogen JM, Bond-Smith D, Seth RJ, et al. Contemporary Incidence and Prevalence of Rheumatic Fever and Rheumatic Heart Disease in Australia Using Linked Data: The Case for Policy Change. J Am Heart Assoc. 2020;9(19):e016851.

34 Australian Institute of Health and Welfare. Aboriginal and Torres Strait Islander health performance framework 2017: supplementary online tables. Cat. no. WEB 170. AIHW, Canberra, 2017.

35 Stacey I, Ralph A, de Dassel J, et al. The evidence that rheumatic heart disease control programs in Australia are making an impact. Australian and New Zealand Journal of Public Health. 2023;47(4):100071.

36 He VYF, Condon JR, Ralph AP, et al. Long-term outcomes from acute rheumatic fever and rheumatic heart diseases: A data-linkage and survival analysis approach. Circulation. 2016;134:222-232.

37 Stacey I, Hung J, Cannon J, et al. Long-term outcomes following rheumatic heart disease diagnosis in Australia. Euro Heart J Open. 2021;1(3):oeab035.

38 Australian Institute of Health and Welfare. Acute rheumatic fever and rheumatic heart disease in Australia 2017–2021. catalogue number CVD 99, AIHW, 2023. Australian Government.

39 Stacey I, Seth R, Nedkoff L, et al. Rheumatic heart disease mortality in Indigenous and non-Indigenous Australians between 2013 and 2017. Heart. 2023;109(13):1025-1033.

40 Colquhoun SM, Condon JF, Steer AC, et al. Disparity in mortality from Rheumatic Heart Disease in Indigenous Australians. JAMA. 2015;4(7):e001282

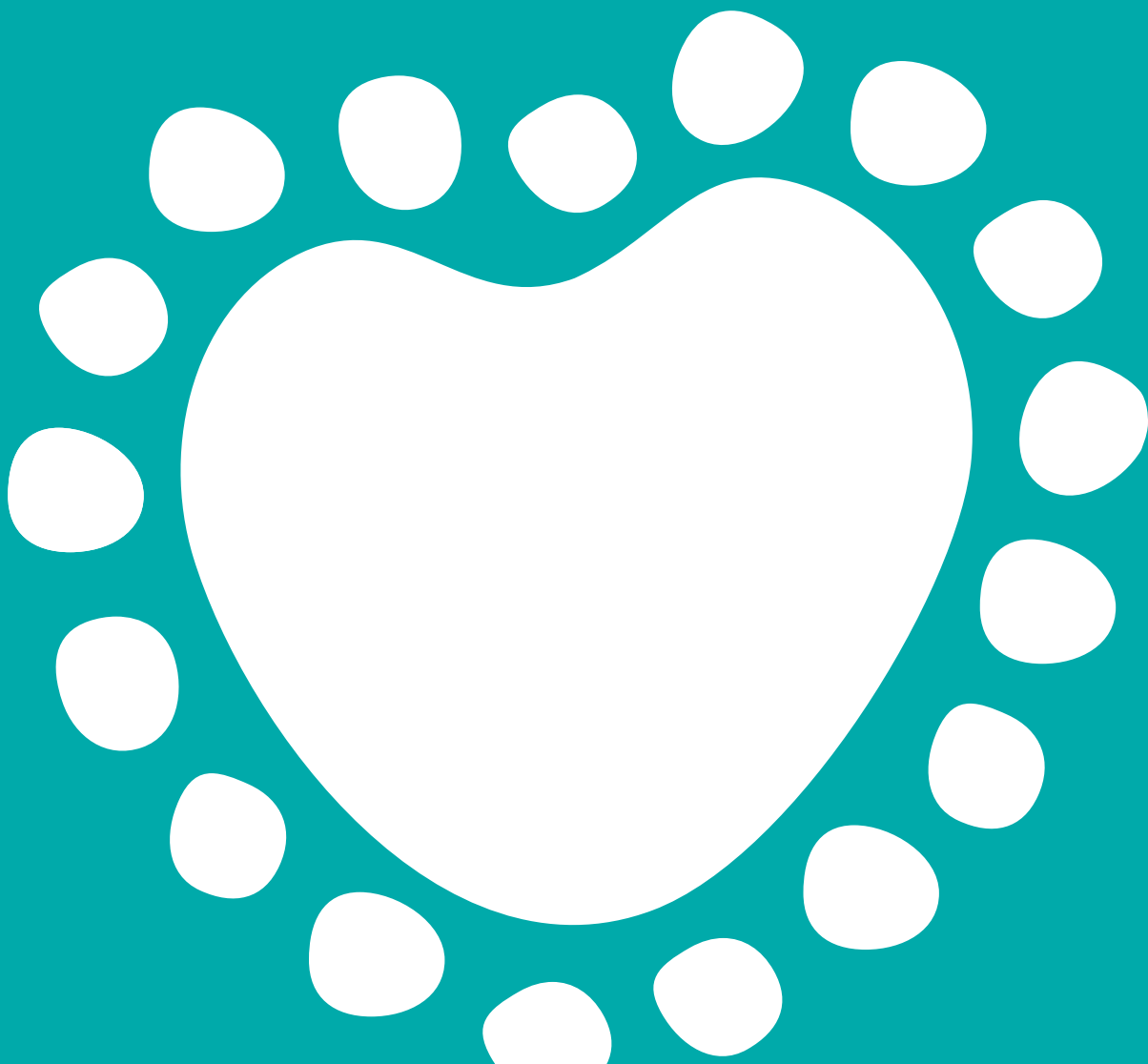
41 Wyber R, Cannon J, Katzenellenbogen J. The Cost of Inaction on Rheumatic Heart Disease: The predicted human and financial costs of rheumatic heart disease for Aboriginal and Torres Strait Islander people 2016-2031. Telethon Kids Institute, Perth. 2018.

42 Cannon J, Bessarab DC, Wyber R, Katzenellenbogen JM. Public health and economic perspectives on acute rheumatic fever and rheumatic heart disease. Medical Journal of Australia. 2019;211(6):250-252.

43 Stacey I, Katzenellenbogen J, Hung J, et al Pattern of hospital admissions and costs associated with acute rheumatic fever and rheumatic heart disease in Australia, 2012–2017. Australian Health Review, 2024 (Online).

CHAPTER 4

Primordial prevention and social determinants of acute rheumatic fever



Primordial prevention and social determinants of acute rheumatic fever

IMPORTANT CHANGES IN THIS CHAPTER

None

KEY INFORMATION

- The socioeconomic and political factors that influence people's lives can cause structural barriers and inequities in health. These social determinants of health within an Indigenous cultural context have profound impacts on health and well-being.
- The circumstances in which people live affect the risk of Group A streptococcus (Strep A) infections, acute rheumatic fever (ARF) and rheumatic heart disease (RHD). Household crowding and limited access to facilities to wash people, clothes and bedding increase the risk of Strep A infections, ARF and RHD.[1]
- Strep A is a human-only infection with no animal or insect hosts; therefore control strategies comprise modifications of human behaviours and environments.
- Nine Healthy Living Practices were developed in the 1980s by the Nganampa Health Council in South Australia to help prioritise what people need to live healthy lives (Table 4.1).[2] There is evidence that the Healthy Living Practices can help reduce Strep A infections.
- While not all Healthy Living Practices apply directly to Strep A, the approach to social determinants of health should be holistic rather than disease specific.
- There are several approaches to increase access to Healthy Living Practices to reduce the development of Strep A skin and throat infections which lead to ARF and RHD.
- Interventions on living practices applied for ARF and RHD are likely to have an impact on other diseases and conditions.

Table 4.1. Healthy Living Practices and their association with reducing Strep A infections, ARF and RHD

HEALTHY LIVING PRACTICE	ASSOCIATION WITH REDUCING STREP A INFECTIONS	NOTES
1 – Washing people	Strong	Washing of hands and bodies, particularly for children, is clearly associated with a reduction in the risk of Strep A infections.
2 – Washing clothes and bedding	Medium	Washing clothing and bedding is an important way to reduce the risk of Strep A skin infections. • Washing clothes and bedding does not directly reduce the risk of Strep A skin infections. • Washing clothes and bedding can reduce the transmission of scabies mites and lice which can cause skin itch and skin damage which lead to Strep A skin infection.
3 – Removing wastewater safely	Weak	Removing wastewater safely is important to reduce the risk of many infectious diseases. • Wastewater is not a major contributor to the spread of Strep A infections.
4 – Improving nutrition, the ability to store, prepare and cook food	Weak	Improving nutrition is important to improve many health outcomes. • Poor nutrition is not known to be a major risk factor for Strep A infection. • Strep A throat infections can spread through food which has not been cooked or stored properly. This is rare and not a major driver of ARF and RHD in Australia.
5 – Reducing the negative impacts of overcrowding	Strong	While households accommodating large family or social groups promotes health and well-being in many cultures, overcrowding is a major contributor to the burden of Strep A, ARF and RHD. • Efforts to reduce household overcrowding or reduce the risk of overcrowded living circumstances are important.
6 – Reducing the negative effects of animals, insects and vermin	Medium (Indirect)	Reducing the rates of skin infestation and damage from animals, insects and scabies are important for reducing the risk of Strep A skin infections. • Strep A only infects humans; dogs and insects do not directly spread Strep A infection. • Animals, insects and scabies mites can cause skin damage which increase the risk of secondary Strep A infection.
7 – Reducing the health impacts of dust	Weak	Dust does not contribute to Strep A infections and does not play a major part in reducing the risk of skin or throat infection.
8 – Controlling the temperature of the living environment	Weak	The risk of Strep A infections may be different in hot, wet weather or cold temperatures when people need to sleep close together for warmth. There can be differentials between rates of throat Strep A and skin Strep A based on temperature and humidity. • The evidence for these associations is variable and there is no clear evidence that controlling household temperature can have a significant impact on Strep A, ARF and RHD risk.
9 – Reducing hazards that cause trauma	Medium	Clean and tidy houses and yards may help reduce Strep A skin infections. • Living in a house with lots of rubbish and debris may increase the risk of skin damage through scratches or abrasions. These can become infected with Strep A.

DISCUSSION

> *"You need to understand the community and the problems that they are facing and then, and only then, you can help them to get rid of RHD."*
>
> RHD Champion, 2019.

Primordial prevention strategies are focused on the prevention of risk factors, and which generally address the Social Determinants of Health which increase the risk of Strep A associated disease.[1,3]

Social Determinants are defined as 'the circumstances in which people grow, live, work, and age, and the systems put in place to deal with illness. The conditions in which people live and die are, in turn, shaped by political, social, and economic forces'.[4]

Improvements in living conditions have been widely credited for the decreasing burden of ARF and RHD in most developed countries, including Australia.[5,6] Internationally, improvements in living conditions have generally occurred at a population level through economic development, policy and regulatory changes.[5,7,8] The biological basis of decreasing burdens of ARF and RHD are linked to decreasing exposure to and transmission of Strep A.

In Australia, the health benefits of economic, social, structural and cultural inclusion have not been realised for many First Nations peoples. The ongoing legacy of colonisation means that Social Determinants remain the critical components of the gap in health outcomes between First Nations peoples and non-Indigenous Australians.[9] In this regard, the incidence of Strep A infection and ARF are conspicuous markers of disadvantage. It may take some time for all the key factors of this disadvantage to be addressed and remedied. In the meantime, specific strategies are needed to address these underlying drivers of ill health. This includes action on the indirect determinants of health (including racism, discrimination, education and economic exclusion) along with focused action on the direct determinants of health, such as inadequate housing and hygiene infrastructure. Other people in Australia who experience similar social determinants of health which increase the risk of Strep A infections, ARF and RHD include homeless populations and some marginalised migrant and refugee populations.[10]

Strategies to improve the Social Determinants of Health are likely to have an impact on Strep A transmission and infection. The Healthy Living Practices have been widely adopted as a framework for addressing the links between housing and health for First Nations peoples. Development of the Healthy Living Practices is outlined in Box 4.1.

Box 4.1: Development and use of the Healthy Living Practices framework

The Healthy Living Practices framework provides a well-recognised model for considering Strep A risk reduction strategies, developed from a remote First Nations community and suitable for direct articulation into existing policy frameworks.

The Nganampa Health Council has provided health services to First Nations people in the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands of South Australia since 1983.[11] In the 1980s, Nganampa Health Council Directors called for a project to 'stop people getting sick'.

This initiated *Uwankara Palyanku Kanyintjaku* – a review of environment and public health in the region funded by the South Australian Minister of Health and jointly conducted by the Nganampa Health Council, South Australia Health Commission, and the Aboriginal Health Organisation South Australia (later, AHCSA), in conjunction with technical experts.[2,12]

The review was based on following three main sources of information.

1. Field survey of household circumstances of Anangu people in all major communities and selected homelands. This incorporated 90 houses with an average of 8.3 residents.
2. Nutrition survey of local dietary practices.
3. Analysis of existing data from the health clinics, healthy survey records, housing details and evaluations of previous projects.

Recommendations from the review were intended for use by government and service agencies, Anangu Pitjantjatjara people and communities. The first recommendation of the review was to develop Healthy Living Practices to describe, define and focus on what people need to live healthy lives.

The nine resulting Healthy Living Practices have been widely adopted as a foundation for communities and governments to consider the environmental determinants of health and help guide priorities for action. Dissemination of the framework has been amplified by Healthabitat, guided by the Nganampa Health Council directors.[13] This included development of the Housing for Health approach and enshrining the concept of 'no survey without service' promulgated by Dr Fred Hollows.[14]

In 2000–1, Healthabitat received Commonwealth government funding to assess and fix 1000 houses using the Housing for Health process.[14] By March 2002, 792 houses in four jurisdictions had been assessed, with the vast majority of work completed by local First Nations staff. Most repairs were able to be completed within the project budget of $3000 per house.[14]

New South Wales subsequently adopted the Housing for Health program and provided jurisdictional funding through the NSW Department of Health in partnership with the Department of Aboriginal Affairs.[13] The NSW Housing for Health program aims to undertake repairs and maintenance of First Nations community housing focusing specifically on improving safety and health for residents.[15]

Health outcomes were encouraging. People receiving the Housing for Health intervention had 40% less hospital admissions for infectious diseases.[15] Guided by the Healthy Living Practices, the program also demonstrated at least a twofold improvement in the ability to wash people, bedding and homes, and a twofold improvement in the safe removal of waste from homes.[15]

Healthy Living Practices also have been used as a framework for research initiatives (including the Housing Infrastructure and Child Health Study in 10 Northern Territory communities[16]), for the National Indigenous Housing Guide[17] and in reporting on the Aboriginal and Torres Strait Islander Health Performance Framework.[9] The Housing for Health approach was also endorsed by the National Aboriginal and Torres Strait Islander Housing Authority, on behalf of jurisdictional partners in their 2018 submission on the Closing the Gap refresh.[19]

Healthy living practice 1 – washing people

No single approach is effective for promoting washing of hands and bodies. Comprehensive strategies are needed and should be developed by local communities to suit community priorities and preferences.

Washing hands and bodies is directly associated with reducing Strep A infections. People who do not have opportunities for effective washing of their hands and bodies may have increased rates of Strep A. This includes poor access to hardware (taps, sinks and water) and consumables (soap and towels) as well as limited information about the importance of washing to reduce the spread of disease. Social beliefs about hygiene practices or barriers to health behaviours may also reduce hand washing.[12] All these preventative factors often work together in places with a high burden of Strep A infection, ARF and RHD.[20,21]

There is strong evidence from studies in Pakistan that daily hand washing by children with soap and water reduces skin infections.[22,23] Antibacterial soap is no better than regular soap.[22,23] A systematic review published in 2019 concluded that daily hand washing can be recommended for treatment and prevention of skin sores in Australia (Level of Evidence GRADE 1A).[24]

Table 4.2. Potential strategies to increase washing of hands and bodies

Health education and health promotion campaigns	Health promotion campaigns encourage people to wash hands and provide information about how and when hands should be washed. Programs promoting hand washing in Australia include social marketing through *No Germs on Me* in the Northern Territory[20,25] and the school-based program *Mister Germ* in Queensland and New South Wales.[26,27] Other programs using local sports people or school programs have been used in other parts of Australia.[28,29] However, health promotion campaigns can be effective only if people have adequate facilities for washing. It is important that any health promotion activities are relevant to the population group and are developed in appropriate First Nations languages. Sustained changes in hand washing are more likely to come from community leadership and engagement than short-term health education campaigns.
Providing consumables for washing	Some health promotion programs distribute soap and other products to support washing. The largest of these is the *Squeaky Clean Kids* program in Western Australia.[30] Other initiatives have aimed to produce soaps locally, sometimes including traditional bush medicines.[31,32] No evaluation of whether these approaches increase washing behaviour is yet available.
Promote hand washing in schools	Quality standards require schools and childcare providers to reduce the risk of spreading infectious diseases,[33] therefore schools have an important role in providing facilities (including sinks, soap and towels) and promoting hand washing. However, not all schools have soap and hand washing facilities, and not all education departments or other governing bodies require the provision of soap at school. Working with local schools to improve hand washing facilities and instruction is an important way to support child health in general and reduce the risk of Strep A infections.
Access to swimming facilities	Swimming provides a mechanism for washing skin. Ten studies have been conducted in remote Australian communities exploring the impact of community swimming pools on skin health outcomes for First Nations peoples.[34] All prospective studies described a drop in skin sore prevalence and severity (when measured). Although caution is recommended in the interpretation of these outcomes given a lack of control groups, the consistent findings across studies is notable. The authors of the systematic review are calling for further evaluation to assess these results and the possible impact that swimming pools have on skin sores.[34]
Access to shared washing facilities	Some Australian communities have introduced communal shower blocks to make it easier for people to access washing facilities,[35,36] although it is not clear whether this approach increases washing behaviours. No evaluation of the effect of these facilities has been identified.

Healthy living practice 2 – washing clothes and bedding

Washing clothes and bedding is indirectly associated with reducing Strep A infections. However, some people do not have access to the resources they need to wash clothing and bedding. Many households do not own a washing machine or do not have functional laundry plumbing for hot and cold water. The need to purchase detergents may also create a financial barrier to washing clothes and bedding.[37]

There is no definite evidence that Strep A bacteria are transmitted via clothes or bedding.[38] However, other causes of skin damage (scabies mites [*Sarcoptes scabiei* var. *hominis*], fleas, lice) may be spread via washable items. These co-infections cause skin disruption which predisposes an individual to Strep A infections (See Chapter 5. Primary Prevention, Strep A skin infections).

Transmission of Strep A bacteria from person to person may occur if clothing or bedding is heavily contaminated with body fluids, including pus or serous discharge from skin sores or nasal secretions. Rarely, scabies mites may be spread though clothes or bedding used by someone who has scabies. Scabies transmission through bedding and clothing is more likely from people with crusted scabies and very high mite burden. Fleas, lice and fungal infections may also have some mechanism of transmission through clothes or bedding and cause skin disruption which predisposes to Strep A infections.

Therefore, ensuring that people have facilities to wash clothes and bedding to kill scabies mites and body lice may reduce the rates of Strep A skin infection. Washing clothes and bedding in hot water is an effective method to kill the scabies mites and body lice.

Scabies reduction strategies which do not rely on washing clothes and bedding are also reasonable options. Isolating bedding and clothing in a plastic bag or exposing to sunlight for one week is a commonly recommended alternative to washing in order to kill the scabies mite.[39] Recent experiments show that the period of isolation should be at least 3 days in temperate-dry conditions (22ºC, 55% relative humidity) and 8 days in warm-humid conditions (26ºC, 80% relative humidity).[40] Other resources recommend the sun exposure of blankets and mattresses.[41] This mechanism of killing scabies mites is likely to be through ultraviolet light, heat and dehydration.[42] Previous studies indicate that exposure to temperatures greater than 25ºC at low humidity for more than 3-5 days, usually in the absence of an ongoing food supply (i.e. human or animal host), is lethal to scabies mites.[43,44]

Other strategies to increase uptake of washing may include providing washing detergent to families,[37,45] offering education about how to wash clothes and bedding to maximise benefits for skin health, exploring the role of hand-operated washing machines not dependent on electricity and complex maintenance,[46] and mobile laundromat facilities.[47] There is insufficient evidence of the health effect of any of these approaches.

Table 4.3. Strategies for effective parasite removal from clothes and bedding

Scabicidal strategies	Scabies eggs and mites on fomites are killed under the following conditions:[40] • Temperature ≥50°C as provided by a hot washing machine or drier • Freezing at -10°C for ≥5 hours • Isolation of the fomites from human hosts for 3 to 8 days (3 days in temperate-dry conditions and 8 days in warm-humid conditions) Water temperature must be at or above 50°C and exposure for at least 10 minutes to kill 100% of scabies mites and eggs. In cooler water (<50°C) mites and eggs survive. Detergent or Ozone treatment have no killing effect. Dry heat for 30 min (e.g. in a dryer) is another way to eliminate mites and eggs on textiles. Other mechanisms to achieve temperatures ≥50°C including ironing or sunlight exposure may also be effective but have not been proven. When exposed to freezing temperatures of -18°C and -10°C for more than 5 hours, 100% of mites are killed.[40]
Head lice and body lice killing strategies	100% head lice mortality is achieved when:[48] • Clothes and bedding are washed at 50°C (with or without detergent) **or** • Clothes and bedding are tumble-dried at high temperature for more than 40 minutes.
Access to functioning household washing machines	Some programs to help people keep their washing machines working appear to have been effective. For example, the *'Washing machine djäma'* East Arnhem Spin Project included regular servicing of washing machines, facilitating loans for households to purchase new machines, stocking of spare parts in communities for quick repair, training programs for local workers to undertake repairs, and social marketing campaigns. Following inspection, 87 existing machines were repaired across five communities.[49] Other initiatives offer no-interest loans for eligible low-income families which can be used to purchase washing machines.[50] No evaluation of the health impact of this loan program has been conducted. Some studies exploring the provision of washing machines to families as part of healthy skin programs are planned but not yet conducted.[51]
Access to community laundromats	Lack of access to household washing machines has prompted a range of initiatives to build community laundromats, particularly in remote areas. Many laundromats have been built, however there has been little evaluation of the health impacts.[52-54] A contemporary laundromat program was initiated by the Aboriginal Investment Group (AIG) in 2019. The AIG Remote Laundries Project aims to reduce instances of scabies, trachoma and RHD while improving school attendance and contributing to community employment opportunities through the provision of community laundromats. Large, converted shipping containers accommodate four washers and dryers linked to soap and water, with room for laundry preparation and folding.[54]
Build, repair and maintain houses which support washing of clothes and bedding	Houses which are well-built and maintained make it easier for people to wash. Poor construction, low-quality materials and poor maintenance of housing are common, particularly in some remote communities.[55] Working with community councils and governments to ensure quality housing according to the National Indigenous Housing Guide can help improve washing facilities.[56]

Healthy living practice 3 – removing wastewater safely

Removing wastewater includes drainage from the bathroom, kitchen and laundry. There is no evidence that wastewater disposal reduces Strep A infection. Likewise, there is no evidence that Strep A is transmitted through contaminated water or human faecal matter.[38]

A study in remote Northern Territory published in 2005 found houses without functional facilities for removing wastewater had higher rates of skin sores.[57] However, this may be correlation rather than causation. Skin sores are more common in crowded households.

Housing is a human right and facilities for removing wastewater are fundamental to fulfilling this right.[58] Safe water management is important for preventing a range of infectious diseases and should be part of any comprehensive environmental health approach.

Healthy living practice 4 – improving nutrition, the ability to store, prepare and cook food

It is not clear whether poor nutrition increases the risk of Strep A infections, ARF and RHD.[1] People who have poor nutrition may have reduced immune function which could increase the risk of Strep A infection. On the other hand, the post-infectious consequences of Strep A infection (ARF, RHD and acute post-streptococcal glomerulonephritis [APSGN]) are typified by an abnormal and exaggerated immune response. Improving nutrition is broadly beneficial to health and well-being so efforts to improve nutrition are justified. In the meantime, future studies may further describe the relationship between nutrition and community levels of Strep A infection, ARF and RHD.

Strep A transmission causing sore throat is possible through contaminated food.[59,60] However, this appears to be rare and is not the major contributor to Strep A infections for First Nations peoples in Australia.

Healthy living practice 5 – reducing the negative impacts of overcrowding

Household crowding sees large numbers of people, often representing multiple generations and extended families, living in confined environments. The impacts of many people living together include biological, psychological, and cultural determinants.[61] These can have positive implications, particularly as close living is considered a strength in some cultures.[62] On this basis, household crowding could equally be considered 'close living' behaviour.[63] The negative impacts of household crowding often result from many occupants living in a house with limited and/or substandard infrastructure, and where members of the household are unwell.

Reducing the negative impacts of household crowding ('overcrowding') has a strong association with reducing Strep A infections. Living in a crowded household may be associated with some health benefits,[62] but also health risks, including increased risk of Strep A infections, ARF and RHD. The risk of Strep A, ARF, and RHD in crowded households has been shown to be up to 1.7 – 2.8 times higher compared to uncrowded households.[1] However, defining and measuring crowding can be complex and identifying risk to individuals is difficult.[64]

Table 4.4. Strategies to address household crowding

Additional housing	As an isolated strategy, building more houses may not solve the problem of household crowding. For example, building a new house may mean that families move from houses which are not necessarily crowded but do not have functional facilities. Moreover, additional houses with functional facilities may perversely drive crowding if new construction is not coupled with repair and maintenance of existing houses.[65] In the Housing Improvement and Child Health Study, new houses were built in 10 Northern Territory communities between 2004 and 2005, with an average of 11 new houses per community (range: 7–15).[66] No concurrent renovation or hygiene programs were conducted. The construction of new houses did not reduce household crowding (defined as the mean number of people per bedroom in the house on the night before the survey) at a population level. At a household level, reductions in the number of people per bedroom in one study did not statistically reduce the risk of skin infections.[16]
Modified existing housing	In addition to the need for additional houses, it is essential to improve existing housing stock to reduce the functional impact of overcrowding.[65] A variety of programs have attempted to increase access to functional living space, including addition of more bedrooms and verandas and more functional yard space.[65,67] It is not clear whether this has an impact on the risk of skin sores.
Behaviour change – safe sleeping	Reasonable approaches to reducing bedroom transmission of Strep A could include having a 'safe sleeping zone' around the nose and mouth to reduce upper airways transmission / acquisition of Strep A, avoiding bed sharing, and sleeping head-to-toe or sleeping further apart. Further research co-designed with communities is needed to identify potential cultural adaptations and define biologic plausibility. Of course, in overcrowded houses, people often sleep on mattresses or blankets in the kitchen, hallway or on the verandas. In the absence of sufficient housing, people living in crowded circumstances may want advice about how to reduce the risks of close contact living. Information about the reality of living with 'big families and small houses' with inadequate infrastructure is clearly needed.[68] One option may be to rearrange bed-sharing so that younger people who are at greatest risk of Strep A infection and ARF are not all in one bed together. Historic studies indicated that moving beds further apart reduced the number of new Strep A infections in military barracks.[69] In a New Zealand study of household crowding, 49% of children with ARF shared a bed with other people; conversely only 19% of children who did not have ARF shared a bed with other people.[70] However, the association between bed-sharing and ARF in New Zealand does not appear to be significant in multivariate analysis in a case control study.[71] In New South Wales, children who have had ARF are encouraged to sleep 'head-to-toe' if they are sharing a bed, to reduce people breathing and/or coughing on each other at night to reduce Strep A transmission. However, the effect of this approach has not been evaluated.[72]
Behaviour change – respiratory hygiene	Exposure to respiratory droplets can be reduced by changes in behaviour. Health promotion and school-based education that targets respiratory hygiene (covered coughing/sneezing, use and disposal of tissues for nasal secretions, and clean faces) could help reduce respiratory transmission of Strep A.[73] Covering the mouth when sneezing and coughing reduces the spread of Strep A.[69] Minimising contact with nasal discharge - which can transmit Strep A bacteria - may also reduce Strep A infections.[74] Some respiratory hygiene messages align with the key messages for other diseases, including trachoma where the evidence base for face washing is relatively more developed.[75] It may be possible to align these health promotion goals into comprehensive hygiene messaging which improves hygiene behaviours to reduce the transmission of multiple diseases. The impact of this approach has not yet been evaluated in real world settings for the prevention of Strep A transmission.
Advocacy for housing equity	Whole of patient care involves managing and advocating for all aspects of health, which includes addressing substandard housing and related homelessness. Primary care staff can support primordial prevention through referrals to environmental health or housing services, and by striving to improve housing more broadly, particularly in communities with or at high risk of ARF and RHD. WellNest, a housing support program created by American medical student volunteers is an example of advocacy through action to improve housing. Between 2021 and 2023, 29 people received secure housing.[76] The impact of advocating for patients can also be beneficial to health staff.[76,77]

Healthy living practice 6 – reducing the negative effects of animals, insects and vermin

Animals, insects and vermin have a range of effects on health outcomes. In some First Nations communities, dogs are recognised as providing protection, companionship and having cultural meaning.[78,79]

Historically, dogs are both companions and hunters for many First Nations communities, however the place of dogs in contemporary society is complex and contested.[79]

Strep A is a human-only pathogen; there is no evidence that Strep A can be transmitted between animals and humans.[38] There is also no evidence that the scabies mites that infest dogs (*Sarcoptes scabiei* var. *canis*) can also infest humans.[80,81] However, dog scabies may rarely cause a temporary skin itch in humans, possibly associated with skin damage that may facilitate Strep A infection.[82] The belief that skin problems in dogs are associated with significant skin infections in humans is widespread but has limited support from currently available evidence.[83]

Insect bites cause localised skin itch which can lead to scratching and skin damage. When small bite wounds become infected with Strep A, they often progress to impetigo (skin sores).

Table 4.5. Strategies to reduce the negative effects of animals, insects and vermin

Animal management	A range of animal management programs exist in remote First Nations communities and are generally focused on improving both animal and human health.[82] Elements to improve human health include education, hygiene and hand washing after contact with dogs, and reducing bed-sharing with dogs. A small number of these programs have been evaluated and show improvement in both human and dog health.[83]
Insect screening	Guidelines for reducing mosquito, midge, and other bites in remote communities include the use of appropriate clothing, mosquito nets and household window screens.[84,85] Recommendations developed for a remote Northern Territory community with a high mosquito burden suggest that *'The best method of avoiding attack at night is to stay inside insect-screened houses'* and that *'Screens should be of the correct mesh, fit tightly and be in good repair'*.[86] However, access to functioning window screening is limited in many remote First Nations communities.[87,88] Working to increase household screen access may reduce insect bites and subsequent skin infections. Health promotion campaigns may give people the information they need to protect themselves from biting insects. For example, the *'Fight the Bite'* campaign is an initiative of the Western Australia Department of Health, to prevent against mosquito-borne diseases.[84] The program appears to be effective in providing some information to reduce the risk of bites through clothing and insect repellent use.[89]

Healthy living practice 7 – reducing the health impacts of dust

In general, dust is not likely to be a major driver of Strep A skin or throat infection. Strep A is not transmitted through outside environmental dust. The dust inside houses may contain Strep A bacteria but it is considered unlikely that this dried form of Strep A can subsequently cause infection.[90,91]

Healthy living practice 8 – controlling the temperature of the living environment

Overall, temperature and climate are likely to have an effect on the risk of Strep A infection, with the seasonal variation in rates of Strep A infections reported internationally.[92] In some settings, rates are higher in colder times and are attributed to greater household crowding, while in other settings (including non-tropical parts of Australia), rates are higher in warmer months, attributed to more opportunities for skin breaches e.g. from bare feet.[92] Yet, infection rates appear to be sustained at high levels all year in remote First Nations communities in Australia.[92] In cold climates (such as Australia's central desert area), cold may be a driver of increased bedroom density at night, and thus for increased Strep A transmission.

In New Zealand, public health messaging includes statements such as: 'In a warm, dry home the family may have more space to spread out around the home, rather than having to crowd in the same room. Having more warm rooms and more sleeping spaces available means germs such as Strep A in the throat, which can lead to rheumatic fever, are less likely to spread.'[93] Therefore low-income homeowners affected by ARF in New Zealand are eligible for government-funded household insulation.[94] However, the effectiveness of this strategy for reducing ARF rates or outcomes is unknown.

Healthy living practice 9 – reducing minor trauma

Some people live in houses which are overcrowded, poorly maintained and contain rubbish and debris.[95] This may increase the risk of minor skin damage from cuts and abrasions, and this skin damage may become infected with Strep A.

Table 4.6. Strategies to maintain tidy home environments to minimise risk of minor trauma

House and yard tidy days	Several initiatives exist encouraging households to clean up their homes and yards to the benefit of their health. Environmental Health Workers, where available, are encouraged to promote community and yard clean-ups as part of their responsibilities at least annually to prevent the build-up of stagnant water and limit the attraction of vermin.[96] In cyclone-prone regions, the regular removal of unrestrained items such as cars, washing machines and refrigerators is particularly necessary as these items can become projectiles during significant winds.[96] Clean-ups can be encouraged at regular community meetings with additional collection supplies arranged if required.[96] Achieving and maintaining a tidy yard and house can be challenging.[97] Some families with a large number of visitors may not be able to secure the co-operation of visitors or tenants to maintain usual hygiene standards. Other people may be physically unable to maintain a tidy yard, including removing large objects or accessing tools or trailers to complete the work.[97]
Home maker and home management programs	A range of home maker, home management and family support programs have been developed in Australia. Many of these programs focus on keeping the inside of houses clean and tidy by reducing house and yard debris, alongside other health promotion messages.[98] These programs may help reduce minor skin trauma, but no health evaluation has demonstrated this in practice.

Culture and workforce considerations to help address Social Determinants of Health in the context of ARF and RHD include:

Locally acceptable and feasible strategies to address the Social Determinants of Health.

Dedicated First Nations Environmental Health Workers employed in high-risk communities.

- Environmental health and housing assessment and action for people with Strep A infections.

Culturally appropriate, respectful and practical information and support for reducing risk factors for Strep A infections available where required/requested.

- Hand and body washing promoted by school, education and housing sectors.
- Provision of adequate washing hardware for people, clothes and bedding.
- Health and government services work with community groups to address the environmental and social determinants of health which drive Strep A infections.

Established cross-sector collaboration of departments and activities.

CASE STUDY

The Murdi Paaki Healthy Housing Worker Program in NSW offers training to First Nations people to develop environmental health, maintenance and construction skills, enabling quick and efficient carpentry, plumbing and electrical repairs to be carried out on homes.[a] Training is delivered by The Batchelor Institute over two years. The aim of the program is to minimise housing and health hardware deterioration and lessen the effects of housing-induced illness and injury.

The Murdi Paaki program addresses the low numbers of skilled tradespeople in rural and remote communities, meaning sewerage, ventilation, hot water and plumbing problems often go unrepaired for extended periods of time, negatively impacting household health. There is a known link between 'Healthy Living Practices' upon which the Murdi Paaki program is based, and child health outcomes, with specific reference to skin disease.[b]

By having a local First Nations workforce to maintain housing, local capacity is developed and there is less reliance on external influence.[c] Local employment, individual self-esteem, and labour competitiveness is enhanced, alongside improved living conditions.

Trainees work alongside qualified environmental health staff and tradespeople, guided by a standardised survey tool that systematically assesses criteria within each household. Resources and equipment, including personal protective items are provided.

Several outcomes of the Murdi Paaki have been identified: improved housing maintenance and functionality, with a quicker response to required repairs; an evident intent of stakeholders to ensure further longevity of these homes, increasing the maximum life of remote First Nations housing; improved employment prospects for trainees; and increased self-confidence among employees, and a new-found place within the community. Community members also saw value in having a First Nations worker working within the local community.

This program has several replicable features, including leadership, local coordination and support, relationship and trust, capacity building within the community, and funding and support.[d] The program has succeeded in improving ownership of homes, reducing rates of disrepair and beneficially impacting upon community health.

a Collier P, King S, Lawrence K, et al. Growing the desert: educational pathways for remote Indigenous people – Support document. Adelaide: National Centre for Vocational Education Research, 2007.

b Bailie RS, Stevens M, McDonald E, et al. Skin infection, housing and social circumstances in children living in remote Indigenous communities: testing and methodological approaches. *BMC Public Health* 2005; 5(1):128

c Balding B, Graham B. Home grown solutions for healthier homes: the Healthy Housing Worker program in far-west NSW. 8th National Rural Health Conference; 2005; Alice Springs.

d Young M, Guenther J, Boyle A. Growing the desert: educational pathways for remote Indigenous people. Adelaide: National Centre for Vocational Education Research, 2007.

REFERENCES

1 Coffey PM, Ralph AP, Krause VL. The role of social determinants of health in the risk and prevention of group A streptococcal infection, acute rheumatic fever and rheumatic heart disease: A systematic review. PLOS Neglected Tropical Diseases. 2018;12(6):e0006577.

2 Committee of Review on Environmental and Public Health within the Anangu Pitjantjatjara Lands in South Australia. Report of Uwankara Palyanyku Kanyintjaku: An Environmental and Public Health Review within the Anangu Pitjantjatjara Lands. Adelaide: Nganampa Health Council, South Australian Health Commission, Aboriginal Health Organisation of South Australia, 1987.

3 Gillman MW. Primordial prevention of cardiovascular disease. Circulation. 2015;131(7):599-601.

4 Commission on Social Determinants of Health. Closing the gap in a generation: health equity through action on the social determinants of health. Final report of the Commission on Social Determinants of Health. Geneva: World Health Organization, 2008.

5 Watkins DA, Johnson CO, Colquhoun SM, et al. Global, Regional, and National Burden of Rheumatic Heart Disease, 1990–2015. The New England Journal of Medicine. 2017;377:713-722.

6 Brown A, McDonald MI, Calma T. Rheumatic fever and social justice. The Medical Journal of Australia. 2007; 86(11):557-578.

7 Markowitz M. The decline of rheumatic fever: role of medical intervention. Lewis W. Wannamaker Memorial Lecture. Journal of Pediatrics. 1985;106(4):545-550.

8 Ekelund H, Enocksson E, Michaelsson M, Voss H. The incidence of acute rheumatic fever in Swedish children 1952-1961. A survey from four hospitals. Acta Medica Scandinavica. 1967;181(1):89-92.

9 Australian Health Ministers' Advisory Council. Aboriginal and Torres Strait Islander Health Performance Framework, 2017. Canberra: AHMAC, 2017.

10 Australian Institute of Health and Welfare. Acute rheumatic fever and rheumatic heart disease in Australia. Cat. no: CVD 100. Australian Institute of Health and Welfare, Canberra. 2024.

11 Aboriginal Health Council of South Australia Ltd. Nganampa Health Council. 2019.

12 Collings M, Thompson P. Report of Uwankara Palyanyku Kanyintjaku: An Environmental and Public Health Review within the Anangu Pitjantjatjara Lands. Adelaide: Nganampa Health Council, South Australian Health Commission and Aboriginal Health Organisation of South Australia; 1987.

13 Healthabitat. Healthabitat - environmental health and design. 2019.

14 Pholeros P. Fixing Houses for Better Health. 2002.

15 Aboriginal Environmental Health Unit - Population Health Division. Closing the gap: 10 Years of Housing for Health in NSW. An evaluation of a healthy housing intervention. North Sydney: NSW Department of Health, 2010.

16 Bailie RS, Stevens M, McDonald EL. The impact of housing improvement and socio-environmental factors on common childhood illnesses: a cohort study in Indigenous Australian communities. Journal of Epidemiology and Community Health. 2012;66(9):821-831.

17 Australian Government. National Indigenous housing guide. 2007.

18 Australian Health Ministers' Advisory Council. Aboriginal and Torres Strait Islander Health Performance Framework. Canberra: AHMAC, 2017.

19 National Aboriginal and Torres Strait Islander Housing Authority. Submission on the Closing the Gap Refresh Targeting Housing and Homelessness. Strawberry Hills: National Congress. 2018.

20 Schobben X, Clements N. 'No Germs on Me' Hand washing Campaign. 7th National Aboriginal and Torres Strait Islander Environmental Health Conference; 2009; Kalgoorlie, Western Australia.

21 McDonald E, Bailie R, Grace J, Brewster D. A case study of physical and social barriers to hygiene and child growth in remote Australian Aboriginal communities. BMC Public Health. 2009;9(1):346-359.

22 Luby SP, Agboatwalla M, Feikin DR, et al. Effect of hand washing on child health: a randomised controlled trial. The Lancet. 2005;366(9481):225-233.

23 Luby S, Agboatwalla M, Schnell BM, Hoekstra RM, Rahbar MH, Keswick BH. The effect of antibacterial soap on impetigo incidence, Karachi, Pakistan. American Journal of Tropical Medicine and Hygiene. 2002;67(4):430-435.

24 May PJ, Tong SYC, Steer AC, et al. Treatment, prevention and public health management of impetigo, scabies, crusted scabies and fungal skin infections in endemic populations: a systematic review. Tropical Medicine and International Health. 2019;24(3):280-293.

25 McDonald E, Cunningham T, Slavin N. Evaluating a hand washing with soap program in Australian remote Aboriginal communities: a pre and post intervention study design. BMC Public Health. 2015;15(1):1188-1200.

26 Queensland Health. Aboriginal and Torres Strait Islander Environmental Health Plan 2008–2013, Appendix 1 - Aboriginal and Torres Strait Islander Environmental Health Program delivery in Queensland. Brisbane: Government of Queensland, 2008.

27 Centre for Epidemiology and Evidence. Aboriginal kids - A healthy start to life: Report of the Chief Health Officer. Sydney: NSW Ministry of Health, 2018.

28 Falk P. Take Pride in Personal Hygiene. 2012.

29 Lansingh VC. Primary health care approach to trachoma control in Aboriginal communities in Central Australia [PhD Thesis]. University of Melbourne 2005.

30 Cook R. More than 19,500 to benefit from free soap through Squeaky Clean Kids program. 2017.

31 Hunter New England Local Health District. Bush medicine; breathing new life into traditional healing. 2018.

32 Centre of Research Excellence in Ear and Hearing Health of Aboriginal and Torres Strait Islander Children. 2017. Darwin: CRE ICHEAR, 2018.

33 Australian Children's Education and Care Quality Authority (ACECQA). Quality Area 2-Children's health and safety. 2019.

34 Hendrickx D, Stephen A, Lehmann D, et al. A systematic review of the evidence that swimming pools improve health and well-being in remote Aboriginal communities in Australia. Australian and New Zealand Journal of Public Health. 2016;40(1):30-36.

35 Empowered Communities East Kimberley, Binarri-binyja Yarrawoo. Empowered Communities East Kimberley, Community Forum Outcomes. 2018.

36 Torzillo P, Kerr C. Contemporary issues in Aboriginal public health. In: Trompf P, Reid J, eds. The health of Aboriginal Australians. Sydney: Harcourt Brace & Co.1997:337-344.

37 Yuen E. Water Consumption Patterns in Australian Aboriginal Communities [Doctor of Philosophy]. Perth: Murdoch University; 2004.

38 Xu R. Systematic review of streptococcus pyogenes transmission mechanisms. (Unpublished 2019).

39 Dowden M, O'Meara I, Westphalen C, et al. Managing households with recurrent scabies; breaking the cycle of recurrent scabies. Tiwi: One Disease, 2017.

40 Bernigaud C, Fernando DD, Lu H, Taylor S, Hartel G, Chosidow O, Fischer K. How to eliminate scabies parasites from fomites - a high throughput ex vivo experimental study. Journal of the American Academy of Dermatology. 2019. pii: S0190-9622(19)33301-33308.

41 Remote Primary Health Care Manuals. CARPA Standard Treatment Manual, 8th edition. Alice Springs: Centre for Remote Health; 2022.

42 Arlian LG, Morgan MS. A review of Sarcoptes scabiei: past, present and future. Parasites and Vectors. 2017;10(1):297.

43 Arlian LG, Vyszenski-Moher DL, Pole MJ. Survival of adults and developmental stages of Sarcoptes scabiei var. canis when off the host. Experimental and Applied Acarolology. 1989;6(3):181-187.

44 Arlian LG, Runyan RA, Achar S, Estes SA. Survival and infectivity of Sarcoptes scabiei var. canis and var. hominis. Journal of American Academy of Dermatology. 1984;11(2):210-215.

45 Hall N, Babrbosa M, Currie D, et al. Water, sanitation and hygiene in remote Indigenous Australian communities: a scan of priorities. Brisbane: University of Queensland, 2017.

46 Rotary Districts of Australia. Rotary District 9455 Aboriginal Reference Group, meeting 4/2018. 2018.

47 Orange Sky Laundry Ltd. Orange Sky Australia; Annual Report 2016-2017. Newmarket: Orange Sky Laundry, 2016.

48 Izri A, Chosidow O. Efficacy of machine laundering to eradicate head lice: recommendations to decontaminate washable clothes, linens, and fomites. Clinical Infectious Diseases. 2006;42(2):e9-e10.

49 Miwatj Health Aboriginal Corporation. Newsletter, Edition 11. 2013.

50 Department of the Environment and Energy. Appliance purchase load assistance. 2019.

51 Thomas J, Australian New Zealand Clinical Trials Registry. Exploring a better treatment option for scabies using tea tree oil-based gel formulation in remote-dwelling Aboriginal and Torres Strait Islander children - Protocol for a pilot, randomised, permethrin controlled trial. 2017.

52 Thompson J. Laundromats to be used in fighting the scourge of scabies in remote Top End communities. 2018.

53 Government of Australia. Community laundry provides new jobs for Walgett. 2013.

54 Aboriginal Investment Group. Remote Laundries. 2019.

55 Ware VA. Housing strategies that improve Indigenous health outcomes. Resource sheet no.25. Canberra: Closing the Gap Clearinghouse.

56 Department of Prime Minister and Cabinet. Remote Housing Review: a review of the National Partnership Agreement on Remote Indigenous Housing and Remote Housing Strategy (2008-2018). Canberra: Commonwealth of Australia, 2017.

57 Bailie RS, Stevens M, McDonald E, et al. Skin infection, housing and social circumstances in children living in remote Indigenous communities: testing and methodological approaches. BMC Public Health. 2005;5(1):128.

58 United Nations General Assembly. Universal declaration of human rights. Geneva: United Nations, 1948.

59 Kemble SK, Westbrook A, Lynfield R, et al. Foodborne outbreak of Group A Streptococcus pharyngitis associated with a high school dance team banquet - Minnesota, 2012. Clinical Infectious Diseases. 2013;57(5):648-654.

60 Katzenell U, Shemer J, Bar-Dayan Y. Streptococcal contamination of food: an unusual cause of epidemic pharyngitis. Epidemiology and Infection. 2001;127(2):179-184 .

61 Memmott P, Birdsall-Jones C, Greenop K. Australian Indigenous Household Crowding. Queensland Research Centre: Australian Housing and Urban Research Institute, 2012.

62 Memmott P, Birdsall-Jones C, Go-Sam C, Greenop K, Corunna V. Modelling crowding in Aboriginal Australia. Brisbane: Australian Housing and Urban Research Institute, Queensland Research Centre and Western Australia Research Centre, 2011. ISBN: 978-1-921610-80-6.

63 Memmott P, Greenop K, Clarke A, et al. NATSSISS crowding data: what does it assume and how can we challenge the orthodoxy. CAEPR Research Monograph No 32. In: Hunter B, Biddle N, editors. Canberra, Australian National University: Centre for Aboriginal Economic Policy Research; 2012.

64 McDonald M, Towers RJ, Andrews RM, et al. Low rates of streptococcal pharyngitis and high rates of pyoderma in Australian Aboriginal communities where acute rheumatic fever is hyperendemic. Clinical Infectious Diseases. 2006;43(6):683-689.

65 Pholeros P. Will the crowding be over or will there still be overcrowding in Indigenous housing? Lessons from the Housing for Health projects 1985-2010. Developing Practice: The Child, Youth and Family Work Journal. 2010;1(27):8-18.

66 Bailie RS, McDonald EL, Stevens M, Guthridge S, Brewster DR. Evaluation of an Australian Indigenous housing programme: community level impact on crowding, infrastructure function and hygiene. Journal of Epidemiology and Community Health. 2011;65(6):432-437.

67 Department of the Chief Minister. Room to Breathe eases overcrowding. 2017.

68 Massey PD, Miller A, Saggers S, et al. Australian Aboriginal and Torres Strait Islander communities and the development of pandemic influenza containment strategies: community voices and community control. Health Policy. 2011;103(2-3):184-190.

69 US Army Public Health Command. Barracks layout to prevent disease transmission. 2010.

70 Oliver JR, Pierse N, Stefanogiannis N, Jackson C, Baker MG. Acute rheumatic fever and exposure to poor housing conditions in New Zealand: A descriptive study. Journal of Paediatrics and Child Health. 2017;53(4):358-364.

71 Baker M. Modifiable risk factors for ARF: results from NZ case- control study. 2019.

72 NSW Government. Staying Healthy. Advice for people diagnosed with acute rheumatic fever or rheumatic heart disease and their families.

73 Saunders-Hastings P, Crispo JAG, Sikora L, Krewski D. Effectiveness of personal protective measures in reducing pandemic influenza transmission: A systematic review and meta-analysis. Epidemics. 2017;20(1):1-20.

74 Marks L, Reddinger R, Hakansson A. Biofilm formation enhances formit survival of Streptococcus pneumoniae and Streptococcus pyogenes. Infection and Immunity. 2014;82(3):1141-1146.

75 Ejere HO, Alhassan MB, Rabiu M. Face washing promotion for preventing active trachoma. Cochrane Database of Systematic Reviews. 2012;4(4):CD003659.

76 Dalapati T, George IA, Tracey S, et al. WellNest: A Medical Student-Run Housing Support Program. Acad Med. 2024;99(8):852-856.

77 Person AK. Infectious Diseases and Advocacy: This Is our Lane. Open Forum Infect Dis. 2020;7(11):ofaa510.

78 Constable S, Dixon RM, Dixon R. For the love of dog: the human–dog bond in rural and remote Australian indigenous communities. Anthrozoös. 2010;23(4):337-349.

79 Willis EM, Ross KE. Review of principles governing dog health education in remote Aboriginal communities. Aust Vet J. 2019;97(1-2):4-9

80 Walton SF, Choy JL, Bonson A, et al. Genetically distinct dog-derived and human-derived Sarcoptes scabiei in scabies-endemic communities in northern Australia. American Journal of Tropical Medicine and Hygiene. 1999;61(4):542-527.

81 The Australian Healthy Skin Consortium. National Healthy Skin Guideline: for the Diagnosis, Treatment and Prevention of Skin Infections for Aboriginal and Torres Strait Islander Children and Communities in Australia (2nd edition), 2023.

82 Schultz R. National healthy skin guidelines for Indigenous Australians: the impact of dog health programs requires evaluation. Med J Aust. 2019;210(7):334.

83 Hill R. Animal Management Worker Program Evaluation. Melbourne, 2014.

84 Department of Health. Fight the Bite campaign. 2019.

85 Nadarajah H. Bush Tech #49 Protecting your home against dengue outbreaks. Alice Springs: Centre for Appropriate Technology, 2010.

86 Lamche G, Kurucz N, Carter J, Whelan P. Biting insect survey of Milingimbi, 7-9 April 2003. Darwin: Medical Entomology Branch, Centre for Disease Control Department of Health and Community Services, Northern Territory Government, 2006.

87 Environmental Health Officer. Nillir Irbanjin (One Mile) Issues and Environmental Health Report. Nillir Irbanjin: Kullari Regional Environmental Health, Nirrumbuk Aboriginal Corporation, 2008.

88 Todd RE, Guthridge SL, Montgomery BL. Evacuation of an Aboriginal community in response to an outbreak of blistering dermatitis induced by a beetle (Paederus australis). The Medical Journal of Australia. 1996;164:238-240.

89 Potter A, Jardine A, Morrissey A, Lindsay MD. Evaluation of a Health Communication Campaign to Improve Mosquito Awareness and Prevention Practices in Western Australia. Frontiers in Public Health, 2019.

90 White E. On the possible transmission of haemolytic streptococci by dust. The Lancet. 1936;227(5878):941-944.

91 Denny FW Jr, Perry WD, Wannamaker L W. Type-specific streptococcal antibody. Journal of Clinical Investigation. 1957;36(1):1092-1100.

92 Manning L, Cannon J, Dyer J, Carapetis J. Seasonal and regional patterns of lower leg cellulitis in Western Australia. Internal Medicine Journal. 2019;49(2):212-216.

93 Ministry of Health Manatū Hauora. Warmer, drier homes.

94 Ministry of Health Manatū Hauora. Healthy Homes Initiative. 2019.

95 Pholeros P, Rainow S, Torzillo P. Housing for health: towards a healthy living environment for Aboriginal Australia. Newport Beach: Healthabitat; 1993.

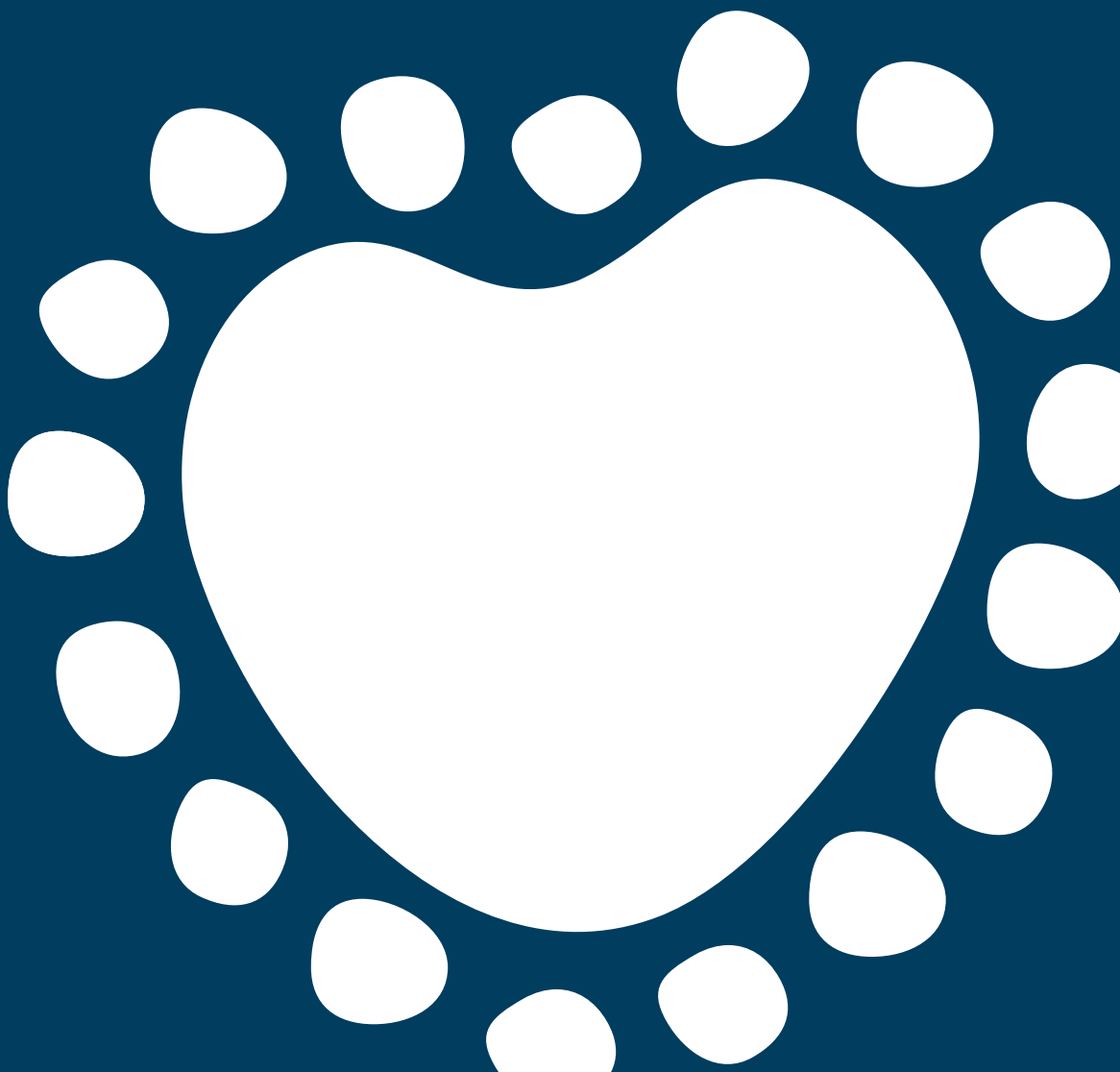
96 Department of Health. Community and yard clean-ups. 2010.

97 Memmott P, Nash D. Housing conditionality, Indigenous lifeworlds and policy outcomes; Mt Isa case study. Brisbane Australian Housing and Urban Research Institute at The University of Queensland 2016.

98 Stubbs B. The trials and triumphs of developing family support programs in a remote setting. 2016.

CHAPTER 5

Primary prevention



Primary prevention

IMPORTANT CHANGES IN THIS CHAPTER

Footnote added to Table 5.4 Recommended antibiotic treatment for Strep A skin sores to caution against use of cotrimoxazole in pregnancy (Updated October 2026)

Addition of Summary of recommendations with GRADE Level of Evidence (Table 5.1)

Oral options have been expanded to include a choice of four antibiotics for treatment of sore throat (Table 5.3) (Updated August 2025)

Progress of molecular point of care tools for identifying Strep A throat infections

Recommendation to use phenoxymethylpenicillin (oral penicillin) as first line treatment for sore throat during periods of rationing premix Benzylpenicillin G (BPG) (Table 5.3)

Clarity that antibiotic treatment is indicated for all people (not just children) with one or more skin sores with pus or thick crust (Table 5.4)

KEY INFORMATION

- Primary prevention of ARF aims to interrupt the link between Strep A infection and the abnormal immune response to Strep A that causes ARF by early identification and treatment of Strep A infections.
- Strep A has been shown to be associated with up to 37% of sore throats.[1] Strep A is only one cause for tonsillitis. Strep A is present in 10% to 40% of children presenting with a sore throat.[2]
- Treatment of the Strep A sore throat in those at risk of ARF can decrease the subsequent development of ARF by up to two-thirds.[3]
- Strep A has been shown to be associated with most impetigo episodes.[4] Strep A impetigo is very common among First Nations children living in remote areas of Australia, with almost one in two affected at any one time.[5] Identification, treatment and prevention of Strep A skin infections may help reduce the burden of ARF.
- Antibiotic management of sore throat differs from antibiotic management of skin sores.
- Individuals already receiving BPG secondary prophylaxis for ARF still need active treatment of sore throats or skin sores. This is necessary because the level of penicillin achieved by BPG wanes by about 7 days to reach a prophylactic level which is lower than a required treatment level. If the last BPG dose was ≥7 days ago, provide antibiotic dosing in accordance with Table 5.2 for sore throat or Table 5.3 for skin sores.
- Strep A in the throat is transmissible to others in the absence of symptoms.[6]
- All superficial Strep A infections of the skin and throat need treatment to reduce ARF risk.
- Skin sores should be covered to prevent cross-infection.
- Molecular point of care tools aid in the timely detection and treatment of Strep A in the throat and may be a useful adjunct in prevention of ARF.
- Molecular point of care testing is not needed for impetigo, as the presence of impetigo confirms Strep A is involved, and treatment of impetigo is required.

Table 5.1. Summary of recommendations with GRADE Level of Evidence

RECOMMENDATIONS	GRADE
Antibiotics should be given empirically for people at high risk of ARF presenting with sore throat	2B
Antibiotics should be given empirically to people at high risk of ARF presenting with one or more skin sores	1A
Individuals already receiving BPG secondary prophylaxis still need active treatment of sore throats or skin sores	2D
Clinical scoring of sore throat is not recommended in Australia	2D

Table 5.2. Risk groups for primary prevention of ARF

At high risk	Living in an ARF-endemic setting† First Nations peoples living in rural or remote settings First Nations peoples, and Māori and/or Pacific Islander peoples living in metropolitan households affected by crowding and/or lower socioeconomic status Personal history of ARF/RHD and aged <40 years
May be at high risk	Family or household recent history of ARF/RHD Household overcrowding (>2 people per bedroom) or low socioeconomic status Migrant or refugee from low- or middle-income country and their children
Additional considerations which increase risk	Prior residence in a high ARF risk setting Frequent or recent travel to a high ARF risk setting Aged 5-20 years (the peak years for ARF)

† This refers to populations where community ARF/RHD rates are known to be high e.g. ARF incidence >30/100,000 per year in 5–14-year-olds or RHD all-age prevalence >2/1000 (Figure 3.4)[7]

Table 5.3. Recommended antibiotic treatment for Strep A sore throat / tonsillitis†

DRUG	DOSE		ROUTE	DURATION
All cases				
Benzathine benzylpenicillin G (BPG)‡	Weight (kg) Child: <10 10 to <20 ≥20 Adult: ≥20	Dose in units (mL)§ 450,000 units (0.9 mL) 600,000 units (1.2 mL) 1,200,000 units (2.3 mL) 1,200,000 units (2.3 mL)	Deep intramuscular injection	Once
If IM injection not possible, use one of the following four oral options depending on circumstances, availability and potential drug intolerances:				
Phenoxymethylpenicillin	Child: 15 mg/kg up to 500 mg, twice daily Adult: 500 mg, twice daily		Oral	For 10 days
Azithromycin	Child: 12 mg/kg up to 500 mg, once daily Adult: 500 mg once daily		Oral	For 5 days
Cefalexin	Child: 25 mg/kg up to 1 g, twice daily Adult: 1 g, twice daily		Oral	For 10 days
Amoxicillin	Child: 25 mg/kg up to 1 g, once daily Adult: 1 g, once daily		Oral	For 10 days

† Antibiotic treatment indicated for proven Strep A infection, and for people at high risk of ARF presenting with sore throat.

‡ For information on managing injection pain, see Chapter 10. Secondary Prophylaxis. During times of rationing of premix BPG supplies due to interruption in supply, (See Chapter 10. Secondary Prophylaxis, Long-acting penicillin supply interruptions) existing premix stock should not be used for the treatment of sore throats. Instead, use phenoxymethylpenicillin as first line treatment.

§ mL is only relevant for the premix product. Volumes of powdered BPG may vary.

Table 5.4. Recommended antibiotic treatment for Strep A skin sores †

DRUG	WEIGHT RANGE	DOSE			ROUTE	DURATION
	For one or more purulent or crusted sore(s)					
Cotrimoxazole‡ § (trimethoprim / sulfamethoxazole) 4 mg/kg/dose trimethoprim component	**Weight range**	**Syrup dose** **(40 mg/5 mL)**	**Tablet dose SS** **(80/400 mg)**	**Tablet dose DS** **(160/800 mg)**	Oral	Morning and night for 3 days
	3–<6 kg	12 mg (1.5 mL)	N/A	N/A		
	6–<8 kg	24 mg (3 mL)	¼ tablet			
	8–<10 kg	32 mg (4 mL)	½ tablet			
	10–<12 kg	40 mg (5 mL)				
	12–<16 kg	48 mg (6 mL)	¾ tablet			
	16–<20 kg	64 mg (8 mL)				
	20–<25 kg	80 mg (10 mL)	1 tablet	½ tablet		
	25–<32 kg	100 mg (12.5 mL)	1 ½ tablets	¾ tablet		
	32–<40 kg	128 mg (16 mL)				
	≥40kg	160 mg (20 mL)	2 tablets	1 tablet		
Benzathine benzylpenicillin G (BPG)	Weight Child: <10 kg 10 to <20 kg ≥20 kg Adult: ≥20 kg			Dose in units (mL)†† 450,000 units (0.9 mL) 600,000 units (1.2 mL) 1,200,000 units (2.3 mL) 1,200,000 units (2.3 mL)	Deep IM injection	Once

† Antibiotic treatment is indicated for all people with one or more lesions with pus or crust.

‡ Cotrimoxazole comes as syrup (40 mg trimethoprim/5 mL) and tablets. The tablets are single strength (SS) (80/400 mg trimethoprim/ sulfamethoxazole) or double strength (DS) (160/800 mg trimethoprim/ sulfamethoxazole). When syrup is unavailable, tablets may be crushed and dissolved in water for small children as per the table above.

§ If pregnancy or suspected pregnancy, use cefalexin 1 g orally, twice a day for 5 days due to the risks associated with cotrimoxazole in pregnancy.

†† mL is only relevant for the premix product. Volumes of powdered BPG products may vary.

DISCUSSION

"In order to end RHD we need to build a stronger and better First Nations workforce in primary health care, one that is supported and valued."

RHD Champion, 2019

Primary prevention of ARF involves the identification and subsequent treatment of Strep A infections in patients at high risk of ARF to prevent an autoimmune response and subsequent ARF. Figure 5.2 outlines the pathways by which multiple Strep A infections of the throat and / or skin can prime the immune system[8,9] for subsequent development of ARF and RHD. Interrupting this process by identifying and treating Strep A infections is the key activity of primary prevention. ARF is the result of an abnormal and exaggerated immune response to Strep A.

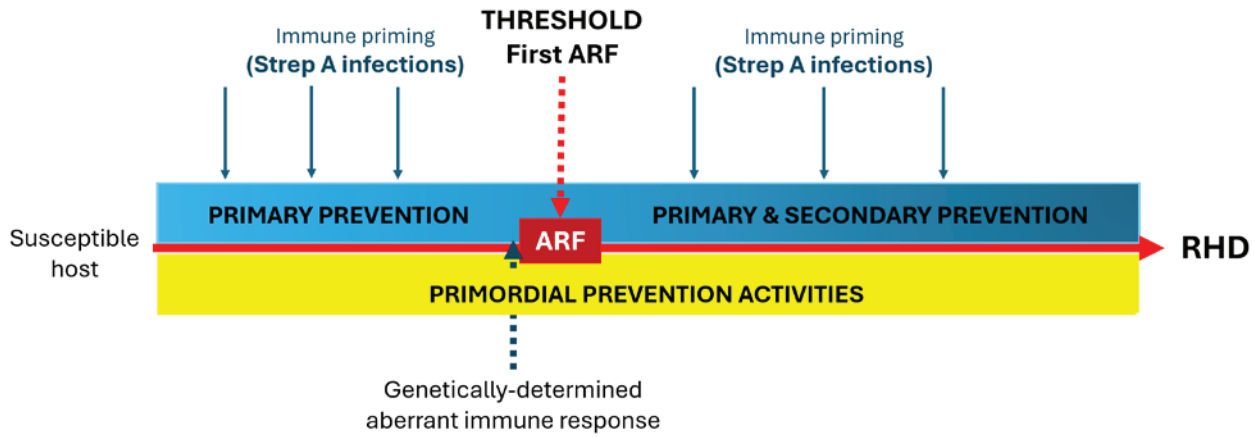


Figure 5.1. Pathway for ARF and RHD with immune priming

This figure illustrates that primordial prevention must be prioritised at all points to interrupt the pathway towards RHD. Primary prevention activities identify and treat all Strep A infections in high-risk children and are important in preventing the first episode of ARF. Once ARF has been diagnosed, maintenance of consistent, regular secondary antibiotic prophylaxis is implemented with primordial and primary prevention activities continuing to operate at the individual and community level.

ARF is preventable. The evidence for this comes from two key observations:

1. On the global level, ARF was previously common around the world. The incidence of ARF dramatically declined in developed countries during the first half of the 20th century. This has been attributed largely to primordial prevention with socioeconomic prosperity resulting in advances in housing, education, health literacy and employment.[10]
2. In highly controlled settings such as United States military barracks, antibiotic treatment of Strep A throat infection, up to nine days from the onset of symptoms, has been shown to reduce the incidence of ARF.[11-13]

Evidence collected since the early 1900s shows that throat infections (tonsillitis) with Strep A, both clinical and subclinical, precede and cause ARF in specific human hosts. Early research in ARF highlighted the importance of early treatment of Strep A sore throats (up to nine days from the onset of symptoms)[13] for the prevention of ARF. Treatment for Strep A throat infections to prevent ARF is well-evidenced and forms the basis of primary prevention of ARF.[11-13]

The proposal that Strep A skin infection can also lead to ARF dates from the early 2000s.[14] Strep A skin infection is known as impetigo or skin sores. The additional element of identification and treatment for Strep A skin infections as part of primary prevention of ARF is included in this edition based on the following evidence:

1. The median prevalence of Strep A skin sores among First Nations children living in remote settings is 44.5% [interquartile range 34.0 – 49.2%].[5,15]
2. The incidence of Strep A sore throats among remote-dwelling First Nations children is relatively low at ~ 4/100/year.[14]

3. The incidence of ARF among these groups continues to be high.

4. There is emerging evidence from New Zealand where ARF diagnosis has followed a recent skin infection.[16,17]

Knowing which populations are at elevated risk of ARF and providing early treatment of Strep A infections can prevent ARF and subsequently RHD, from occurring. In Australia, such populations include children aged between five and 20 years who are First Nations peoples, Māori or Pacific Islander, first-generation migrants and refugees from low- and middle-income countries where rates of ARF and RHD are high (Table 5.1).[18] In Australia, more than 90% of new ARF cases are diagnosed in First Nations children.[7] Increased resources and research at primary healthcare service level can improve recognition, prevention and treatment of ARF. Primary prevention relies on all health staff being aware of the risk factors for ARF and providing treatment for all people with sore throats or skin sores who are at high risk of ARF.

Strep A only infects humans and is transferred from person to person.[19] Transmission to humans from insects, dogs, wild animals or water is very rare, and publication of case reports of this transmission is evidence of how exceptional this is. Infection with Strep A ranges from mild to severe, and even rapidly fatal, for instance invasive Strep A infections with bacteraemia. Many mild infections may be subclinical; and people with mild infections may not seek medical attention. This chapter focuses on identification and treatment of the superficial Strep A infections of sore throat and skin sores as the key strategies of primary prevention of ARF and RHD.

Vaccines to prevent Strep A infection have been in various stages of development in several countries since the early 20th century. The large number of Strep A strains makes vaccine development challenging.[20] There are several potential vaccine candidates in the pipeline, including from Australia (See Chapter 14. New Technologies, Strep A Vaccine Development).

Strep A transmission from person to person is increased when there is household crowding, especially when poorly maintained housing conditions make hygiene difficult. Strep A is especially shared around households where there are children with respiratory infections and skin conditions such as impetigo, scabies and head lice.

Strep A throat infections

Colonisation (carriage)

Colonisation or carriage is defined as Strep A cultured from the throat in the absence of symptoms or signs of tonsillitis.[1] Reported throat colonisation rates of Strep A in Australian children vary from <5% in some remote Northern Territory communities to 15% in an urban setting.[21]

Infection (tonsillitis or sore throat)

The acquisition of Strep A (infection) and multiplication of Strep A organisms in the tonsils usually causes clinical symptoms (Table 5.5). This may be associated with an immunological response i.e. a rise in Strep A serological titres e.g. antistreptolysin O (ASO), anti-DNase B.

Individuals already receiving BPG secondary prophylaxis still need treatment for sore throats and skin sores. This is necessary because the level of penicillin achieved by BPG wanes from about 7 days to reach a prophylactic level which is lower than a required treatment level. If the last BPG dose was ≥7 days ago, provide antibiotic dosing in accordance with Table 5.3 for sore throat or Table 5.4 for skin sores.

Figure 5.2. Strep A infection of the throat

Photo courtesy of Professor Asha Bowen, The Kids Research Institute

Where possible, clinicians should consider referral to environmental health or housing services if available and needed, where high risk of ARF has been identified because of homelessness, household crowding, or poor household maintenance. (Chapter 4. Primordial Prevention and Social determinants of ARF)

Symptoms and signs

Table 5.5. Symptoms and signs of a sore throat / tonsillitis † [22]

SYMPTOMS	SIGNS
Throat pain / sore throat	Fever (>38°C)
Difficulty swallowing	Swollen, enlarged tonsils
Not eating as much	Erythematous tonsils with exudate
Not drinking as much	Enlarged, tender cervical lymph nodes
Croaky voice	Absence of cough
Feeling hot	

† High risk patients presenting with one or more of these symptoms should be swabbed for Strep A and provided with treatment.

Clinical scoring of sore throats

Several international clinical scoring methods for predicting Strep A tonsillitis are available. Symptoms and signs are collated using a scoring system e.g. Centor Criteria (elevated temperature, tender anterior cervical adenopathy, tonsillar swelling or exudate, absence of cough or upper respiratory symptoms).[23-25]

Use of these clinical scoring methods is not recommended because none has been validated in the Australian context

Whilst this is the case, it is helpful for clinicians to have a diagnostic algorithm to follow in determining whether Strep A tonsillitis is likely. Until new evidence is available, the following algorithm provides guidance (Figure 5.3).

The utility of clinical scoring systems and new molecular rapid diagnostic tests in predicting the presence of Strep A versus non-Strep A tonsillitis should be evaluated in Australia before being adopted, particularly in First Nations communities.

The challenges of treating sore throats

Timely treatment of Strep A sore throats should prevent ARF, however, only some sore throats are caused by Strep A. Antibiotic treatment of all episodes of clinical tonsillitis would expose a significant proportion of patients to unnecessary medication. Depending on the setting, it is likely that only 20–40% of tonsillitis episodes are caused by Strep A.[2,26] The remainder are mostly caused by viruses or by bacteria for which antibiotic treatment is not recommended.

Health staff will often be more familiar with guidelines that prevent overuse of antibiotics for sore throats. Therefore, awareness of the need for antibiotics to treat sore throats to prevent ARF is an important learning point for all health staff working with populations at high risk of ARF.

Empirical antibiotic treatment of all Australian children presenting with a sore throat is not recommended. In addition to the unwarranted inconvenience, there is cost and potential risk from adverse medication events, while increasing the pressures that promote antibiotic resistance.

People presenting with sore throat who are identified as being at high risk for ARF (Table 5.2), including people who have a history of confirmed ARF or established RHD, should be treated with antibiotics if they develop a sore throat, irrespective of other clinical features, and irrespective (at present) of any testing using rapid tests or culture for confirmation of Strep A infection.[12, 13]

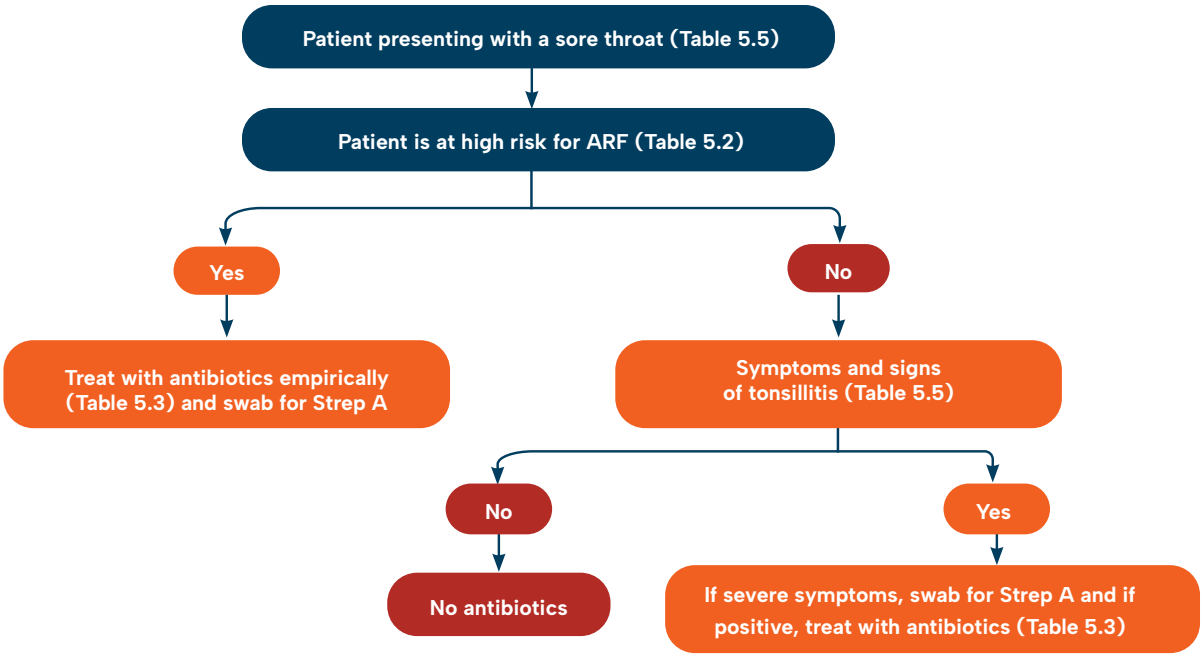


Figure 5.3. Assessment of sore throat

Strep A skin infections

Skin sores or impetigo

The introduction of Strep A through a break in the skin (e.g. insect bite, scabies, head lice, tinea, minor trauma) can result in the development of skin sores (impetigo). Strep A skin sores are often round or linear, 1–2 cm in size and have pus or a thick crust evident (Figure 5.4 and Figure 5.5) Strep A has been known since the 1970s as the predominant primary pathogen in skin sore development,[27] especially in tropical environments, with reinforcement of this important finding recently.[4,15] There is a clear relationship between the prevalence of skin sores in children and the level of household crowding.[28] If a skin sore is present, Strep A is the inciting pathogen, and the sore needs treatment.[4,15]

Figure 5.4. Progression of impetigo from purulent, inflamed and crusted (left), to crusted (middle) to flat and dry (right)

Photos courtesy of Professor Asha Bowen from the Skin Sore Trial[15]

Figure 5.5. Strep A infections of the foot and leg

Photos courtesy of Professor Asha Bowen from the Skin Sore Trial[15]

Antibiotic treatment of skin sores (impetigo)

Strep A skin infection is likely to play a direct and/or indirect role in the development of ARF/RHD. Improved skin health is also likely to have broader health impacts; in regions where there is a high concurrent burden of impetigo and ARF it is likely that improved skin health activities will reduce the overall burden of Strep A-related diseases, including ARF.

Cotrimoxazole and BPG have been compared in a randomised controlled trial in Australian First Nations children. A three-day course of twice-daily or a five-day course of once-daily cotrimoxazole were found to be non-inferior to BPG for treatment of skin sores.[15] Cotrimoxazole had significantly fewer side effects, was well tolerated, and provides a pain-free alternative for treatment of skin sores for children. Work among First Nations groups in Western Australia's Pilbara region found that mothers and grandmothers prefer that treatment options are discussed with them, and they want to be involved in deciding the best solution for their child on each occasion.[29,30,31]

Dressing skin sores may reduce bacterial transmission. Where dressings are available and affordable, covering sores should be done as an adjunct to treatment, and should not be in lieu of treatment with antibiotics.

There is an ongoing need for culturally appropriate health education.[29] Health promotion material related to the identification and management of Strep A infections should be available for community members, nurses and health workers. It should be developed with and by community members in appropriate language and using local metaphors to increase health literacy and empower decision-making. (See Healthy Skin Resources, and Kimberley Health Promotion Resources)[32]

Partnerships between the clinic, community and schools to support children with skin sores by providing school-based education on the risk factors and community attitudes towards skin sores are beneficial.[30,31]

Strep A rapid diagnostics

Simple, reliable, rapid point-of-care tests for detecting Strep A from throat swabs could improve management[33] and are available. A new generation of rapid molecular tests such as polymerase chain reaction (PCR) are as sensitive as culture, with results available in 5-25 minutes.[34] Some have already been approved for use by non-experts at the point of care to detect Strep A tonsillitis, outside of microbiology laboratories.[35,36]

Strep A molecular point-of care tests are being evaluated for use in remote clinics to accurately diagnose Strep A tonsillitis. These tests are not useful for skin sores, as the visual diagnosis of impetigo is sufficient to provide treatment without the need for a confirmatory test.

The role of non-A strains of streptococci

Group C streptococcus (GCS) and group G streptococcus (GGS) are occasionally detected from throat swabs and skin sores during infection. They may be relevant to ARF prevention as described and should be treated similarly to Strep A sore throats and skin sores.

CASE STUDIES

Treatment of Strep A tonsillitis to prevent ARF

Research from the 1950s in the United States military showed that antibiotic treatment of Strep A tonsillitis prevented ARF. Denny et al[12] followed 1602 servicemen admitted to hospital for tonsillitis; 798 received penicillin treatment while 804 controls received no treatment, with blinded follow-up three to four weeks after the initial infection. In the treated group, two patients developed definite ARF and two developed probable ARF (4/798, 0.9%). In the control group, 17 developed definite ARF (relative risk [RR] 8.4), and six developed probable ARF (RR 3.0) (23/804, 2.9%). Microbiological clearance of Strep A was higher in the treated group. A later study showed that even when penicillin treatment was delayed until nine days after the onset of illness when acute symptoms had subsided and when near maximal antibody response had occurred, it was still effective in preventing ARF.[13]

Skin control programs

The STOP Trial in the Kimberley region of Western Australia has confirmed the importance of community wide skin screening and treatment programs to reduce the burden of skin infections. The screening and treatment protocols should be considered in all communities with a high burden of skin sores.[37]

Population-based sore throat management

Sore throat management programs may be effective in a broader context than the military trial described, with reduced incidence and prevalence of ARF and RHD in Costa Rica[38] and Cuba[39] following primary prevention programs.[40] In Costa Rica in the 1970s, a program recommended that all people with clinical signs consistent with possible Strep A throat infections be treated empirically with intramuscular BPG.[38] This was associated with a sharp decline in ARF incidence (70/100,000 in the early 1970s, down to 1/100,000 in 1990), but other factors may have facilitated this as the decline commenced before an increased uptake in the use of BPG injections. A substantial decline in the occurrence and severity of ARF/RHD was reported in Cuba, following a 10-year prevention strategy.[39] A multidimensional strategy focused on the development of a registry and recall system for patients with ARF/RHD and enhanced sore throat management[41] was associated with an 80% decline in ARF incidence. None of these programs only involved sore throat management - secondary prevention of ARF/RHD, health education for the public and healthcare professionals, epidemiological surveillance, and implementation of a national healthcare plan were all included. The success of these programs is assessable only using historical surveillance data and no control groups exist, so it is difficult to accurately quantify the effectiveness of sore throat management strategies.[38,39]

The New Zealand Rheumatic Fever Prevention Program (RFPP; 2012–2017)[42] was one of the most ambitious ARF prevention programs ever conducted. It focused on sore throat management in schools using a widespread health promotion campaign. In addition, accessibility of sore throat treatment through primary care was enhanced. This approach reduced the incidence of ARF in a high-risk setting and further analysis will have lessons for improving primary prevention initiatives elsewhere in NZ and internationally.[43]

REFERENCES

1 Shaikh N, Leonard E, Martin JM. Prevalence of streptococcal pharyngitis and streptococcal carriage in children: a meta-analysis. Pediatrics. 2010;126(3):e557-e564.

2 Oliver J, Malliya Wadu E, Pierse N, et al. Group A Streptococcus pharyngitis and pharyngeal carriage: A meta-analysis. PLOS Neglected Tropical Diseases. 2018;12(3):e0006335.

3 Spinks A, Glasziou PP, Del Mar C B. Antibiotics for sore throat. Cochrane Database of Systematic Reviews. 2013;(11):CD000023.

4 Bowen AC, Tong SY, Chatfield MD, Carapetis JR. The microbiology of impetigo in indigenous children: associations between Streptococcus pyogenes, Staphylococcus aureus, scabies, and nasal carriage. BMC Infect Dis. 2014;14:727.

5 Bowen AC, Mahé A, Hay RJ, et al. The Global Epidemiology of Impetigo: A Systematic Review of the Population Prevalence of Impetigo and Pyoderma. PLOS One. 2015;10(8):e0136789.

6 Lacey JA, Marcato AJ, Chisholm RH, et al. Evaluating the role of asymptomatic throat carriage of Streptococcus pyogenes in impetigo transmission in remote Aboriginal communities in Northern Territory, Australia: a retrospective genomic analysis. The Lancet Microbe. 2023;4(7):e524-e533.

7 Australian Institute of Health and Welfare. Acute rheumatic fever and rheumatic heart disease in Australia. Cat. no: CVD 100, 2024. Australian Institute of Health and Welfare, Canberra.

8 Zabriskie JB, Hsu KC, Seegal BC. Heart-reactive antibody associated with rheumatic fever: characterization and diagnostic significance. Clinical and Experimental Immunology. 1970;7:147-159.

9 Bright PD, Mayosi BM, Martin WJ. An immunological perspective on rheumatic heart disease pathogenesis: more questions than answers. Heart. 2016;102(19):1527-1532.

10 Stollerman GH. Rheumatic fever in the 21st century. Clinical Infectious Diseases. 2001;33(6):806-814.

11 Wannamaker LW. The Chain that Links the Heart to the Throat. Circulation. 1973;48(1):9-18.

12 Denny F, Wannamaker LW, Brink WR, et al. Prevention of rheumatic fever; treatment of the preceding streptococcic infection. Journal of the American Medical Association. 1950;143:151-153.

13 Catanzaro F, Stetso CA, Morris AJ, et al. The role of the streptococcus in the pathogenesis of rheumatic fever. American Journal of Medicine. 1954;17(6):749-756.

14 McDonald M, Currie BJ, Carapetis JR. Acute rheumatic fever: a chink in the chain that links the heart to the throat? Lancet Infectious Diseases. 2004;4(4):240-245.

15 Bowen AC, Tong SYC, Andrews RM, et al. Short-course oral co-trimoxazole versus intramuscular benzathine benzylpenicillin for impetigo in a highly endemic region: an open-label, randomised, controlled, non-inferiority trial. The Lancet. 2014;384(9960):2132-2140.

16 Thornley S, Marshall R, Jarrett P, et al. Scabies is strongly associated with acute rheumatic fever in a cohort study of Auckland children. Journal of Paediatrics and Child Health. 2018;54:625-632.

17 O'Sullivan L, Moreland NJ, Webb RH, et al. Acute rheumatic fever after Group A Streptococcus pyoderma and Group G Streptococcus pharyngitis. The Pediatric Infectious Disease Journal. 2017;36(7):692-694.

18 Jaine R, Baker M, Venugopal K. Epidemiology of acute rheumatic fever in New Zealand 1996– 2005. Journal of Paediatrics and Child Health. 2008;44:564-571.

19 Enkel SJ, Barnes S, Daw J, et al. Systematic Review of Household Transmission of Strep A: A Potential Site for Prevention That Has Eluded Attention, The Journal of Infectious Diseases. 2024;jiae136.

20 Giffard PM, Tong SYC, Holt DC, et al. Concerns for efficacy of a 30-valent M-protein-based Streptococcus pyogenes vaccine in regions with high rates of rheumatic heart disease. PLOS Neglected Tropical Diseases. 2019;13(7):e0007511.

21 Danchin MH, Rogers S, Kelpie L, et al. Burden of acute sore throat and group A streptococcal pharyngitis in school-aged children and their families in Australia. Pediatrics. 2007;120(5):950-957.

22 Pickering J, Sampson C, Mullane M, et al. A pilot study to develop assessment tools for Group A Streptococcus surveillance studies. PeerJ. 202314;11:e14945.

23 Breese B. A simple scorecard for the tentative diagnosis of streptococcal pharyngitis. American Journal of Diseases of Children. 1977;131(5):514-517.

24 McIsaac W, White D, Tannenbaum D, Low DDE. A clinical score to reduce unnecessary antibiotic use in patients with sore throat. Canadian Medical Association Journal. 1998;158(1):75-83.

25 Wald E, Green MD, Schwartz B, Barbadora K. A streptococcal score card revisited. Pediatric Emergency Care. 1998;14(2):109-111.

26 Bisno A, Gerber MA, Jr. GJ, Kaplan EL, Schwartz RH. Practice guidelines for the diagnosis and management of group A streptococcal pharyngitis. Clinical Infectious Diseases. 2002;35(2):113-125.

27 Dajani AS. The Scalded-Skin Syndrome: Relation to Phage-Group II Staphylococci. Journal of Infectious Diseases. 1972;125(5):548-551.

28 Aung PTZ, Cuningham W, Hwang K, et al. Scabies and risk of skin sores in remote Australian Aboriginal communities: A self-controlled case series study. PLOS Neglected Tropical Diseases. 2018;12(7):e0006668.

29 Amgarth-Duff I, Hendrickx D, Bowen A, et al. Talking skin: attitudes and practices around skin infections, treatment options, and their clinical management in a remote region in Western Australia. Rural and Remote Health. 2019.

30 Thomas HMM, Enkel SL, Mullane M, et al. Trimodal skin health programme for childhood impetigo control in remote Western Australia (SToP): a cluster randomised, stepped-wedge trial.The Lancet Child & Adolescent Health. 2024;8(11):809-820.

31 Thomas HMM, Mullane M, Enkel SL, et al. Multi-methods process evaluation of the SToP (See, Treat, Prevent) trial: a cluster randomised, stepped wedge trial to support healthy skin. EClinicalMedicine. 2024;9(77):102793.

32 The Australian Healthy Skin Consortium. National Healthy Skin Guideline: for the Diagnosis, Treatment and Prevention of Skin Infections for Aboriginal and Torres Strait Islander Children and Communities in Australia (2nd edition). 2023.

33 Ralph AP, Holt DC, Islam S, et al. Potential for Molecular Testing for Group A Streptococcus to Improve Diagnosis and Management in a High- Risk Population: A Prospective Study. Open Forum Infectious Diseases. 2019;6(4):ofz097.

34 Pritt BS, Patel R, Kirn TJ, Thomson RB Jr. Point-Counterpoint: A nucleic acid amplification test for streptococcus pyogenes should replace antigen detection and culture for detection of bacterial pharyngitis. Journal of Clinical Microbiology. 2016;54:2413-2419.

35 Cohen DM, Russo ME, Jaggi P, Kline J, Gluckman W, Parekh A. Multicenter clinical evaluation of the novel alere i Strep A isothermal nucleic acid amplification test. Journal of Clinical Microbiology. 2015;53:2258-2261.

36 Wang F, Tian Y, Chen L, et al. Accurate Detection of Streptococcus pyogenes at the Point of Care Using the cobas Liat Strep A Nucleic Acid Test. Clinical Pediatrics. 2017;56(12):1128-1134.

37 Mullane MJ, Barnett TC, Cannon JW, et al. SToP (See, Treat, Prevent) skin sores and scabies trial: study protocol for a cluster randomised, stepped-wedge trial for skin disease control in remote Western Australia. BMJ Open. 2019;9(9):e030635.

38 Arguedas A, Mohs E. Prevention of rheumatic fever in Costa Rica. Journal of Pediatrics. 1992;121(4):569-572.

39 Nordet P, Lopez R, Duenas A, Sarmiento L. Prevention and control of rheumatic fever and rheumatic heart disease: The Cuban experience (1986-1996-2002). Cardiovascular Journal of Africa. 2008;19(3):135-140.

40 Karthikeyan G, Mayosi BM. Is Primary Prevention of Rheumatic Fever the Missing Link in the Control of Rheumatic Heart Disease in Africa? Circulation. 2009;120(8):709-713.

41 Bach J, Chalons S, Forier E, et al. 10-year educational program aimed at rheumatic fever in two French Caribbean islands. The Lancet. 1996;347:644-648.

42 New Zealand Ministry of Health. Rheumatic fever. 23 January 2019.

43 Lennon D, Kerdemelidis M, Arroll B. Meta-analysis of trials of streptococcal throat treatment programs to prevent rheumatic fever. The Pediatric Infectious Disease Journal. 2009;28(7):e259-e264.

CHAPTER 6

Diagnosis of acute rheumatic fever

Diagnosis of acute rheumatic fever

IMPORTANT CHANGES IN THIS CHAPTER

Clarity provided on secondary prophylaxis use for post streptococcal reactive arthritis in high and low risk groups (page 85) (Updated October 2026)

Addition of Summary of Recommendations with GRADE Level of Evidence (Table 6.1)

Clarification of who may be initially managed in the community with suspected ARF (on medical specialist advice)

Addition of "advanced conduction abnormalities" on ECG as a minor manifestation of ARF

Dengue, chikungunya and malaria added to the differential diagnosis of polyarthritis and fever

Section 'Echocardiography and ARF' updated in line with the 2023 World Heart Federation RHD diagnosis guidelines

- Discussion related to valvulitis: minimal echocardiographic criteria diagnosis of acute rheumatic fever for pathological regurgitation removed
- Discussion related to morphological changes associated with rheumatic carditis removed

Clarification that echocardiography cannot accurately determine the timing or duration of rheumatic valve changes

Updated considerations for managing suspected and confirmed ARF in the community (on specialist advice)

KEY INFORMATION

- Diagnosis of ARF results leads to opportunity for secondary prophylaxis with benzathine benzylpenicillin G (BPG), which can prevent recurrent ARF and cumulative heart valve damage.
- Patients with sterile joint aspirates should never be treated speculatively for septic arthritis without further investigation, particularly in areas with a high ARF/RHD prevalence.
- Over-diagnosis results in the individual receiving BPG injections unnecessarily and an increased use of health system resources.
- Recurrent definite, probable or possible ARF is generally not diagnosed until more than 90 days after a previous episode of ARF, to account for prolonged or rebound symptoms related to the original episode.
- Ideally, anyone suspected to have ARF should be admitted to a hospital as soon as possible for specialist review and echocardiography. However, some people may be managed within the community on the advice of a medical specialist.
- Echocardiogram is mandatory for all people suspected and confirmed with ARF. Echocardiogram can enable a confirmation of ARF by demonstrating carditis which may not be clinically evident. It is also used to establish a baseline of cardiac status, and to determine whether valve damage (acute carditis or established RHD) is present and if so, to determine the severity.
- Electrocardiogram is also mandatory for all suspected and confirmed ARF. While first degree heart block (prolonged P-R interval) is most common, advanced conduction abnormalities (second-degree heart block, complete heart block or accelerated junctional rhythm) occur in approximately 8% of those presenting with ARF (Figures 6.9 to 6.11) and are highly specific for ARF, in the presence of other ARF diagnostic criteria.[1]
- An ARF diagnosis calculator app is available to support clinicians in the diagnosis of ARF.
- For each episode of suspected ARF, a final diagnosis should be reached and specified as either:
    - Definite ARF (confirmed).
    - Probable ARF (highly suspected).
    - Possible ARF (uncertain.
    - Definite ARF recurrence.
    - Probable ARF recurrence.
    - Possible ARF recurrence.
    - Not ARF.
- The final diagnosis and age of the patient determines the subsequent management recommendations, including need for and duration of secondary prophylaxis with BPG; frequency of follow-up echocardiograms; and frequency of primary care and specialist reviews (Table 10.3, Table 7.4).

Table 6.1. Summary of recommendations with GRADE Level of Evidence

RECOMMENDATION	GRADE
Anyone suspected to have ARF who is high risk for complications should be admitted to a hospital within 24–72 hours for echocardiography and specialist review.	1B
Echocardiogram is indicated for all suspected and confirmed ARF as a baseline and to determine underlying carditis or valve damage.	1A
Echocardiography is more sensitive and specific for acute rheumatic carditis than auscultation.	1A
Electrocardiogram (ECG) is indicated for all suspected and confirmed ARF.	1A
Testing CRP alone can result in a missed diagnosis of definite ARF when ESR is ≥30 mm/h but CRP is <30 mg/L.	1B
Molecular methods of Strep A detection, including rapid point-of-care tests, are more sensitive than culture.	1C
Many of the clinical features of ARF are non-specific, so a wide range of differential diagnoses should be considered.	1A
Streptococcal antibody titres are the most useful modality for detecting a recent Strep A infection if bacterial culture is negative.	1C
Streptococcal titre should be determined in the acute phase, and then in the convalescent phase 14–28 days later, with a positive result defined as a rise in titre of twofold or more.	2A
If only a single pathological specimen is available, a streptococcal titre greater than the ULN at initial testing be considered presumptive evidence of a preceding Strep A infection.	1C
Sydenham chorea alone is enough to confirm ARF provided other causes of chorea are excluded	1A
Suspected ARF (without Sydenham chorea) requires elevated serum streptococcal serology demonstrated to enable confirmation of a diagnosis of ARF.	1C
Patients with sterile joint aspirates should be investigated further, particularly in areas with a high ARF/RHD prevalence.	1B
A definite history of arthritis is sufficient to satisfy arthritis as a major manifestation of ARF.	1C
Monoarthritis is a major manifestation in high risk groups.	1C
ARF should always be considered a differential diagnosis for individuals from a high-risk population presenting with monoarthritis.	1A
Withholding NSAIDs in patients with monoarthralgia or monoarthritis, to observe the development of polyarthritis, can also help in confirming a diagnosis of ARF.	1C
Echocardiography is essential for all patients with Sydenham chorea	1A

Table 6.2. Risk groups for ARF

At high risk	Living in an ARF-endemic setting† First Nations peoples living in rural or remote settings First Nations peoples, and Māori and/or Pacific Islander peoples living in metropolitan households affected by crowding and/or lower socioeconomic status Personal history of ARF/RHD and aged <40 years
May be at high risk	Family or household recent history of ARF/RHD Household overcrowding (>2 people per bedroom) or low socioeconomic status Migrant or refugee from low- or middle-income country and their children
Additional considerations which increase risk	Prior residence in a high ARF risk setting Frequent or recent travel to a high ARF risk setting Aged 5–20 years (the peak years for ARF)

† This refers to populations where community ARF/RHD rates are known to be high e.g. ARF incidence >30/100,000 per year in 5–14-year-olds or RHD all-age prevalence >2/1000 (Figure 3.4).

Probable or possible ARF (first episode or recurrence[§])	A clinical presentation in which ARF is considered a likely diagnosis but falls short in meeting the criteria by either: • one major or one minor manifestation, or • no evidence of preceding Strep A infection (streptococcal titres within normal limits or titres not measured) Such cases should be further categorised according to the level of confidence with which the diagnosis is made: • Probable ARF (previously termed 'probable: highly suspected') • Possible ARF (previously termed 'probable: uncertain')	
Major manifestations	Carditis (including subclinical evidence of rheumatic valvulitis on echocardiogram) Polyarthritis[¶] or aseptic monoarthritis or polyarthralgia Sydenham chorea[††] Erythema marginatum[‡‡] Subcutaneous nodules	Carditis (including subclinical evidence of rheumatic valvulitis on echocardiogram) Polyarthritis[¶] Sydenham chorea[††] Erythema marginatum[‡‡] Subcutaneous nodules
Minor Manifestations	Fever ≥38°C[§§] Monoarthralgia[¶¶] ESR ≥30 mm/h or CRP ≥30 mg/L Prolonged P-R interval or advanced conduction abnormalities on ECG[††† ‡‡‡]	Fever ≥38.5°C Polyarthralgia or aseptic monoarthritis[¶¶] ESR ≥60 mm/h or CRP ≥30 mg/L Prolonged P-R interval or advanced conduction abnormalities on ECG[††† ‡‡‡]

† High-risk groups are those living in communities with high rates of ARF (incidence >30/100,000 per year in 5–14-year-olds) or RHD (all-age prevalence >2/1000). First Nations peoples living in rural or remote settings are known to be at high risk. Data are not available for other populations but First Nations peoples living in urban settings, Māori and Pacific Islanders, and potentially immigrants from developing countries, may also be at high risk.

‡ Elevated or rising antistreptolysin O or Anti-DNase B, or a positive throat culture or rapid antigen or nucleic acid test for preceding Strep A infection.

§ Recurrent definite, probable or possible ARF requires a time period of more than 90 days after the onset of symptoms from the previous episode of definite, probable or possible ARF.

¶ A definite history of arthritis is sufficient to satisfy this manifestation. Note that if polyarthritis is present as a major manifestation, polyarthralgia or aseptic monoarthritis cannot be considered an additional minor manifestation in the same person.

†† Chorea does not require other manifestations or evidence of preceding Strep A infection, provided other causes of chorea are excluded.

‡‡ Care should be taken not to label other rashes, particularly non-specific viral exanthems, as erythema marginatum.

§§ In high-risk groups, fever can be considered a minor manifestation based on a reliable history (in the absence of documented temperature) if anti-inflammatory medication has already been administered.

¶¶ If polyarthritis is present as a major criterion, monoarthritis or arthralgia cannot be considered an additional minor manifestation.

††† Advanced conduction abnormalities include second-degree heart block, complete heart block or accelerated junctional rhythm.

‡‡‡ If carditis is present as a major manifestation, a prolonged P-R interval cannot be considered an additional minor manifestation.

Table 6.4. Suggested upper limits of normal (ULN) for serum streptococcal antibody titres in children and adults[2]

AGE GROUP	ULN (U/ML)	
(years)	**ASO titre**	**Anti-DNase B titre**

1–4	170	366
5–14	276	499
15–24	238	473
25–34	177	390
≥35	127	265

Anti-DNase B: antideoxyribonuclease B, ASO: antistreptolysin O, ULN: upper limit of normal.

Table 6.5. Upper limits of normal for P–R interval

AGE GROUP (YEARS)	SECONDS
3–11	0.16
12–16	0.18
17+	0.20

Source: Adapted from Park MK, Pediatric cardiology for practitioners, 2nd ed. Chicago: Year Book Medical; 1998.

DISCUSSION

"We now know she had some of the symptoms of the fever (acute rheumatic fever) but at the time we had no idea what was going on with her, we put it down to growing pains. We had a lack of understanding about ARF & RHD."

RHD Champion, 2019

ARF is a self-limiting, inflammatory illness that occurs in response to an untreated Strep A infection. Currently, there is no diagnostic laboratory test for ARF, so diagnosis remains a clinical decision based on the ARF diagnostic algorithm. The pre-test probability for the diagnosis of ARF varies according to location and ethnicity. For example, in a region with a high incidence of ARF, a person with fever and arthritis is more likely to have ARF than in a low-incidence region. Similarly, in Australia, First Nations peoples are more likely than other people to have ARF.

Difficulties with ARF diagnosis

The diagnosis of ARF relies on health professionals being aware of the diagnostic features, particularly when presentation is delayed or atypical. Populations with the highest incidence of ARF are often the most isolated. A prospective study of ARF in Australian children found that there were delays in both the presentation and referral of patients.[3] There was little difference in the proportion of delayed presentations and delayed referrals between urban/rural areas and remote areas (range: 16–20%). There was also little difference in the median time of delayed presentation and referral between the two geographical locations (14–17 days for all groups). This highlights the importance of:

- Increasing awareness of the symptoms of ARF among the broader community.
- Training health staff to recognise potential ARF when it does present and ensuring rapid referral for specialist review and confirmation of the diagnosis.

Many medical practitioners and other health staff in Australia have never seen a case of ARF, because the disease has largely disappeared from the affluent and non-Indigenous populations among whom they trained and work. This may partly explain why up to 78% of newly diagnosed cases of RHD have not been previously diagnosed with ARF.[4]

Health staff moving to, and working in, areas with high rates of ARF and RHD (e.g. remote locations) should receive appropriate training on identifying and managing people suspected to have ARF. Regular workforce education should be provided to health staff working with First Nations communities. (See eLearning programs)

Indication for hospitalisation

ARF can be difficult to diagnose, and some people are at higher risk of complications. Generally, ARF and probable ARF should be initially managed in hospital to facilitate access to timely workup – most importantly echocardiography, to commence clinical management and education, and to plan follow up.

Hospitalisation is important for timely investigations including blood testing, ECG, echocardiography and specialist review, monitoring of fever and joint symptoms, and health education (with family where possible). Notably, many people with suspected ARF ultimately are found to have a non-ARF diagnosis made; many of these diagnoses are serious conditions requiring hospitalisation, such as severe lupus or sepsis presenting as polyarthralgia / polyarthritis. Hospitalisation will maximise the likelihood of an accurate diagnosis, ensure prompt and optimal treatment, and formulate a longer-term management plan and clear arrangements for follow-up. However, some people with suspected or newly confirmed ARF are at lower risk of complications of ARF and could be managed in the community following advice and with ongoing support from a medical specialist. As a guide, those who may not need immediate transfer to hospital should meet ALL of the following criteria:

- Mild symptoms of possible ARF such as mild arthralgia, **and**
- No symptoms or signs of any new cardiac involvement, **and**
- Patient able to attend clinic regularly over a number of days for assessment of evolving symptoms, **and**
- Presence in primary care of a medical practitioner who can assess and make a diagnosis, **and**
- No persisting fever, **and**
- Can access echocardiography as an outpatient within 2 weeks, **and**
- No other high risk factors (e.g. pregnancy, aged less than 10 years, multiple recurrent ARF episodes, post valve surgery), **and**
- There has been discussion with a relevant specialist with experience and expertise in ARF, **and**
- Differential diagnoses can be considered and worked up appropriately in primary care.

Evolution of the Jones criteria and unifying American and Australian guidelines

The Jones criteria for the diagnosis of ARF were developed in the USA and introduced in 1944.[5] The criteria divide the clinical features of ARF into major and minor manifestations, based on their prevalence and specificity. Major manifestations are those that make the diagnosis more likely, whereas minor manifestations are considered suggestive, but insufficient on their own, for a diagnosis of ARF. The exception to this is in the diagnosis of recurrent ARF, which may be made on minor manifestations alone. The Jones criteria have been periodically modified and updated since 1944. Up to 1992,[6] each change was made to improve the specificity of the criteria at the expense of sensitivity, largely in response to the falling incidence of ARF in the USA. As a result, the criteria were sometimes found to be inadequately sensitive to pick up disease in high-incidence populations, where the consequences of under-diagnosis may be greater than those of over-diagnosis. Clinicians caring for First Nations patients were increasingly recognising cases of ARF that did not fulfil the 1992 version of the Jones criteria.[3,7,8]

In 2001, an expert group convened by the World Health Organization (WHO) provided additional guidelines as to how the Jones criteria should be applied in primary and recurrent episodes.[9] In 2006, this was taken further in the first version of the Australian guidelines, which proposed additional criteria for high-risk groups, particularly First Nations peoples.[10] Specifically, subclinical carditis, aseptic monoarthritis and polyarthralgia were included as major manifestations in high-risk groups in the 2006 edition. Subsequently in 2012, monoarthralgia was included as a minor manifestation in the second edition of the Australian guidelines.[11]

In 2015, the American Heart Association (AHA) further revised the Jones criteria to separate moderate-high and low-risk populations, and to include echocardiography as a tool to diagnose cardiac involvement.[12] They noted that the new guidelines aligned more closely with the Australian guidelines and these 2015 re-revised Jones criteria were endorsed by the World Heart Federation.

Criteria used in New Zealand differ based on local research findings: polyarthralgia is considered a minor criterion (although hip pain and limp is considered to fulfil the diagnosis of arthritis, a major criterion), and in the New Zealand 2024 Guideline, transient advanced atrioventricular block (second- or third-degree heart block or junctional rhythm) is included as a major criterion when accompanied by other manifestations of ARF.[13]

In the third edition of the Australian guidelines for diagnosis of ARF, minor changes are made to the 2012 Australian guidelines to bring them in alignment with the 2015 AHA revised Jones criteria.[4] The four specific changes to the 2012 Australian guidelines are:

- In low-risk populations, subclinical carditis is now a major criterion.
- In low-risk populations, ESR as a minor criterion is now ≥60 mm rather than ≥30 mm.
- In low-risk populations, fever as a minor criterion is now ≥38.5°C rather than ≥38.0°C.
- For a definite recurrent episode of ARF in a patient with known past ARF or RHD, the requirements are now 2 major, or 1 major and 2 minor, or 3 minor criteria, rather than 2 major, or 1 major and 1 minor, or 3 minor criteria.

These changes mean that the 2020 Australian criteria for diagnosis of ARF are now fully aligned with the 2015 AHA Jones criteria. The exception is in the classification of ARF certainty: Australia guidelines provide for definite, probable and possible ARF categories (see below) whereas AHA guidelines provide for only definite and possible ARF. One issue to note is that in high-risk groups, fever can be considered a minor manifestation based on a reliable history (in the absence of documented temperature) if antipyretic medication has already been administered.

Table 6.6. Evolution of diagnostic criteria for ARF since 1992

MANIFESTATION	AHA 1992	WHO 2003	AUSTRALIA 2006		AUSTRALIA 2012		AUSTRALIA 2020 AHA 2015	
			High Risk	Low Risk	High Risk	Low Risk	High Risk	Low Risk
Carditis	Major	Major	Major		Major		Major	
Subclinical carditis	--	--	Major		Major	--	Major	
Prolonged P-R interval	Minor	Minor	Minor		Minor		Minor	
Polyarthritis	Major	Major	Major		Major		Major	
Polyarthralgia	Minor	Minor	Major	Minor	Major	Minor	Major	Minor
Aseptic monoarthritis	--	--	--	--	Major	Minor	Major	Minor
Monoarthralgia	--	--	--	--	Minor	n/a	Minor	--
Subcutaneous nodules	Major	Major	Major		Major		Major	
Sydenham chorea	Major	Major	Major		Major		Major	
Erythema marginatum	Major	Major	Major		Major		Major	
Fever	Minor	Minor	Minor		Minor		Minor	
							Temp ≥38°C	Temp ≥38.5°C
Raised inflammatory markers	Minor	Minor	Minor		Minor		Minor	
							ESR ≥30 mm/h	ESR ≥60 mm/h
Evidence of recent Group A streptococcal infection	Required	Required	Required		Required		Required	

AHA: American Heart Association. ESR: erythrocyte sedimentation rate. WHO: World Health Organization.

ARF categorised as definite (confirmed), probable (highly suspected) or possible (uncertain)

The 2006 Australian guidelines suggested that, for patients who did not fulfil the criteria, but in whom the clinician suspected ARF, it would be reasonable to administer a single dose of BPG and perform an echocardiogram within one month, looking for evidence of rheumatic valvular damage.

While patients with suspected ARF may have an alternative diagnosis and not ARF, they may also truly have ARF but not fulfil the criteria for definite (confirmed) ARF for a number of reasons:[8,14-16] atypical presentations with variability from the historical Jones clinical criteria and even from the current less strict criteria; delayed presentation (more than 20% of cases in one study) which can affect both clinical features and laboratory results; and incomplete investigation, missing one or more of erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), electrocardiogram (ECG) or streptococcal serology. For example, ESR and/or CRP testing was absent for 19% of 151 children with ARF identified during a national study of ARF in children, and diagnosis was unable to be confirmed for another eight children in whom timely streptococcal serology was not done.[3] The absence of ESR result may also reflect transport issues as specimens must be at the laboratory ideally within 4 hours but at least within 24 hours of collection for ESR to be measured. The issue of incomplete investigation should be at least partially addressed by transfer to hospital, where indicated. Nevertheless, it is important to note that diagnostic capabilities for such investigations may be limited or absent in many low-resource countries or remote settings where ARF and RHD remain major issues (Table 7.3).

Since 2012, additional categories of probable and possible ARF are provided to include patients who did not satisfy the criteria for definite (confirmed) ARF but in whom the clinician felt that ARF was the most likely diagnosis. Probable ARF was defined as a clinical presentation that falls short by either one major or one minor manifestation, or the absence of streptococcal serology results (but one in which ARF was considered the most likely diagnosis). It has become clear that while many of these patients most likely did have ARF and some progressed to RHD, the diversity of such presentations includes a substantial number of patients who likely never had ARF. Nevertheless, commencement of secondary prophylaxis with BPG and follow-up echocardiogram is required for all those in this diverse group. To avoid unnecessarily prolonged secondary prophylaxis with BPG, while still emphasising the critical importance of follow-up, the categories of probable (highly suspected) ARF and possible (uncertain) ARF have now been clarified with different management timelines for follow-up and duration of BPG specified for each category (Table 10.3, Table 7.4). For categorising into probable and possible ARF, emphasis is placed on whether ARF is considered the most likely diagnosis, and that decision should be made in consultation with a paediatric or medical specialist with experience in the diagnosis of ARF.

Important points about ARF diagnosis in difficult cases

- Patients presenting with monoarthritis should be considered to have septic arthritis until proven otherwise.
- Patients presenting with polyarthritis or polyarthralgia should be thoroughly investigated for alternative diagnoses, including arboviral infections and disseminated gonococcal infection in regions where these diseases are prevalent, as outlined in the notes in Table 6.9.
- Make sure all investigations are conducted, both for ARF and for potential differential diagnoses, depending on the clinical presentation.

The management implications of making a diagnosis of probable or possible ARF are outlined in Chapter 7, Management of ARF (Table 7.4).

CLINICAL FEATURES OF ARF: MAJOR MANIFESTATIONS

Overview

The nature of ARF presentations is highly diverse and may vary geographically and by ethnicity. Presentations are often subtle and evolve over time. If clinicians are expecting to find a constellation of ARF diagnostic criteria simultaneously in one individual, they are likely to be missing mild cases of ARF, such as those who present with joint pain and fever only. Skin and subcutaneous manifestations are uncommon but do appear to vary in frequency across populations; this may be partly because of greater difficulty appreciating erythema marginatum on deeply pigmented skin.

A comparison of types of presentation between an Australian setting and New Zealand revealed slight differences, with carditis, erythema marginatum and subcutaneous nodules being more common in New Zealand.[11] A much higher rate of arthritis presentations without other major manifestations in Australia may in part reflect differences in diagnostic approaches (polyarthralgia being permitted as a major manifestation in Australia but not New Zealand).

Arthritis

Arthritis is defined as a swollen and hot joint with pain on movement. Arthralgia differs from arthritis in that there is pain on joint movement without evidence of swelling or heat (See Arthralgia). Monoarthritis is involvement of a single joint while polyarthritis is involvement of more than one joint, either at the same time or sequentially. Arthritis is the most common presenting symptom of ARF, yet diagnostically, it can be the most difficult. It is usually asymmetrical and migratory (one joint becoming inflamed as another subsides) but may be additive (multiple joints progressively becoming inflamed without waning). Large joints are most commonly affected, especially the knees and ankles, and symptoms can be transient. Arthritis of the hip is often difficult to diagnose, because objective signs may be limited to a decreased range of movement.

The arthritis is usually extremely painful on movement, often out of proportion to the clinical signs. It is exquisitely responsive to treatment with non-steroidal anti-inflammatory drugs (NSAIDs) including aspirin. This can be a useful diagnostic feature, as arthritis continuing unabated more than three days after starting NSAID therapy is unlikely to be due to ARF. Equally, withholding NSAIDs in patients with monoarthralgia or monoarthritis, to observe the development of polyarthritis, can also help in confirming a diagnosis of ARF. Paracetamol may be used to relieve pain in children in the interim (Table 7.1). This approach needs to be balanced with prioritising patient welfare by ensuring pain is adequately relieved.

Figure 6.1. Redness and swelling of right ankle associated with arthritis.

Because of the migratory and evanescent nature of the arthritis, a reliable history of arthritis, rather than observation by the clinician, is sufficient to satisfy this manifestation.

ARF should always be considered in the differential diagnosis of patients in high-risk populations presenting with arthritis. Arthritis caused by ARF is not uncommonly initially attributed by a patient and family to a minor traumatic event which may have occurred, such as with sporting activities. In the hospital setting, physicians and surgeons should collaborate when the diagnosis of arthritis is unclear. Joint aspiration for microscopy, culture and molecular testing for Neisseria gonorrhoeae, in appropriate clinical circumstances and ages, is recommended. Patients with sterile joint aspirates should never be treated speculatively for septic arthritis without further investigation, particularly in areas with a high ARF/RHD prevalence.[17]

In high-risk populations in Australia, monoarthritis or polyarthralgia are common manifestations of ARF and are often associated with overt or subclinical carditis.[15] While ARF can present as monoarthritis, septic arthritis should initially be ruled out. Monoarthritis was present in 19% of high-risk children with ARF and accounted for 24% of all joint manifestations of ARF in a two-year prospective, national study of ARF in children.[2] Monoarthritis was first included as a major manifestation of ARF for high-risk groups in the 2006 Australian guidelines[18,19] to increase sensitivity in populations at high risk of developing RHD.

In these high-risk populations, aseptic monoarthritis or polyarthralgia may be considered as a major manifestation, in place of polyarthritis (Table 6.3). However, alternative diagnoses should be carefully excluded (Table 6.9).

Patients presenting with monoarthritis should be thoroughly investigated for septic arthritis, as well as rheumatic fever and any other relevant differential diagnoses. Once initial investigations have been sent, including joint aspirate for microscopy and culture (collected appropriately to avoid clotting of the sample), it may be appropriate to treat presumptively with empirical antibiotics appropriate to cover septic arthritis pathogens until an alternative diagnosis, such as rheumatic fever, is confirmed. However, in high-risk populations, such as First Nations communities, ARF should always be considered in the differential diagnosis. Monoarthritis may also be the presenting feature, especially if anti-inflammatory medication is commenced early in the illness prior to other joints becoming inflamed.

Figure 6.2. Polyarthritis of the fingers in ARF demonstrating inter-phalangeal joint swelling

Source: Photo courtesy of Professor Bart Currie, Menzies School of Health Research.

Sydenham chorea

Confirmation of Sydenham chorea alone is enough to satisfy a diagnosis of definite ARF.

This manifestation predominantly affects females, particularly in adolescence.[20,21] It is common in First Nations peoples (between 12%[22] and 28%[21] of ARF presentations in this population). Sydenham chorea consists of jerky, uncoordinated and uncontrollable movements, especially affecting the hands, feet, tongue and face. The movements disappear during sleep. They may affect one side only (hemichorea).

The motor features of Sydenham chorea may be stigmatising, confusing to patients and their families and misclassified as willful misbehaviour and contributes to school absenteeism.

Clinical signs include:

- 'Milkmaid's grip' (rhythmic squeezing when the patient grasps the examiner's fingers).
- 'Spooning' (flexion of the wrists and extension of the fingers when the hands are extended).
- 'Pronator sign' (turning outwards of the arms and palms when held above the head).
- Inability to maintain protrusion of the tongue.

Other examples of Sydenham chorea:

https://youtu.be/JPlvvGFn9vM

https://youtu.be/apjTB2NOdYs

https://www.youtube.com/watch?v=4O5IfwOHcXk

https://www.youtube.com/watch?v=VFBOTwmVA0A

As well as the motor manifestations, up to 50% of children with Sydenham's chorea have neuropsychi-atric manifestations. These may pre-date the appearance of the motor manifestations by weeks. Symptoms may comprise new-onset emotional lability, anxiety, attention deficit or hyperactivity, depression and obsessive-compulsive disorder.[23-25] These features are often under-appreciated and can persist for years.[23,26] Such symptoms should be sought through sensitive history taking, with reassurance provided that these are part of the medical illness. Because chorea may occur after a prolonged latent period following Strep A infection,[27-29] the diagnosis of ARF under these conditions does not require the presence of other manifestations or elevated plasma streptococcal antibody titres. Patients with pure chorea may also have a mildly elevated ESR (for example 40 mm/h) but have a normal serum CRP level and white cell count.[21,30,31]

Chorea is the ARF manifestation most likely to recur and may occur in pregnancy or with oral contraceptive use. Chorea in a pregnant First Nations woman should be suspected as Sydenham chorea and investigated. The majority of cases resolve within six months (usually within six weeks), although rare cases lasting three years have been documented.

During outbreaks of ARF in the USA in the 1980s, up to 71% of patients with chorea were found to have carditis.[32] Studies in Australia indicate that between 25%[21] and 48%[11] of First Nations peoples with rheumatic chorea have evidence of carditis, and 78% have either carditis or established RHD.[33] Approximately 25% of patients with chorea without detected cardiac involvement also eventually developed RHD in studies from the 1940s and 1980s.[34,35] This highlights the importance of early follow-up echocardiography in all people with ARF, including those without evidence of carditis initially, to detect evolving cardiac pathology. Echocardiography is essential for the assessment of all patients with chorea to assess for carditis and/or RHD, regardless of the presence of cardiac murmurs. Even in the absence of echocardiographic evidence of carditis, patients with chorea should be considered at risk of subsequent cardiac damage. Therefore, they should all receive secondary prophylaxis and be carefully followed up with echocardiography for the subsequent development of RHD (See Chapter 7. Management of ARF, Treatment of Sydenham chorea).

Carditis

Rheumatic carditis refers to the active inflammation of the endocardium, most importantly the valvular endocardium, with or without involvement of the myocardium and pericardium, which occurs in ARF. While myocarditis[36] and pericarditis[18,37] may occur in ARF, the predominant manifestation of carditis is the involvement of the endocardium presenting as a valvulitis, especially of the mitral and aortic valves.[16,34] Only rheumatic endocarditis and, more specifically, valvulitis, counts for diagnosis of carditis as a major criterion in Australian and AHA criteria.[20] To meet the diagnostic definitions for the major criterion "carditis", there must be pathologic regurgitation of the mitral and/or aortic valve.[18,37] The incidence of carditis in initial attacks of ARF varies between 30% and 82%.[9,21,37,38]

The clinical picture of carditis in ARF and the timing of the appearance of cardiac findings are variable. In many patients with ARF, evidence of carditis can be found at presentation, along with fever and arthritis, but in some patients, signs of carditis appear after presentation, usually within the first two to six weeks,[39-41] and repeated examination during admission is therefore important.[42] A less common presentation of rheumatic carditis is the so-called 'insidious onset' or 'indolent' carditis. This mode of presentation was described in the USA in the first half of the twentieth century and is characterised by a subacute illness of several weeks in children aged under six years with mild or no fever, few joint symptoms and relatively severe cardiac involvement. Insidious onset carditis may be under recognised in First Nations children, in which case, it could potentially explain some cases of RHD presenting without a documented history of ARF. However, such presentations in themselves do not constitute definitive evidence of insidious onset carditis since prior discreet episodes of ARF may have occurred but were not diagnosed.

Clinical examination findings of carditis are insensitive and nonspecific. Only more severe disease resulting in significant regurgitation or congestive cardiac failure tends to be detected clinically by most practitioners. Examination findings are commensurate with the nature and degree of cardiac involvement. They are, in order of decreasing frequency:

- Significant murmur.
- Cardiac enlargement.
- Cardiac decompensation.
- Pericardial friction rub or effusion.

An important component of the clinical examination is ECG, which may show conduction abnormalities (first, second, third degree heart block; junctional rhythm), or sinus tachycardia.

Definitive diagnosis is made on the basis of evidence of valvulitis on echocardiogram.[4]

A significant organic (pathological) murmur as a sign of valvulitis is the most common clinical manifestation of rheumatic carditis. Reliance on auscultation, at least in established RHD, is highly unreliable.[43] Valvulitis most commonly affects the mitral valve, leading to mitral regurgitation (MR), although with prolonged or recurrent disease scarring, may lead to stenotic lesions (See Chapter 8. Diagnosis of RHD, Mitral valve disease).[44] MR presents clinically as an apical blowing, holosystolic (pansystolic) murmur. The presence of an associated mid-diastolic flow murmur (Carey Coombs murmur, reflecting blood flow across the thickened mitral valve) implies significant mitral valve regurgitation; however, it must be differentiated from the diastolic murmur of mitral stenosis (MS), which is often preceded by an opening snap. The Carey Coombs murmur disappears if the mitral valvulitis improves. Aortic valvulitis manifests as aortic regurgitation (AR) and is characterised by a decrescendo early diastolic murmur heard at the base of the heart (aortic area) or left sternal edge, accentuated by the patient sitting forward in held expiration.

During the first episode of ARF, carditis is often but not always mild,[38,45] and echocardiographic findings may precede clinical evolution of a murmur.[42,46,47]

Even moderate valvular lesions can go undetected by auscultation,[42] emphasising the importance of echocardiographic evaluation in making the diagnosis of rheumatic carditis.

Cardiac enlargement can be detected clinically by the displacement of the apical impulse and confirmed on echocardiography or chest X-ray. Cardiac failure in ARF results from valvular dysfunction, secondary to severe valvulitis, and is not due to primary myocarditis.[39,47,48] Cardiac decompensation occurs in less than 10% of patients during their first episode,[44,45,49-51] and is more common in patients with recurrent attacks of ARF.[44,45,49,52] The physical findings of heart failure are variable, and depend on the severity of disease and age of the patient. Findings of heart failure in younger children can be subtle, and may include tachypnoea, resting tachycardia, displaced apex beat, basal crepitations, hepatomegaly and facial puffiness. In older patients, the more classical findings of frank pulmonary oedema, raised jugular venous pressure and bipedal oedema may be elicited.

Pericarditis is uncommon in ARF, and is rarely, if ever, an isolated finding.[53-55] Pericarditis should be suspected in patients with ARF who have chest pain. The main clinical finding of pericarditis is a friction rub, which is characterised by a superficial scratching or grating sound on auscultation of the precordium. A pericardial effusion may also be present and is suspected if there is muffling of the heart sounds. If pericarditis is present, the friction rub may obscure valvular murmurs. Sinus tachycardia is a non-specific manifestation of ARF. In the absence of a fever and pain, the presence of sleeping tachycardia should raise the suspicion of carditis.

Subcutaneous nodules

These are rare (less than 2% of cases) but are considered highly specific manifestations of ARF.[15] Nodules are usually 0.5–2 cm in diameter, round, firm, freely mobile and painless nodules that occur in crops of up to 12 over the elbows, wrists, knees, ankles, Achilles tendon, occiput and posterior spinal processes of the vertebrae. They tend to appear one to two weeks after the onset of other symptoms, last only one to two weeks (rarely more than a month) and are strongly associated with carditis.

Figure 6.3. Example of subcutaneous nodules on the inner aspect of the wrist

Figure 6.4. Example of subcutaneous nodules on the knee

Erythema marginatum

Erythema marginatum is also rare, being reported in less than 2% of cases.[11] As with subcutaneous nodules, erythema marginatum is considered highly specific for ARF.

It occurs as bright pink macules or papules that blanch under pressure and spread outwards in a circular or serpiginous pattern. It is rapidly evanescent (that is, waxes and wanes during the course of a day). It has similarities with urticaria, with some claiming Erythema marginatum is urticaria.[56] However, a key distinguishing feature is that the lesions of erythema marginatum are not itchy or painful. They occur on the trunk and proximal extremities, but almost never on the face. The rash can be difficult to detect in darkly pigmented skin, so close inspection is required. The rash is not affected by anti-inflammatory medication, and may recur for weeks or months, despite resolution of the other features of ARF. The rash may be more apparent after showering.

Figure 6.5 Erythema marginatum on the back

Note the erythematous lesions with pale centers and rounded or serpiginous margins.

Reproduced with permission from: Binotto MA, Guilherme L, Tanaka AC. Rheumatic fever. Images Paediatric Cardiology 2002; 11:12. Copyright © 2002 Images in Paediatric Cardiology. Graphic 50841 Version 2.0

Figure 6.6. Examples of erythema marginatum

Source: DermNet, (New Zealand) at https://creativecommons.org/licenses/by-nc-nd/3.0/nz/legalcode

Table 6.7. Key points in identifying major manifestations of ARF

MANIFESTATION	POINTS FOR DIAGNOSIS
Arthritis	Most common presenting symptom of ARF Usually extremely painful Polyarthritis (or polyarthralgia) is usually asymmetrical and migratory but can be additive Monoarthritis may be a presenting feature in high-risk populations Large joints are usually affected, especially knees and ankles Should respond within three days of starting NSAID therapy, including aspirin
Sydenham chorea	Present in up to one-quarter of ARF presentations, particularly females, and predominantly in adolescence Consists of jerky, uncoordinated movements, especially affecting the hands, feet, tongue and face, disappears during sleep Neuropsychiatric features such as decreased school performance, emotional lability, anxiety and obsessional disorder may be present Echocardiography is essential for all patients with chorea
Carditis	Asymptomatic unless moderate or severe If moderate or severe, usually presents clinically as an apical holosystolic (pansystolic) murmur (MR), and/or an early diastolic murmur at the base of the heart or left sternal edge (AR) May only be detected using echocardiography (subclinical carditis)
Subcutaneous nodules	Rare, but highly specific, manifestation of ARF and strongly associated with carditis Present as crops of small, round, painless nodules over the elbows, wrists, knees, ankles, Achilles tendon, occiput and posterior spinal processes of the vertebrae
Erythema marginatum	Extremely rare, as well as difficult to detect in darker skin pigmentation; highly specific for ARF Occurs as circular patterns of bright pink macules or papules on the trunk and proximal extremities

NSAID, non-steroidal anti-inflammatory drug; MR, mitral regurgitation; AR, aortic regurgitation.

CLINICAL FEATURES OF ARF: MINOR MANIFESTATIONS

Arthralgia

Arthralgia differs from arthritis in that there is pain on joint movement without evidence of swelling or heat.

In high-risk groups, polyarthralgia can be considered a major manifestation and monoarthralgia can be considered a minor manifestation. In low-risk groups, polyarthralgia can be a minor manifestation.

Arthralgia is a non-specific symptom that usually occurs in the same pattern as rheumatic polyarthritis (migratory, asymmetrical, with large joints more commonly affected). The pain is usually out of proportion to clinical findings and is associated with movement. While it may be undetectable at rest, lower limb arthralgia can be elicited by noting a limp when asking the patient to walk, and upper limb arthralgia can be elicited by noting movement restriction when asking the patient to undertake a movement such as reaching behind their head. Alternative diagnoses should be considered in a patient with arthralgia, especially if it is not typical of ARF. (Table 6.9)

Fever

With the exception of chorea, most manifestations of ARF are accompanied by fever. Earlier reports of fever described peak temperatures commonly greater than 39°C[6,57] but lower peak temperatures have been described more recently.

In First Nations peoples and others in high-risk groups, defining fever as a temperature greater than 38°C results in improved sensitivity for the diagnosis of ARF.[15] However, in low-risk groups, fever remains defined as ≥38.5°C rather than ≥38.0°C (Table 6.3).[4] One issue to note is that in high-risk groups, fever can be considered a minor manifestation based on a reliable history (in the absence of documented temperature), especially if antipyretic medication has already been administered. Fever, like arthritis and arthralgia, is usually quickly responsive to aspirin or other NSAID therapy.

Elevated acute-phase reactants

ESR is more sensitive than CRP in rheumatic fever but is not always available in remote settings. Testing ESR once laboratory access is available is recommended if CRP does not meet the diagnostic threshold.

Typically, ARF patients have a raised serum CRP level and/or ESR. The peripheral white blood cell (WBC) count is $<15\times10^9$ /L in 75% of patients, so an elevated WBC is an insensitive marker of inflammation in ARF.[15] Further analysis of these data demonstrated that less than 4% of patients with confirmed ARF, excluding chorea, had both a serum CRP level of <30 mg/L and an ESR of <30 mm/h. (J Carapetis, unpublished data)

Therefore, it is recommended that for high-risk groups, a serum CRP level of ≥30 mg/L or ESR of ≥30 mm/h is needed to satisfy the minor manifestation of elevated acute-phase reactants. For low-risk groups, the ESR cut-off has been changed to align with the 2015 AHA revised Jones criteria of a serum CRP level of ≥30 mg/L or ESR of ≥60 mm/h. The serum CRP concentration rises more rapidly than the ESR and falls more rapidly with resolution of the attack. The ESR may remain elevated for three to six months, despite symptoms resolving within a much shorter period. Organising an ESR test can be problematic in rural and remote settings, but it remains an important part of the workup for suspected ARF and can be achieved once the patient reaches hospital. Testing CRP alone can result in a missed diagnosis of definite ARF when ESR is ≥30 mm/h but CRP is <30 mg/L.

Prolonged P-R interval and other rhythm abnormalities

All patients with suspected and confirmed ARF should have an ECG.

Some healthy people show a prolonged P-R interval on ECG; however, one that resolves over the ensuing days to weeks may be a useful diagnostic feature in cases where the clinical features are not definitive. More advanced forms of AV conduction block sometimes lead to a junctional rhythm, usually with a heart rate similar to the sinus rate, but sometimes faster (when the rate of the atrioventricular junctional pacemaker exceeds that of the sinus node, resulting in an accelerated junctional rhythm).[55,58] Accelerated junctional rhythm also can occur without a prolonged P-R interval. Second-degree, and even complete heart block can occur in ARF, and if associated with a slow ventricular rate, may give the false impression that carditis is not significant. In a resurgence of ARF in the USA into the 1990s, 32% of patients had abnormal atrioventricular conduction, usually a prolonged P-R interval. A small proportion had more severe conduction abnormalities, which were sometimes found by auscultation or echocardiography in the absence of evidence of valvulitis.[37] In a large study from New Zealand, advanced conduction abnormalities (second-degree heart block, complete heart block or accelerated junctional rhythm) occurred in 8% of those presenting with ARF, and these ECG changes have been added to the minor manifestations.[59]

Therefore, an ECG should be performed in all cases of suspected ARF. If a prolonged P-R interval is detected, the ECG should be repeated after one and two weeks, and if still abnormal, it should be repeated again at one and two months to document a return to normal. If it has returned to normal, ARF becomes a more likely diagnosis. The P-R interval increases normally with age. The ULN for P-R interval for age groups are provided in Table 6.5.[60]

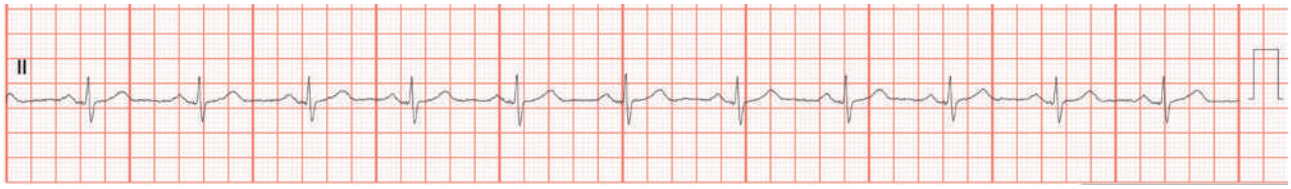


Figure 6.7. Normal Sinus Rhythm

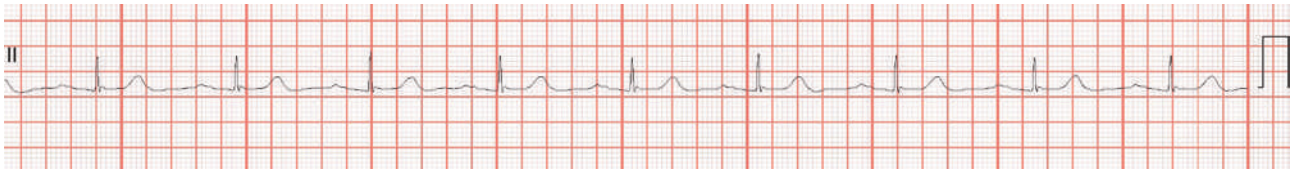


Figure 6.8. First degree heart block

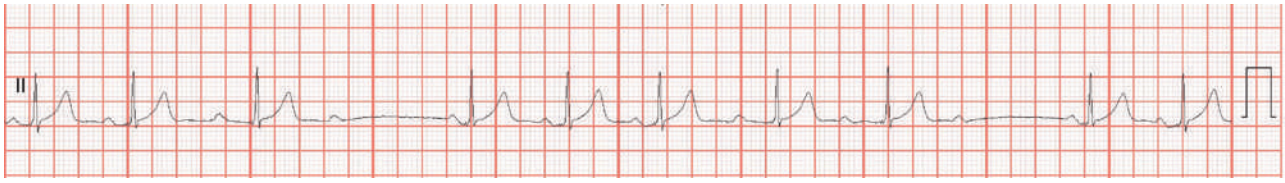


Figure 6.9. Second degree heart block

Figure 6.10. Third degree (complete) heart block

Figure 6.11. Accelerated junctional rhythm

OTHER LESS COMMON FEATURES OF ARF

Other less common clinical features include abdominal pain, epistaxis, mild elevations of plasma transaminase levels, and microscopic haematuria, pyuria or proteinuria. Acute post-streptococcal glomerulonephritis (APSGN) has been described to occur at the same time as ARF, but this is very uncommon.[61] Some patients with acute carditis also present with pulmonary infiltrates on chest radiography and have been labelled as having 'rheumatic pneumonia'. This is probably a misnomer, as it likely represents unilateral pulmonary oedema in patients with fulminant carditis with ruptured chordae tendinae.[62,63] Table 6.8 includes the key points in identifying minor manifestations of ARF.

Table 6.8. Key points in identifying minor manifestations of ARF

MANIFESTATION	POINTS FOR IDENTIFICATION
Arthralgia	Suggestive of ARF if the arthralgia occurs in the same pattern as rheumatic polyarthritis (migratory, asymmetrical, affecting large joints).
Fever	Most manifestations of ARF are accompanied by fever (which can be low-grade and transient.) Oral, tympanic or rectal temperature ≥38°C (high-risk groups) or ≥38.5°C (low-risk groups) on/after admission or documented with a reliable history during the current illness (high-risk groups only), should be considered as fever.
Elevated acute-phase reactants	Serum CRP level of ≥30 mg/L (both high-risk and low-risk groups) or ESR of ≥30 mm/h (high-risk groups) or ≥60 mm/h (low-risk groups) meets this diagnostic criterion.
Prolonged PR interval	If a prolonged P-R interval or a more advanced conduction abnormality is detected on ECG, the ECG should be repeated daily during ARF (as often evolves in the acute process), then if still abnormal on discharge, on each follow up visit until normal. If the P-R interval or a more advanced conduction abnormality has returned to normal, ARF becomes a more likely diagnosis.

ECG, electrocardiogram; ESR, erythrocyte sedimentation rate.

EVIDENCE OF STREPTOCOCCAL A INFECTION

Streptococcal antibody titres are the most useful modality for detecting a recent Strep A infection. The most commonly used tests are the plasma anti-streptolysin O (ASO) and the anti-DNase B titres. Previous data suggest that a rise in the ASO titre occurs in 75–80% of untreated Strep A pharyngeal infections, and that the addition of anti-DNase B titre increases the sensitivity of testing.[64] ASO and antiDNase B antibody responses can be elicited by all beta-haemolytic streptococci rather than being confined to Group A streptococci. Streptococcal serology results can lack sensitivity and specificity, and longitudinal changes are not always in keeping with expectations.[11,65] Nevertheless, while research is underway to identify more clinically useful serological markers of Strep A infection,[66] ASO and anti-DNase B comprise critical components of the diagnosis of ARF.

The serum ASO titre usually rises within one to two weeks and reaches a maximum at about three to six weeks after infection, while the serum anti-DNase B titre can take up to six to eight weeks to reach a maximum.[67] The rate of decline of these antibodies varies enormously, with the ASO titre starting to fall six to eight weeks, and the anti-DNase B titre three months after infection.[68] In the absence of re-infection, the ASO titre usually approaches pre-infection levels after 6–12 months, whereas the anti-DNase B titre tends to remain elevated for longer and sometimes indefinitely during childhood, especially in communities with high rates of Strep A skin infections.[69]

Single antibody titres are often misleading, and sequential samples more accurately define occurrence and time of infection.[61] To confirm a current Strep A infection, ideally it is recommended that the titre be determined in the acute phase, and then in the convalescent phase 14–28 days later, with a positive result defined as a rise in titre of twofold or more.[70] However, relying on rising titres in paired sera is often not useful in ARF diagnosis. Because of the delay of one to five weeks between Strep A infection and the onset of symptoms of ARF, the ASO and often the anti-DNase B titres are already elevated at presentation. Moreover, it is sometimes impractical to draw a second blood sample if the patient has been discharged.

Therefore, it is generally accepted that if only a single specimen is available, a titre greater than the ULN at initial testing be considered presumptive evidence of a preceding Strep A infection. The ULN for Strep A serology has been defined by separating the upper 20% from the lower 80% of the group distribution in a dichotomous fashion.[70-72] The choice of the 80th centile cut-off for the ULN is based on the observation that more than 80–90% of patients with ARF have Strep A titres that are above the 80th centile of healthy controls with no clinical evidence of recent streptococcal infection.[70,71]

Streptococcal titres vary according to several factors, including age. The ranges cited by many laboratories in Australia are taken from adult studies and are often inappropriately low for use in children.

A study of 424 adults and children in Fiji, a population with a similar epidemiology of Strep A infection to Australian First Nations peoples (including a high prevalence of Strep A skin infections) provides ULN for Strep A serology applicable to the Australian context across all ages (Table 6.4).[2]

The high prevalence of Strep A infections (mainly pyoderma) in First Nations communities of northern and central Australia often causes a very high background titres of serum streptococcal antibodies.[73,74] All cases of suspected ARF should have elevated serum streptococcal serology demonstrated to enable confirmation of a diagnosis of ARF (Table 6.4).

If the initial titre is above the ULN, there is no need to repeat serology. If the initial titre is below the ULN for age, testing should be repeated 10–14 days later (Table 6.4).

Evidence of preceding Strep A infection may also be provided by the identification of Strep A on culture of a throat culture. However, this may represent colonisation or may be negative due to the time interval elapsed between infection and ARF. Identification of Strep A from a skin lesion swab is suggestive, and is shown to pre-date ARF occurrences,[75] but is not currently included in the formal diagnostic criteria.

Rates of isolation of Strep A from throat swabs vary geographically; for example, it has been isolated from about 90% of throat swabs from children with rheumatic fever in New Zealand and about 30% of throat swabs from children with rheumatic fever at the Royal Darwin Hospital (START Study data, un-published). Molecular methods of Strep A detection, discussed below, appear to be more sensitive than culture (See Streptococcus A rapid diagnostics).[76]

STREPTOCOCCUS A RAPID DIAGNOSTICS

A simple, reliable, rapid point-of-care test for detecting Strep A from throat swabs will improve the management of throat infections and diagnosis of ARF.[59] Strep A rapid tests include rapid antigen detection tests (RADT) and molecular tests. Current RADT are not as accurate as culture for detecting Strep A[77] but are still an important diagnostic tool for Strep A pharyngitis in some countries. However, these rapid tests currently have limited use in children and in public health interventions for control of ARF and RHD. Where RADT are used, clinical practice guidelines recommend a negative test is followed by a backup throat swab culture.[78] Molecular test which are rapid and point-of-care are superior to RADT including being more sensitive than culture and highly specific, and hence their use is encouraged, where such testing is available (see Chapter 5. Primary Prevention, Strep A rapid Diagnostics).

DIFFERENTIAL DIAGNOSIS

Many of the clinical features of ARF are non-specific, so a wide range of differential diagnoses should be considered (Table 6.9).[79]

The most likely alternative possibilities will vary according to location (e.g. arboviral arthritis is less likely in temperate than tropical climates) and ethnicity (e.g. some autoimmune conditions may be more or less common in particular ethnic groups).

Table 6.9. Differential diagnoses of common major presentations of ARF

PRESENTATION		
Polyarthritis and fever	**Carditis**	**Sydenham chorea**
Septic arthritis (including disseminated gonococcal infection)†	Innocent murmur	Systemic lupus erythematosus
Connective tissue and other autoimmune disease‡	Mitral valve prolapse	Drug intoxication
Viral arthropathy including Dengue and Chikungunya§	Congenital heart disease	Wilson's disease
Reactive arthropathy§	Infective endocarditis	Tic disorder††
Malaria¶	Hypertrophic cardiomyopathy	Choreoathetoid cerebral palsy
Lyme disease¶	Myocarditis: viral or idiopathic	Encephalitis
Sickle cell anaemia	Pericarditis: viral or idiopathic	Familial chorea
Infective endocarditis§§		(including Huntington's)
Leukaemia or lymphoma		Intracranial tumour
Gout and pseudo-gout		Lyme disease¶
		Hormonal‡‡

† Gonorrhoea should be actively sought in all potentially sexually active cases. Tests for gonorrhoea include microscopy and culture and polymerase chain reaction (PCR) of joint aspirate, endocervical swab, or first-pass urine/self-collected vaginal swabs in cases where endocervical PCR is not possible.

‡ Includes rheumatoid arthritis, juvenile chronic arthritis, inflammatory bowel disease, systemic lupus erythematosus, systemic vasculitis and sarcoidosis. Note that systemic lupus erythematosus occurs at a significantly higher rate in the northern Australian First Nations population than in the non-Indigenous population.[80]

§ Ross River Virus, Barmah Forest Virus, Mycoplasma, cytomegalovirus, Epstein–Barr virus, parvovirus, chlamydia, hepatitis, rubella vaccination, and Yersinia spp. and other gastrointestinal pathogens.

¶ If these conditions occur locally, or there is a relevant travel history.

†† Tourette's syndrome and possibly including PANDAS (paediatric autoimmune neuropsychiatric disorder associated with streptococcal infection).

‡‡ Includes oral contraceptives, hyperthyroidism and hypoparathyroidism.

§§ Ensure separate sets of blood cultures are collected and stigmata of endocarditis are investigated (See Chapter 11. Management of RHD, Prevention of infective endocarditis).

SYNDROMES THAT MAY BE CONFUSED WITH ARF

Post-streptococcal reactive arthritis

Some patients present with arthritis not typical of ARF, but with evidence of recent streptococcal infection (group A, or groups C and G, that is, *Streptococcus dysgalactiae* subsp. *equisimilis*), are said to have post-streptococcal reactive arthritis. In these cases, the arthritis may affect joints such as the small joints of the hand that are not so commonly affected in ARF. The arthritis is less responsive to anti-inflammatory treatment and may be more prone to relapse after cessation of anti-inflammatory treatment.[81] These patients are said not to be at risk of carditis,[82] and therefore, do not require secondary prophylaxis. However, some patients diagnosed with post-streptococcal reactive arthritis have developed later episodes of ARF, indicating that the initial diagnosis should have been atypical ARF.

It is therefore recommended that the diagnosis of post-streptococcal reactive arthritis should rarely, if ever, be made in high-risk populations, and with caution in low-risk populations.

For diagnosis of post-streptococcal reactive arthritis with normal echocardiogram and definite, possible and probable ARF ruled out:

- in low risk groups, no secondary prophylaxis and repeat echocardiogram in one year.
- in high risk groups, give secondary prophylaxis for 2 years with yearly echocardiogram and cease prophylaxis after 2 years if echocardiogram findings are still normal, and repeat echocardiogram 1 year later.

Echocardiography should be used to confirm the absence of valvular damage in all of these patients from both high- and low-risk populations, both before making the diagnosis and before discontinuing secondary prophylaxis.

Paediatric autoimmune neuropsychiatric disorders associated with Strep A infections

Some cases of chorea are mild or atypical, and may be confused with motor tics, or the involuntary jerks of Tourette's syndrome. There may be overlap between Sydenham chorea and these conditions. Indeed, obsessive–compulsive features have been found at increased frequency in long-term follow-up studies of patients with ARF and RHD.[83,84] The term 'paediatric autoimmune neuropsychiatric disorders associated with streptococcal infections' (PANDAS) refers to a subgroup of children with tic or obsessive–compulsive disorders, whose symptoms may develop or worsen following recurrent Strep A infection, and who are said to be at no risk of cardiac valvular damage.[85,86]

However, the evidence supporting PANDAS as a distinct disease entity has been questioned.[87,88] PANDAS may be a subset of Sydenham's chorea in which cardiac, joint or other organ involvement is lacking. PANDAS is very rare in high-risk ARF populations, and clinicians should err on the side of diagnosis of ARF and provision of secondary prophylaxis. Neuropsychiatric symptoms in childhood can be disabling and stigmatised, impairing school performance and socialisation, and hence prevention of these occurrences with antibiotic prophylaxis is important. Echocardiograms are essential for such circumstances.

ECHOCARDIOGRAPHY AND ARF

All patients with suspected and confirmed ARF (with or without an audible murmur) should have an echocardiogram

- To confirm the presence of acute valvulitis,
- To assess severity of valvulitis and cardiac function status,
- To establish the presence of pre-existing, undiagnosed RHD, and
- As a baseline for future monitoring of disease progression and/or recurrent ARF.

Before the introduction of echocardiography, the diagnosis of rheumatic carditis relied on clinical evidence of valvulitis, supported by ECG or radiographic evidence of cardiomegaly. Echocardiography is more sensitive and specific for acute rheumatic carditis than auscultation,[18,42,47] and it is therefore mandatory that all patients with suspected or definite ARF should undergo echocardiography. With the advent of portable machines and specialist outreach services, echocardiography should be available to all Australians, including those living in remote settings. In high-risk settings, handheld echocardiography has facilitated uncovering of subclinical carditis as a major manifestation in "silent" ARF.[89]

- In patients with definite ARF, echocardiography can confirm the presence, severity and aetiology of valvular regurgitation. It can identify additional valve involvement (without an associated detectable murmur), pericardial effusion, and assess cardiac size and function (Table 6.10).
- In patients with suspected ARF, reliance on the clinical finding of a murmur may result in misclassification of congenital heart disease, or even of physiological (functional) murmurs, as rheumatic carditis. The likelihood of misclassification has increased in recent years, as most clinicians' auscultatory skills have become less proficient.[9] Poor sensitivity and specificity of auscultation by healthcare providers also has been shown in established RHD.[12]
- In patients with suspected ARF without a clinically significant murmur, echocardiography can identify subclinical valvular damage that is likely to be rheumatic, thus increasing the likelihood that the presentation is due to ARF. Subclinical carditis is now acceptable as a major manifestation of ARF in both high-risk and low-risk groups (Table 6.6).[4]

In 2012, under the auspices of the World Heart Federation, an international consortium published minimal criteria for a diagnosis of RHD on echocardiography.[90] Those criteria did not specifically address the differentiation between the acute carditis of ARF and chronic RHD. In 2023, the World Heart Federation updated the guidelines for the echocardiographic diagnosis of RHD[91] (See Chapter 8, Diagnosis of Rheumatic Heart Disease). The same criteria are recommended for defining pathological regurgitation in ARF with carditis as in RHD (see below and Table 6.11). However, acute carditis does not require any of the morphological features. It remains the case that differentiation between acute valvulitis of ARF and established RHD with valve regurgitation poses a clinical dilemma. Features of the mitral valve such as annular dilation and chordal elongation leading to anterior or posterior mitral valve prolapse are recognised as classical features of acute carditis.[92] Chordal rupture can also occur and result in a flail leaflet and significant MR.[18,92,93-95] Beading or nodularity of the leaflet tips can also be noted during an episode of ARF.[18,38] Whereas features such as restricted leaflet motion, significant thickening of valve leaflets or mitral stenosis, would all be considered features of established RHD. However, these findings often co-exist, and echocardiographic interpretation is relatively subjective. Echocardiography cannot accurately measure when the rheumatic changes occurred, but a comparison with previous echocardiograms to assess the severity and progression of the valve lesions can be useful in determining whether there is acute valve inflammation in the setting of a possible ARF recurrence. This illustrates the critical role of serial echocardiography for patients with ARF and/or RHD.

Morphological changes to the valve are often minimal in acute carditis in first episode ARF, as these take time to develop and may be somewhat different than those found in chronic RHD.[38,50,92,93] Many cases of ARF are recurrent ARF occurring on the background of chronic RHD, and acute and chronic changes can then co-exist.

- Pathological regurgitation of the mitral or aortic valve (in the absence of an alternative diagnosis, such as bicuspid aortic or mitral valve prolapse) is sufficient to fulfil the minimal echocardiographic criteria of acute carditis in the setting of suspected or definite ARF.
- The presence of additional morphological valvulitis changes to the mitral or aortic valve increases the confidence with which the diagnosis can be made.
- Morphological changes of the mitral or aortic valve, in the absence of pathological valvular regurgitation, are not sufficient to diagnose acute rheumatic carditis. Such cases should be followed with repeat echocardiography after four to six weeks to detect evolving acute carditis (Table 8.3).

Table 6.10. Uses of echocardiography in ARF

Valvulitis
Define the severity of mitral, aortic and/or tricuspid regurgitation.
Define the severity of mixed valve disease (mixed stenotic and regurgitant).
Identify subclinical evidence of rheumatic valve damage.
Visualise valvular anatomy and define mechanism of regurgitation (prolapse, flail leaflet, annular dilatation etc).
Cardiac function
Assess left ventricular size and function.
Pericarditis
Confirm the presence of a pericardial effusion.
Reveal inaudible or subclinical valvular regurgitation in the presence of a friction rub.
Exclude other causes of cardiac murmur
Identify congenital heart disease, such as bicuspid aortic valve and congenital mitral valve anomalies, as the cause for a pathological murmur.
Confirm normal valvular function and morphology in the presence of flow or innocent murmurs.

Table 6.11. Minimal echocardiographic criteria to allow a diagnosis of pathological valvular regurgitation

Pathological (at least mild) MR (all criteria must be met)	Pathological (at least mild) AR (all criteria must be met)
1. Seen in at least 2 views 2. In at least one view, MR jet length measures ≥1.5 cm (in individuals weighing < 30 kg) or ≥2.0 cm (in individuals weighing ≥30 kg)† 3. Velocity ≥3 m/sec for one complete envelope‡§ 4. Pan-systolic jet in at least one envelope†† §	1. Seen in at least 2 views 2. In at least one view jet length ≥1 cm‡‡† 3. Velocity ≥3 m/sec in early diastole§ 4. Pan-diastolic jet in at least one envelope§

† Cut off is based on expert consensus. If weight is not available, then an age cut off at ≤10 years or >10 years can be applied)

AR, aortic regurgitation; MR, mitral regurgitation.

‡ Body of the pansystolic envelope should be ≥3 m/s

§ It is reasonable to use separate Continuous Wave Doppler traces seen in different views to document the pansystolic / pan-diastolic envelope and jet velocity.

†† Given the difficulty in aligning spectral Doppler through eccentric regurgitant jets, it is reasonable to use an appearance of a jet being pan-systolic based on qualitative assessment, such as colour jet seen throughout systole.

‡‡ A regurgitant jet length should be measured from the vena-contracta to the last pixel of regurgitant colour (blue or red).

AR, aortic regurgitation; MR, mitral regurgitation.

Echocardiography in ARF recurrences

Echocardiography cannot accurately determine the timing or duration of rheumatic valve changes.

In a patient with established RHD, the diagnosis of acute carditis during a recurrence of ARF relies on the accurate documentation of the echocardiographic findings before the recurrence, so that new clinical or echocardiographic features can be confirmed. New findings may include worsening severity of an existing valve lesion or affliction of an additional valve not previously involved.

Left ventricular size and function

M mode and two-dimensional echocardiography (2DE) are used in evaluating chamber size and ventricular function. More complex formulae based on 2DE can also be used to calculate LV function (e.g. single-plane ellipse and Simpson's methods of discs).[48] Impairment of systolic function and LV/left atrium dilation in rheumatic carditis / rheumatic heart disease typically reflects more advanced valvular dysfunction.

Three-dimensional echocardiography

Many cardiac surgical centres now routinely use three-dimensional echocardiography (3DE) to further evaluate RHD, both in its acute and chronic phases.[97] It facilitates more detailed assessment of the mechanism of regurgitation, and hence, aids surgical decision-making.

Evidence of subclinical rheumatic valve damage

Subclinical rheumatic carditis that is silent on auscultation, but detectable by echocardiography, is recognised worldwide as a manifestation of ARF.[37,42,47,98-111] This echocardiographic finding has been incorporated as a major diagnostic criterion for ARF in the Australian and the New Zealand guidelines[13] for high-risk ARF populations since 2006 (Table 6.6). It was subsequently incorporated as a major diagnostic criterion for ARF for both high-risk and low-risk groups in the 2015 AHA revised Jones criteria with which this edition of the Australian guidelines now aligns.[4] This is supported by data indicating that the course of subclinical carditis[110,111] appears similar to that of mild carditis with an audible murmur.[44,111]

A systematic review in 2007 estimated the prevalence of subclinical carditis as 17% among those with ARF.[110] Echocardiographic findings persisted or progressed in 45% of cases.[110] A study from North Queensland reported that 71% of their patients with subclinical carditis had a long-term valvular consequence.[16] This indicates importance of prescription of and adherence to secondary antibiotic prophylaxis after detection of subclinical carditis. Complete echocardiographic resolution of mild clinical carditis can be expected within five years in two-thirds of patients with high levels of adherence to secondary prophylaxis.[44]

CASE STUDY

Health staff need to be aware of ARF in populations that are at high risk.

Sam's Story

Background

Sam is a nine-year-old First Nations boy who lives in a rural community in Western Australia. One day he noticed that he had strange movements in his hands which caused him to drop things; his speech was mumbled, and he was tired all the time. His mother was worried and took him to the hospital believing he had ARF. She recognised the symptoms from her own experience with ARF as a young woman.

Hospitalisation

Sam stayed in hospital for a few months; *"I know it was a long time because I missed Christmas and the start of the school year. I was scared and upset because the doctors did not listen to my mum when she said it was rheumatic fever. The doctors even took my appendix out, but the appendix had nothing wrong with it."*

Sam had been exhibiting signs of Sydenham chorea associated with ARF and, after many tests, he was eventually also diagnosed with RHD, with echocardiogram showing heart valve damage.

Living with RHD

The lengthy hospital admission and delayed diagnosis resulted in long-lasting social, emotional and health effects.

"I regret not getting the proper treatment sooner. I couldn't even hold a pen properly and I had trouble reading. Sometimes I still get my words muddled and this makes me shame (embarrassed). I missed a lot of school and opportunities like going to boarding school down south with my cousin. The school thought I was dumb and put me in the learning difficulties class."

Sam never had any problems with schooling before his illness. He is determined to show people that he can still do amazing things. *"It was hard seeing my mum so upset, I try to protect her now from getting upset about my illness. There are family pressures too, because sometimes my brothers and sisters think I get special treatment."*

Sam wants to stay positive and does not let RHD get him down.

"I like to set my own challenges like learning to play the trumpet and trying harder at sports, and I want to go to the clinic by myself one day to get my needles to give my mum a break. When I get mumbled words, I stop and just listen to my friends talking and when my hands get all shaky, I hold on to something."

Discussion

A delayed or missed diagnosis of ARF can have serious consequences for the patient and the family. This extends to family and social relationships, work and schooling, missed opportunity and an increased reliance on health services.

REFERENCES

1 Agnew J, Wilson N, Skinner J, Nicholson R. Beyond first-degree heart block in the diagnosis of acute rheumatic fever. Cardiology in the Young. 2019;29:744–748.

2 Steer AC, Vidmar S, Ritika R, et al. Normal ranges of streptococcal antibody titers are similar whether streptococci are endemic to the setting or not. Clinical and Vaccine Immunology. 2009;16(2):172-175.

3 Noonan S, Zurynski YA, Currie BJ, et al. A national prospective surveillance study of acute rheumatic fever in Australian children. The Pediatric Infectious Disease Journal. 2013;32(1):e26-e32.

4 Australian Institute of Health and Welfare. Acute rheumatic fever and rheumatic heart disease in Australia 2018–2022. catalogue number CVD 100, AIHW, Australian Government. 2024.

5 Jones T. Diagnosis of rheumatic fever. Journal of the American Medical Association. 1944;126:481-484.

6 Guidelines for the diagnosis of rheumatic fever. Jones Criteria, 1992 update. Special Writing Group of the Committee on Rheumatic Fever, Endocarditis, and Kawasaki Disease of the Council on Cardiovascular Disease in the Young of the American Heart Association. JAMA. 1992 Oct 21;268(15):2069-2073.

7 Stewart T, McDonald R, Currie B. Use of the Jones criteria in the diagnosis of acute rheumatic fever in an Australian rural setting. Australian and New Zealand Journal of Public Health. 2005;29(6):526-529.

8 Ralph A, Jacups S, McGough K, et al. The challenge of acute rheumatic fever diagnosis in a high-incidence population: a prospective study and proposed guidelines for diagnosis in Australia's Northern Territory. Heart Lung and Circulation. 2006;15(2):113-138.

9 World Health Organization. Rheumatic fever and rheumatic heart disease: report of a WHO expert consultation, Geneva, 29 October–1 November 2001. WHO technical report series 923. 2004.

10 National Heart Foundation of Australia (RF/ RHD Guidelines Development Working Group) and the Cardiac Society of Australia and New Zealand. Diagnosis and management of acute rheumatic fever and rheumatic heart disease in Australian - An evidence-based review. 2006.

11 RHDAustralia (ARF/RHD writing group), National Heart Foundation of Australia and the Cardiac Society of Australia and New Zealand. Australian guideline for prevention, diagnosis and management of acute rheumatic fever and rheumatic heart disease (2nd edition). 2012.

12 Gewitz MH, Baltimore RS, Tani LY, et al. Revision of the Jones Criteria for the diagnosis of acute rheumatic fever in the era of Doppler echocardiography: a scientific statement from the American Heart Association. Circulation. 2015;131(20):1806-1818.

13 Anderson A, Mills C, Rentta N, et al. Aotearoa New Zealand Guidelines for the Prevention, Diagnosis, and Management of Acute Rheumatic Fever and Rheumatic Heart Disease: 2024 Update. Wellington: Health New Zealand | Te Whatu Ora. 2025.

14 Parnaby MG, Carapetis JR. Rheumatic fever in Indigenous Australian Children. Journal of Paediatrics and Child Health. 2010;46(9):527-533.

15 Carapetis J, Currie BJ. Rheumatic fever in a high incidence population: The importance of mono-arthritis and low-grade fever. Archives of Disease in Childhood. 2001;85(3):223-237.

16 Cann M, Sive AA, Norton RE, et al. Clinical presentation of rheumatic fever in an endemic area. Archives of Disease in Childhood. 2010;95(6):455-457.

17 Mataika R, Carapetis JR, Kado J, Steer AC. Acute rheumatic fever: an important differential diagnosis of septic arthritis. Journal of Tropical Pediatrics. 2008;54(3):205-207.

18 Vijayalakshmi I, Vishnuprabhu RO, Chitra N, et al. The efficacy of echocardiographic criterions for the diagnosis of carditis in acute rheumatic fever. Cardiology in the Young. 2008;18(6):586-592.

19 Carapetis J, Brown A, Wilson NJ, et al. An Australian guideline for rheumatic fever and rheumatic heart disease: An abridged outline. Medical Journal of Australia. 2007;186(11):581-586.

20 Lessof M. Sydenham's chorea. Guy's Hosp Reports. 1958;107:185-206.

21 Carapetis J, Currie BJ. Rheumatic chorea in northern Australia: a clinical and epidemiological study. Archive of Diseases in Childhood. 1999;80(4):353-358.

22 Jack S, Moreland NJ, Meagher J, et al. Streptococcal Serology in Acute Rheumatic Fever Patients: Findings From 2 High-income, High-burden Settings. The Pediatric Infectious Disease Journal. 2019;38(1):e1-e6.

23 Moreira J, Kummer A, Harsányi E, et al. Psychiatric disorders in persistent and remitted Sydenham's chorea. Parkinsonism Relat Disord. 2014;20(2):233-236.

24 Orsini A, Foiadelli T, Magistrali M, et al. A nationwide study on Sydenham's chorea: Clinical features, treatment and prognostic factors. Eur J Paediatr Neurol. 2022;36:1-6.

25 Dale RC, Heyman I, Surtees RA, et al. Dyskinesias and associated psychiatric disorders following streptococcal infections. Arch Dis Child. 2004;89(7):604-610.

26 Punukollu M, Mushet N, Linney M, et al. Neuropsychiatric manifestations of Sydenham's chorea: a systematic review. Dev Med Child Neurol. 2016;58(1):16-28.

27 Taranta A, Stollerman GH. The relationship of Sydenham's chorea to infection with group A streptococci. American Journal of Medicine. 1956;20(2):170-175.

28 Taranta A. Relation of isolated recurrences of Sydenham's chorea to preceding streptococcal infections. New England Journal of Medicine. 1959;260(24):1204-1210.

29 Ayoub E, Wannamaker LW. Streptococcal antibody titers in Sydenham's chorea. Pediatrics. 1966;38(6):846-956.

30 Stollerman G, Glick S, Patel DJ, et al. Determination of C-reactive protein in serum as a guide to the treatment and management of rheumatic fever. American Journal of Medicine. 1953;15(5):645-655.

31 Aron A, Freeman JM, Carter S. The natural history of Sydenham's chorea. Review of the literature and long-term evaluation with emphasis on cardiac sequelae. American Journal of Medicine. 1965;38:83-95.

32 Centers for Disease Control. Acute rheumatic fever - Utah. MMWR Morbidity Mortality Weekly Report. 1987;36(8):108-110.

33 Soller TJ, Roberts K, Middleton B, Ralph A. Sydenham chorea in the top end of Australia's Northern Territory: A 20-year retrospective case series. J Paediatr Child Health. 2023;59:1210-1216.

34 Bland E. Chorea as a manifestation of rheumatic fever: a long-term perspective. Transactions of the American Clinical and Climatological Association. 1943;73:209-213.

35 Sanyal S, Berry AM, Duggal S, et al. Sequelae of the initial attack of acute rheumatic fever in children from North India. Circulation. 1982;65:375-379.

36 Edwards W, Peterson K, Edwards JE. Active valvulitis associated with chronic rheumatic valvular disease and active myocarditis. Circulation. 1978;57(1):181-185.

37 Veasy L, Tani LY, Hill HR. Persistence of acute rheumatic fever in the intermountain area of the United States. Journal of Pediatrics. 1994;124(1):9-16.

38 Vasan RS, Shrivastava S, Vijayakumar M, et al. Echocardiographic evaluation of patients with acute rheumatic fever and rheumatic carditis. Circulation. 1996;94(1):73-82.

39 Williams R, Minich LL, Shaddy RE, et al. Evidence for lack of myocardial injury in children with acute rheumatic carditis. Cardiology in the Young. 2002;12(6):519-523.

40 Marcus R, Sareli P, Pocock WA, et al. The spectrum of severe rheumatic mitral valve disease in a developing country. Correlations among clinical presentation, surgical pathologic findings, and hemodynamic sequelae. Annals of Internal Medicine. 1994;120(3):177-183.

41 Alehan DAC, Hallioglu O. Role of serum cardiac troponin T in the diagnosis of acute rheumatic fever and rheumatic carditis. Heart. 2004;90(6):689-690.

42 Abernethy M, Bass N, Sharpe N, et al. Doppler echocardiography and the early diagnosis of carditis in acute rheumatic fever. Australia New Zealand Journal of Medicine. 1994;24(5):530-535.

43 Roberts KV, Brown AD, Maguire GP, et al. Utility of auscultatory screening for detecting rheumatic heart disease in high-risk children in Australia's Northern Territory. Medical Journal of Australia. 2013;199(3):196-199.

44 Kassem A, el-Walili TM, Zaher SR, et al. Reversibility of mitral regurgitation following rheumatic fever: clinical profile and echocardiographic evaluation. Indian Journal of Pediatrics. 1995;62(6):717-723.

45 Chagani H, Aziz K. Clinical profile of acute rheumatic fever in Pakistan. Cardiology in the Young. 2003;13(1):28-35.

46 Lanna C, Tonelli E, Barros MVL, et al. Subclinical rheumatic valvitis: a long-term follow-up. Cardiology in the Young. 2003;13(5):31-38.

47 Voss L, Wilson NJ, Neutze JM, et al. Intravenous immunoglobulin in acute rheumatic fever: a randomized controlled trial. Circulation. 2001;103(3):401-406.

48 Gentles T, Colan SD, Wilson NJ, et al. Left ventricular mechanics during and after acute rheumatic fever: contractile dysfunction is closely related to valve regurgitation. Journal of the American College of Cardiology. 2001;37(1):201-207.

49 Meira Z, Goulart EMA, Colosimo EA, Mota CC. Long term follow up of rheumatic fever and predictors of severe rheumatic valvar disease in Brazilian children and adolescents. Heart (British Cardiac Society). 2005;91(8):1019-1022.

50 Kamblock J, N'Guyen L, Pagis B, et al. Acute severe mitral regurgitation during first attacks of rheumatic fever: clinical spectrum, mechanisms and prognostic factors. Journal of Heart Valve Disease. 2005;14(4):440-446.

51 Milliken A. The short-term morbidity of acute rheumatic fever in children and youth under the age of 20 years at first diagnosis in Auckland, 1998–1999. 2003. The University of Auckland: New Zealand.

52 Smith M, Lester-Smith D, Zurynski Y, et al. Persistence of acute rheumatic fever in a tertiary children's hospital. Journal of Paediatrics and Child Health. 2011;47(4):198-203.

53 Stollerman, G. Rheumatic fever and streptococcal infection. 1975: Grune & Stratton.

54 Kamblock J, Payot L, Iung B, et al. Does rheumatic myocarditis really exist? Systematic study with echocardiography and cardiac troponin I blood levels. European Heart Journal. 2003;24(9):855-862.

55 Ceviz N, Celik V, Olgun H, Karacan M. Accelerated junctional rhythm in children with acute rheumatic fever: is it specific to the disease? Cardiology in the Young. 2014;24(3):464-468.

56 Thampy D, Del Pozo D, Hyde JT, Hsu S. Erythema marginatum may be urticaria. JAAD Int. 2024;1675-1676.

57 Schreier A, Hockett VE, Seal JR. Mass prophylaxis of epidemic streptococcal infections with benzathine penicillin G. Experience at a naval training center during the winter of 1955–56. New England Journal of Medicine. 1958;258(25):1231-1238.

58 Karacan M, Isıkay S, Olgun H, Ceviz N. Asymptomatic rhythm and conduction abnormalities in children with acute rheumatic fever: 24-hour electrocardiography study. Cardiology in the Young. 2010;20(6):620-630.

59 Agnew J, Wilson N, Skinner J, Nicholson R. Beyond first-degree heart block in the diagnosis of acute rheumatic fever. Cardiology in the Young. 2019;29(6):744-748.

60 Park MK. Pediatric Cardiology for Practitioners, 2nd edition. 1988, Chicago: Year Book Medical Publishers.

61 Nakauyaca AV, Ralph AP, Majoni WS, Kangaharan N. Case Report: Concurrent Rheumatic Fever and Acute Post-Streptococcal Glomerulonephritis in a High-Burden Setting. American Journal of Tropical Medicine and Hygiene. 2019;101(5):1054-1057.

62 Anderson Y, Wilson N, Nicholson R, et al. Fulminant mitral regurgitation due to ruptured chordae tendinae in acute rheumatic fever. Journal of Paediatrics and Child Health. 2008;44(3):134-137.

63 Mahajan C, Bidwai PS, Walia BNS, et al. Some uncommon manifestations of rheumatic fever. The Indian Journal of Pediatrics. 1973;40:102.

64 Markowitz M, Gordis L. Rheumatic fever, in Major problems in clinical pediatrics, Vol 2, A. Schaffer, Editor. 1972, WB Saunders: Philadelphia.

65 Johnson DR, Kurlan R, Leckman J, Kaplan EL. The Human Immune Response to Streptococcal Extracellular Antigens: Clinical, Diagnostic, and Potential Pathogenetic Implications. Clinical Infectious Diseases. 2010;50(4):481-490.

66 Hanson-Manful P, Whitcombe AL, Young PG, et al. The novel Group A Streptococcus antigen SpnA combined with bead-based immunoassay technology improves streptococcal serology for the diagnosis of acute rheumatic fever. Journal of Infection. 2018;76(4):361-368.

67 Kaplan E, Ferrieri P, Wannamaker LW. Comparison of the antibody response to streptococcal cellular and extracellular antigens in acute pharyngitis. Journal of Paediatrics. 1974;84(1):21-28.

68 McCarty M. The antibody response to streptococcal infections, in Streptococcal infections, Columbia University Press: New York. p.130-142.

69 Stollerman G, Lewis AJ, Schultz I, et al. Relationship of immune response to group A streptococci to the course of acute, chronic and recurrent rheumatic fever. American Journal of Medicine. 1956;20(2):163-169.

70 Wannamaker L, Ayoub EM. Antibody titers in acute rheumatic fever. Circulation. 1960;21:598-614.

71 Ayoub E, Wannamaker LW. Evaluation of the streptococcal deoxyribonuclease B and diphosphopyridine nucleotide antibody tests in acute rheumatic fever and acute glomerulonephritis. Pediatrics. 1962;29(4):527-538.

72 Klein G, Baker CN, Jones WL. 'Upper limits of normal' antistreptolysin O and antideoxyribonuclease B titers. Applied Microbiology. 1971;21(6):999-1001.

73 Nimmo G, Tinniswood RD, Nuttall N, et al. Group A streptococcal infection in an Aboriginal community. Medical Journal of Australia. 1992;157(8):521-522.

74 Van Buynder P, Gaggin JA, Martin D, et al. Streptococcal infection and renal disease markers in Australian aboriginal children. Medical Journal of Australia. 1992;156(8):537-540.

75 Oliver J, Bennett J, Thomas S, et al. Preceding group A streptococcus skin and throat infections are individually associated with acute rheumatic fever: evidence from New Zealand. BMJ Global Health. 2021;6:e007038.

76 Ralph AP, Holt DC, Islam S, et al. Potential for Molecular Testing for Group A Streptococcus to Improve Diagnosis and Management in a High Risk Population: A Prospective Study. Open Forum Infectious Diseases. 2019;6(4):ofz097.

77 Lean WL, Arnup S, Danchin M, Steer AC. Rapid diagnostic tests for group A streptococcal pharyngitis: a meta-analysis. Pediatrics. 2014;134(4):771-781.

78 Shulman ST, Bisno AL, Clegg HW, et al. Clinical Practice Guideline for the Diagnosis and Management of Group A Streptococcal Pharyngitis: 2012 Update by the Infectious Diseases Society of America. Clinical Infectious Diseases. 2012;55:e86-e102.

79 Carapetis JR, McDonald M, Wilson NJ. Acute rheumatic fever. Lancet, 2005;366(9480):155-168.

80 Anstey NM, Bastian I, Dunckley H, Currie BJ. Systemic lupus erythematosus in Australian aborigines: high prevalence, morbidity and mortality. Australian and New Zealand Journal of Medicine. 1993;23(6):646-651.

81 Balan S, Krishna MP, Sasidharan A, Mithun CB. Acute rheumatic fever and Post-streptococcal reactive arthritis. Best Pract Res Clin Rheumatol. 2025:102067.

82 van Bemmel J, Delgado V, Holman ER, et al. No increased risk of valvular heart disease in adult poststreptococcal reactive arthritis. Arthritis and Rheumatology. 2009;60(4):987-993.

83 Alvarenga P, Hounie AG, Petribu K, et al. Obsessive-compulsive spectrum disorders in adults with past rheumatic fever. Acta Neuropsychiatrica. 2007;19(4):263-264.

84 van Toorn R, Weyers HH, Schoeman JF. Distinguishing PANDAS from Sydenham's chorea: case report and review of the literature. European Journal of Paediatric Neurology. 2004;8(4):211-216.

85 Swedo S, Leonard HL, Mittleman BB, et al. Identification of children with pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections by a marker associated with rheumatic fever. American Journal of Psychiatry. 1997;154(1):10-12.

86 Snider L, Swedo SE. PANDAS: current status and directions for research. Molecular Psychiatry. 2004;9(10): 00-7.

87 Kurlan R, Kaplan EL. The pediatric autoimmune neuropsychiatric disorders associated with streptococcal infection (PANDAS) etiology for tics and obsessive-compulsive symptoms: hypothesis or entity? Practical considerations for the clinician. Pediatrics. 2004;113(4):883-886.

88 Leckman J, King RA, Gilbert DL, et al. Streptococcal upper respiratory tract infections and exacerbations of tic and obsessive-compulsive symptoms: a prospective longitudinal study. Journal of the American Academy of Child and Adolescent Psychiatry. 2011;50(2):108-18.e.

89 Ali S, Beaton A, Ndagire E, Alhag L. Silent acute rheumatic fever unmasked by using handheld echocardiography for febrile children presenting in a rheumatic heart disease-endemic area. J Pediatr. 2024;8(268):113954.

90 Reményi B, Wilson N, Steer A, et al. World Heart Federation criteria for echocardiographic diagnosis of rheumatic heart disease: an evidence-based guideline. Nature Review Cardiology. 2012.

91 Rwebembera J, Marangou J, Mwita JC, et al. 2023 World Heart Federation guidelines for the echocardiographic diagnosis of rheumatic heart disease. Nat Rev Cardiol. 2024;21(4):250-263.

92 Marcus R, Sareli P, Pocock WA, et al. Functional anatomy of severe mitral regurgitation in active rheumatic carditis. American Journal of Cardiology. 1989;63(9):577-584.

93 Camara E, Neubauer C, Camara GF, et al. Mechanisms of mitral valvar insufficiency in children and adolescents with severe rheumatic heart disease: an echocardiographic study with clinical and epidemiological correlations. Cardiology in the Young. 2004;14(5):527-532.

94 Zhou L, Lu K. Inflammatory valvular prolapse produced by acute rheumatic carditis: echocardiographic analysis of 66 cases of acute rheumatic carditis. International Journal of Cardiology. 1997;58(2):175-178.

95 Lembo N, Dell'Italia LJ, Crawford MH, et al. Mitral valve prolapse in patients with prior rheumatic fever. Circulation. 1988;77(4):830-836.

96 Wilkins GT, Weyman AE, Abascal VM, et al. Percutaneous balloon dilatation of the mitral valve: an analysis of echocardiographic variables related to outcome and the mechanism of dilatation. British Heart Journal. 1988;60(4):299-308.

97 Zamorano J, Cordeiro P, Sugeng L, et al. Real-time three-dimensional echocardiography for rheumatic mitral valve stenosis evaluation: an accurate and novel approach. Journal of the American College of Cardiology. 2004;43(11):2091-2096.

98 Veasy L, Wiedmeier SE, Orsmond GS, et al. Resurgence of acute rheumatic fever in the intermountain area of the United States. The New England Journal of Medicine. 1987;316(8):421-427.

99 Wilson N, Neutze JM. Echocardiographic diagnosis of subclinical carditis in acute rheumatic fever. International Journal of Cardiology. 1995;50(1):1-6.

100 Minich L, Tani LY, Pagotto LT, et al. Doppler echocardiography distinguishes between physiologic and pathologic 'silent' mitral regurgitation in patients with rheumatic fever. Clinical Cardiology. 1997;20(11):924-926.

101 Folger G Jr, Hajar R. Doppler echocardiographic findings of mitral and aortic valvular regurgitation in children manifesting only rheumatic arthritis. American Journal of Cardiology. 1989;63(17):1278-1280.

102 Folger G Jr, Hajar R, Robida A, et al. Occurrence of valvar heart disease in acute rheumatic fever without evident carditis: colour flow Doppler identification. British Heart Journal. 1992;67(6):434-438.

103 Mota C. Doppler echocardiographic assessment of subclinical valvitis in the diagnosis of acute rheumatic fever. Cardiology in the Young. 2001;11(3):251-254.

104 Figueroa F, Fernandez MS, Valdes P, et al. Prospective comparison of clinical and echocardiographic diagnosis of rheumatic carditis: long term follow up of patients with subclinical disease. Heart. 2001;85(4):407-410.

105 Regmi P, Pandey MR. Prevalence of rheumatic fever and rheumatic heart disease in school children of Kathmandu city. Indian Heart Journal. 1997;49(5):518-520.

106 Cotrim C, Macedo AJ, Duarte J, et al. The echocardiogram in the first attack of rheumatic fever in childhood. Revista Portuguesa de Cardiologia. 1994;13(7-8):581-586.

107 Agarwal P, Misra M, Sarkari NB, et al. Usefulness of echocardiography in detection of subclinical carditis in acute rheumatic polyarthritis and rheumatic chorea. Journal of the Association of Physicians of India. 1998;46(11):937-938.

108 Beg A, Sadiq M. Subclinical valvulitis in children with acute rheumatic fever. Pediatric Cardiology. 2008;29(3):619-623.

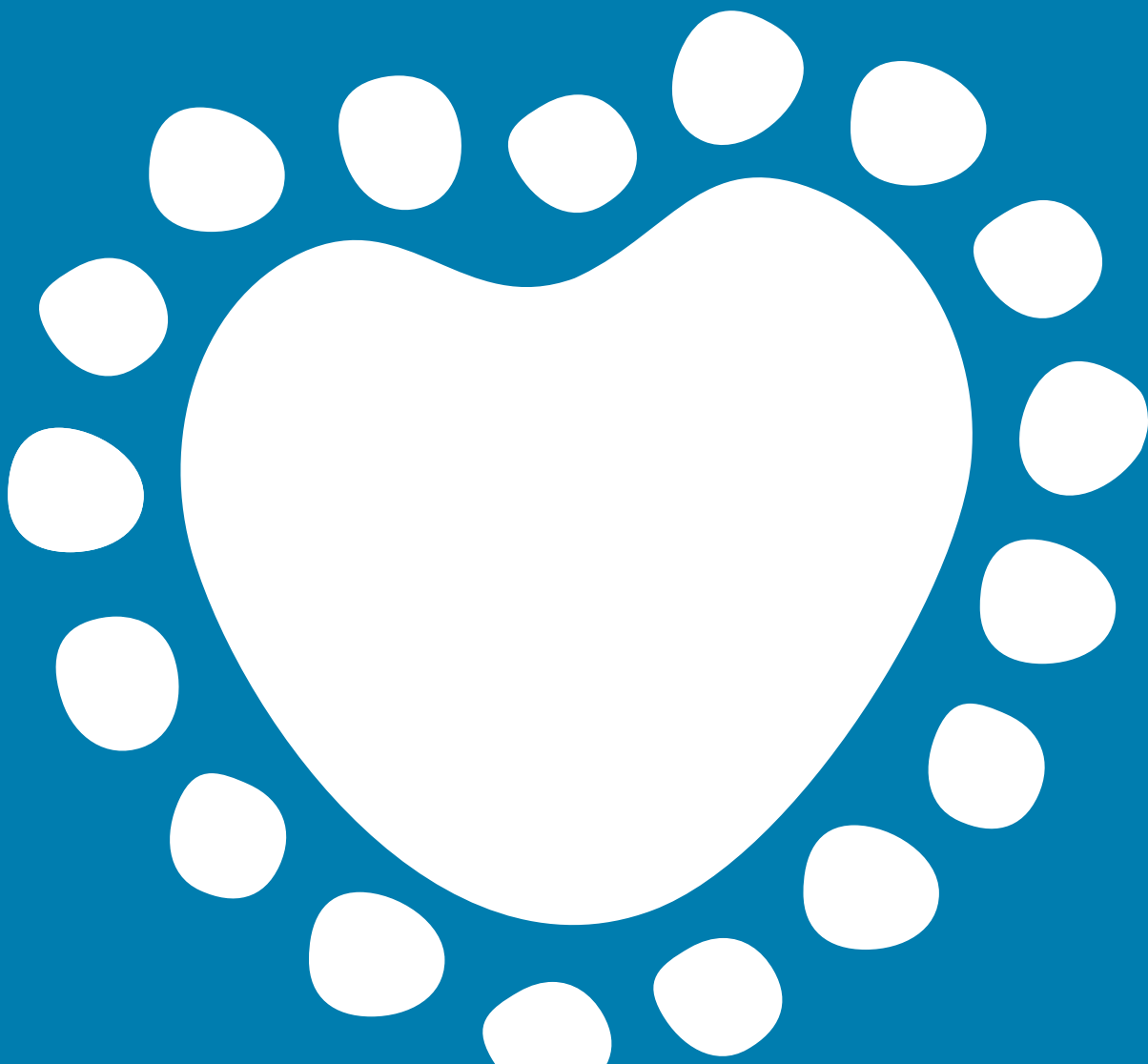
109 Rayamajhi A, Sharma D, Shakya U, et al. First-episode versus recurrent acute rheumatic fever: is it different? Pediatrics International. 2009;51(2):269-275.

110 Tubridy-Clark M, Carapetis JR. Subclinical carditis in rheumatic fever: a systematic review. International Journal of Cardiology. 2007;119(1):54-58.

111 Caldas A, Terreri MT, Moises VA, et al. What is the true frequency of carditis in acute rheumatic fever? A prospective clinical and Doppler blind study of 56 children with up to 60 months of follow-up evaluation. Pediatric Cardiology. 2008;29(6):1048-1053.

CHAPTER 7

Management of acute rheumatic fever



Management of acute rheumatic fever

IMPORTANT CHANGES IN THIS CHAPTER

Updated 'Medications used for acute rheumatic fever' with GRADE Level of Evidence (Table 7.1)

Removal of tramadol from management of severe pain while awaiting diagnostic confirmation (Table 7.1)

Addition of an anticonvulsant agent (corticosteroid) in the management of Sydenham chorea (Table 7.1)

Integration of management recommendations for all stages of RHD based on 2023 WHF guidelines, Table 7.4. Priority classification and recommended follow-up (updated 2024)

Updated Sydenham chorea management strategies (Table 7.6)

Removal of the discussion about tramadol from the text (updated August 2025)

Correction of Priority 1 and Priority 2 RHD Stage definitions in Table 7.4 (updated August 2025)

KEY INFORMATION

- People suspected to have acute rheumatic fever (ARF) should be referred as soon as possible for investigations (including echocardiography), treatment and education.
- Admission to a hospital with echocardiography services is generally recommended in order to facilitate correct diagnosis. Echocardiographic findings inform the management plan including recommended duration of secondary prophylaxis. A normal echocardiogram does not exclude ARF.
- While the diagnosis is uncertain, giving salicylate or non-steroidal anti-inflammatory drug (NSAID) therapy should be deferred because they might mask symptom evolution, and thereby impede correct diagnosis.
- 'Suspected ARF' is a term that applies during diagnostic workup. For each ARF episode, a final diagnosis should be reached and specified as either:
    - Definite ARF (initial or recurrence);
    - Probable ARF (initial or recurrence);
    - Possible ARF (initial or recurrence);
    - Not ARF.
- For definite ARF, a 'priority' grade 1 through 4 based on the presence and severity of any accompanying RHD should also be provided, using the revised priority classification (Table 7.4). The priority determines which care plan to use, including frequency of medical reviews and echocardiograms.
- The 'priority' grade and recommended follow up schedule represents best practice according to expert consensus opinion for the Australian context (GRADE 1D). These acknowledge that ongoing advocacy is needed to achieve levels of servicing to meet recommendations.
- People diagnosed with ARF should be:
    - Notified to the local Disease Control Unit or Public Health Unit in accordance with jurisdictional legislation (Table 13.1); and
    - Registered with the jurisdictional RHD Control Program, with details of their secondary prophylaxis requirements (Table 10.2).
- The pillars of management are
    - Eradication of the inciting infection using antibiotics as directed (penicillin or azithromycin for initial prevention, and penicillin or an alternative if allergic to penicillin)
    - Management of symptoms with analgesic / antipyretic agents as needed.

Table 7.1. Medications used for acute rheumatic fever

INDICATION	MEDICATION OPTIONS LISTED IN ORDER OF PREFERENCE	COMMENT	GRADE
Eradication of inciting streptococcal infection	1. Benzathine benzylpenicillin G (BPG) 1,200,000 units (child <20 kg: 600,000 units; ≥20 kg: 1,200,000 units) IMI single dose or	Streptococcal infection may not be evident by the time ARF manifests (e.g. cultures often negative) but eradication therapy for possible persisting streptococci is recommended, nonetheless. Intramuscular penicillin is preferred due to better adherence and its ongoing use in secondary prophylaxis.	1B
	2. Phenoxymethylpenicillin 500 mg (child: 15 mg/kg up to 500 mg) orally 12-hourly for 10 days		
	3. Penicillin hypersensitivity (non-severe): cefalexin 1 g (child: 25 mg/kg up to 1 g) orally, 12-hourly for 10 days	Between 3 and 30% of Group A Streptococcus isolates internationally are resistant to macrolide antibiotics (e.g. azithromycin).	
	4. Severe penicillin hypersensitivity: azithromycin 500 mg (child: 12 mg/kg up to 500 mg) orally daily for 5 days		
Initial analgesia while awaiting diagnostic confirmation: mild-moderate pain	Paracetamol 1000 mg (child 15 mg/kg) orally, 4-hourly up to a maximum of 60 mg/kg/day or 4000 mg/day	Preferred initial analgesia during diagnostic uncertainty, to avoid the masking effect that anti-inflammatory use can have on migratory joint symptoms, fever and inflammatory markers.	2D
Symptomatic management of arthritis/arthralgia after confirmation of ARF diagnosis	1. Naproxen immediate-release 250-500 mg (child 10–20 mg/kg/day) orally twice daily or	Naproxen may be safer than aspirin, and convenient due to twice daily dosing and the capability for oral suspension. Ibuprofen is well tolerated and readily available but data and experience with its use are less in ARF than for naproxen. The dose of NSAIDS needed for ARF is generally higher than the dose recommended for other conditions, therefore it may be appropriate to commence at the higher dose range. Due to the rare possibility of Reye's syndrome in children, aspirin may need to be ceased during intercurrent acute viral illness, and influenza vaccination is strongly recommended.	1B
	2. Ibuprofen 200-400 mg (child 5-10 mg/kg) orally three times daily or		
	3. Aspirin adults and children 50-60 mg/kg/day orally, in four to five divided doses. Dose can be escalated up to a maximum of 80-100 mg/kg/day in four to five divided doses		
Symptomatic management of moderate to severe chorea / chorea paralytica (Table 7.6)	1. Carbamazepine 3.5 to 10 mg/kg per dose orally, twice daily 2. Sodium valproate 7.5 to 10 mg/kg per dose orally, twice daily Plus 1. Prednisone/prednisolone 1 to 2 mg/kg up to a maximum of 80 mg orally, once daily or in divided doses Plus consider intravenous immunoglobulin therapy or plasma exchange	Treatment of Sydenham chorea should be considered if movements interfere substantially with normal activities.	2B

Table 7.1. Medications used for acute rheumatic fever (continued)

INDICATION	MEDICATION OPTIONS LISTED IN ORDER OF PREFERENCE	COMMENT	GRADE
Symptomatic management of carditis	Paediatric dosing: Furosemide (frusemide) 1 to 2 mg/kg orally as a single dose, then 0.5 to 1 mg/kg (to a maximum of 6 mg/kg) orally, 6- to 24-hourly Spironolactone 1 to 3 mg/kg (initially) up to 100 mg orally, daily in 1 to 3 divided doses. Round dose to a multiple of 6.25 mg (a quarter of a 25 mg tablet) Enalapril 0.1 mg/kg orally, daily in 1 or 2 divided doses increased gradually over 2 weeks to a maximum of 1 mg/kg orally, daily in 1 or 2 divided doses, other ACE inhibitors (captopril, lisinopril, ramipril, perindopril)	Treatment of heart failure may be required in severe, acute carditis. Seek advice from a specialist cardiologist. Choice of ACE inhibitor will vary depending on the clinical situation. Seek advice from a specialist cardiologist.	1B
	Adult dosing: Furosemide (frusemide) 20–40 mg oral or intravenous as a single dose followed by 20–40 mg oral or intravenous 8–12 hourly. Ongoing dose adjustment based on clinical progression and renal function Spironolactone may be added for patients having limited or no response to loop diuretic, 12.5–25 mg spironolactone orally daily Nitrate therapy may be added for patients having limited or no response to diuretic therapy, whose systolic blood pressure is greater than 90 mmHg. Intravenous or topical glyceryl trinitrate may be used ACE inhibitor is recommended in patients with moderate or severe left ventricular systolic dysfunction, unless contraindicated	The management of acute carditis follows the same principles as the management of acute heart failure. This table gives a guide to the initial management of acute heart failure due to acute carditis in adults. Seeking advice from a specialist cardiologist early is strongly recommended.	1B
	Digoxin 15 micrograms/kg orally, as a single dose, then 5 micrograms/kg after 6 hours, then 3–5 micrograms/kg (adult: 125–250 micrograms) orally, daily	Digoxin is rarely used in the treatment of acute carditis. Seek advice from a specialist cardiologist.	2C
Disease-modifying (immunomodulatory) treatments	Prednisone/prednisolone 1 to 2 mg/kg up to a maximum of 80 mg orally, once daily or in divided doses	Considered for use in selected cases of severe carditis, despite meta-analyses in which overall benefit was not evident.	2C

IMI, intramuscular injection; NSAID, non-steroidal anti-inflammatory drug; ACE, Angiotensin-converting enzyme

DISCUSSION

> *"The use of traditional healers to complement western medicine is important to Aboriginal and Torres Strait Islander peoples with ARF or RHD."*
>
> RHD Champion, 2019

The priority in the first few days after a person presents with suspected ARF is confirmation of the diagnosis. The priorities in managing ARF are outlined in Table 7.2.

Healthcare providers who have trained and worked in settings where ARF is rare may underestimate the importance and urgency of accurate diagnosis and prompt treatment, which includes admission to hospital (See Indication for Hospitalisation). This highlights the need for new medical and nursing staff in hospitals and primary care settings in high-burden regions to undergo education about ARF and RHD. Education should be embedded into clinical orientation programs, including systems for regular clinical updates.

The guidance in this chapter relates to individuals who present with features suggestive of ARF. RHD detected during screening is described in Management of Rheumatic Heart Disease.

Pre-hospital management of ARF

The diagnosis of ARF is often not evident on first presentation to a primary care centre, since symptoms may evolve over several weeks. Primary care clinicians require a high degree of suspicion for ARF; presentations can be very subtle. The majority of RHD diagnoses are made in individuals who's prior ARF episodes have never been recognised (in the Northern Territory, around 75% of RHD cases),[1] illustrating the high proportion of people with ARF who either do not present to primary care services or do present and are misdiagnosed. Retrospective chart reviews reveal that individuals with RHD often have presented to health services with joint pain or unexplained fever which would have met criteria for possible, probable or definite ARF (unpublished). Had the patient been referred to hospital for echocardiogram, ECG, blood tests and close monitoring of symptom evolution, and a diagnosis of ARF made, then secondary prophylaxis could have been instituted to avert the development or mitigate the severity of RHD.

A first dose of benzathine benzylpenicillin G (BPG) should be given (or alternative oral antibiotic regimen commenced) prior to hospitalisation to individuals with suspected ARF. If fever is documented, blood cultures should be obtained prior to antibiotic administration since an alternative diagnosis such as septic arthritis or endocarditis may be present.

The arthritis, arthralgia and fever of ARF respond to NSAIDs.[2-4] However, early administration of NSAIDs may mask the development of migratory polyarthritis or fever. Until the diagnosis is confirmed, it is therefore recommended that joint pain be treated with paracetamol.[5] This approach may still mask a fever meeting diagnostic criteria of ≥38°C, but fever tends to occur early in the illness and hence is likely to be evident prior to commencing antipyretic analgesics. A history of subjective fever is also sufficient as a minor Jones criterion (Table 6.8). Severe joint pain may require escalation of analgesia e.g. to codeine or tramadol, but there are significant safety concerns with use of these agents in children aged under 12 years.[6]

Decision-making regarding hospitalisation

Occasionally, when the diagnosis has already been confirmed and the patient is not unwell (e.g. mild arthralgia or mild recurrent Sydenham chorea in a child with no other symptoms or signs), outpatient management may be appropriate if a timely echocardiogram is also able to be obtained (i.e. within 2 weeks of symptom onset). (See Indication for Hospitalisation)

While hospitalisation is strongly recommended for the reasons outlined below, in some cases management in the community may be more patient-centred and sensitive to cultural needs. In such cases, health staff **must** seek expert advice, ensure accurate documentation of history and examination findings including vital sign monitoring (regular temperature, pulse rate and rhythm, respiratory rate and blood pressure). Video recording after obtaining patient / guardian consent of examination findings e.g. to demonstrate joint examination findings or chorea, can be a helpful way of providing accurate information to the consulting off-site specialist. Appropriate investigations, treatment, health education and patient registration must all be completed, and consultation with an expert is essential. ESR testing can be challenging in remote communities but can help make the diagnosis of ARF if elevated when CRP is not meeting the threshold. Collect into the correct tube required by the pathology service and this can be stored at 4°C ideally for 4 hours but up to 24 hours before processing.

People managed in the community should have an integrated care plan that includes nursing, medical, and allied health involvement, with consideration for tradition and culture, and which is centred on the needs of the patient. Timely echocardiography is essential for all people with suspected ARF.

All suspected and confirmed new and recurrent ARF episodes should be reported to the local Disease Control Unit by the treating hospital or community Medical Officer, according to local legislation for notifiable conditions (Table 13.1).

Hospital management of ARF

Where available, hospital based First Nations health staff and Liaison Officers should be engaged at the time of admission for First Nations patients.

Most patients with suspected ARF (first episode or recurrence) should be hospitalised as soon as possible after the onset of symptoms,[5] guided by the above advice. This ensures that investigations are performed, especially echocardiography, ECG, inflammatory markers, streptococcal serology, and investigation that may be indicated to exclude differential diagnoses (Table 7.2). Hospitalisation also provides an opportunity for clinical observation and regular temperature charting for a period prior to commencing anti-inflammatory analgesics, to confirm the diagnosis. However, in cases of mild ARF, it is common for symptoms to have resolved by the time the individual reaches hospital, emphasising the importance of clinical history obtained from the individual, their family and the community primary care staff.

Communication between the healthcare provider and the patient and family should be conducted in a language and setting in which clear and accurate information can be safely relayed.

Table 7.2. Priorities in managing ARF in the acute setting

ADMISSION TO HOSPITAL	
Anyone suspected to have ARF who is high risk for complications (See Chapter 6 Diagnosis of ARF, Indications for Hospitalisation).	
DETERMINE THE DIAGNOSIS	
The diagnosis is determined based on • Understanding of epidemiological risk. • History obtained from primary care staff and/or patient and their family. • Clinical observation prior to anti-inflammatory treatment: use paracetamol (first line) during this time if required for fever or joint pain. • Investigations (Table 7.3). • Follow up findings o The final diagnosis may not be clear until several months after the acute episode, e.g. if Jones criteria are not met for a diagnosis of definite ARF but a follow up echocardiogram confirms rheumatic valvular changes not visible at the outset, then the diagnosis shifts from possible or probable to definite ARF.	
TREATMENT	
All cases	Provision of supportive, culturally safe care. Antibiotic management using pain avoidance techniques for delivery of intramuscular injection (Figure 10.1). Influenza vaccine – annual influenza vaccination is part of the long-term care plan but needs to be considered acutely as a strategy to reduce the risk of Reye's syndrome for children receiving aspirin.
Arthritis and fever	Paracetamol (first line) until diagnosis confirmed. Naproxen, ibuprofen or aspirin once diagnosis confirmed, if arthritis or severe arthralgia present. Mild arthralgia and fever may respond to paracetamol alone.
Sydenham chorea	No pharmacological treatment for mild cases. Anticonvulsant such as carbamazepine or sodium valproate if indicated (Table 7.1). Stepwise use of other agents as per text below (Table 7.6). Evidence base is limited.
Carditis/heart failure	Bed rest, with mobilisation as symptoms permit. Anti-failure medication as required (Table 7.1). Corticosteroids for severe carditis or pericarditis with effusion. (Tables 7.1 and 7.5) Valve surgery for life-threatening acute carditis (rare).

Table 7.2. Priorities in managing ARF in the acute setting (continued)

LONG-TERM PREVENTIVE MEASURES AND DISCHARGE PLANNING
Prepare for discharge to primary care facility and follow-up. • Notify case to the jurisdictional ARF/RHD register (where it exists) (Table 13.1). • Contact the patient's local primary care service and community pharmacist. • Provide a discharge letter to the patient or family, the primary care service and community pharmacist including information about: o ARF diagnosis (possible, probable, definite). o Priority classification of RHD if also present (Priority 1, 2 or 3) (Table 11.2). o A recommended care plan summary based on disease priority classification (Table 7.4). o Date of last BPG administration. o Required frequency of BPG, and the due date of next dose. o Date of next medical appointment. o Date of next echocardiogram. o Information about vaccinations administered in hospital. o Relevant contraception information and/or pregnancy planning for women. • Arrange dental review and ongoing dental care to reduce risk of endocarditis. Family and community engagement • Involve family in care. • Engage interpreters for patients and families whose first language is not English. • Provide education that is culturally appropriate and age-appropriate. • With consent from family, notify school (for school-aged children) to encourage support for ongoing care. • Acknowledge the significance of a chronic disease diagnosis in childhood, including the need for linkage with peer-support networks, psychological support, ongoing education, transition care as the individual ages, and self-management support. Where indicated, engage adolescent support services (Table 11.4).

Five priorities during hospitalisation

1. Classify as either:
   - Definite ARF (initial or recurrence);
   - Probable ARF (initial or recurrence);
   - Possible ARF (initial or recurrence);
   - Not ARF.
2. Notify the case to the local Disease Control Unit in accordance with jurisdictional legislation (Table 13.1).
3. Register the patient with the jurisdictional RHD Control Program and provide details of secondary prophylaxis requirements (Table 10.2).
4. Provide education for the patient and their family (including for ARF recurrence).
5. Commence secondary prophylaxis: (Table 10.2)
   a. Ensure that the secondary prophylaxis regimen has been commenced prior to discharge, even if an alternative oral antibiotic regimen has been given for treatment of Strep A infection.
      - Only one dose of BPG needs to be given, so the dose should not be repeated if it has been given already for Strep A eradication.
   b. The second dose of BPG should be scheduled to be given 21–28 days after the first dose (no later than 28 days).
   c. In the case of ARF recurrence, ensure secondary prophylaxis is given as required, and the register is notified as per jurisdictional protocol.

Principles of management of ARF are shown in Table 7.2 and Table 7.3.

Table 7.3. Testing and monitoring of ARF in the acute setting

Investigations	Always request:
	• Electrocardiogram (ECG).
	• Echocardiogram.
	• Full blood count (FBC).
	• Erythrocyte sedimentation rate (ESR).
	• C-reactive protein (CRP).
	• Streptococcal serology (anti-streptolysin O and anti-DNase B).
	
	In relevant situations:
	• Throat swab.
	• Skin sore swab.
	• Blood cultures.
	• Synovial fluid aspirate.
	  o Ensure sample does not clot by using correct tubes which have been well mixed and transported promptly to the laboratory.
	  o Include request for cell count, microscopy, culture and gonococcal polymerase chain reaction (PCR).
	• Pregnancy test.
	• Creatinine test (UEC [urea, electrolytes, creatinine]) since NSAIDS can affect renal function.
	
	Tests to exclude alternative diagnoses, depending on clinical presentation and locally endemic infections:
	• Autoantibodies, double-stranded DNA, anti-cyclic citrullinated peptide (anti-CCP) antibodies.
	• Urine for Neisseria gonorrhoeae molecular test.
	• Urine for Chlamydia trachomatis molecular test.
	• Serological or other testing for viral hepatitis, Yersinia spp, cytomegalovirus (CMV), parvovirus B19, respiratory viruses, Ross River virus, Barmah Forest virus.

Clinical observations	Temperature, pulse, respiratory rate, blood pressure 4 times daily. On occasions of rapid or irregular pulse, ensure ECG is recorded. Thorough skin examination for skin sores, erythema marginatum, subcutaneous nodules. Regular assessment of joints.
Diet	Standard healthy diet. Early dietary advice if overweight (especially if in heart failure), to avoid further weight gain. Consider testing lipids, HbA1c. Weekly weight.
If clinical carditis is present	Document cardiac symptoms and signs. Include sleeping pulse in regular nursing observations (e.g. 0200 hours), as long as this can be done without waking the patient. Individuals with heart failure or severe acute valve disease should be encouraged to rest in bed and avoid exertion until symptoms are improving. Daily weight and fluid balance chart. Weekly echocardiograms in severe acute valvulitis while patient is hospitalised, if able.

Education

Effective communication supports self-management. Poor communication is a significant barrier to care, particularly if there are language, cultural or social barriers. For First Nations peoples, clinical yarning has been used in clinical consultations to build rapport and trust between patients and healthcare providers. It is a conversational, relaxed, open-ended style of communication that allows storytelling to understand a patient's health issue within the context of their life, and to communicate health information. It marries a cultural base – a consultation style that is culturally congruent with First Nations ways of communicating – to western biomedical knowledge.[7]

Hospitalisation offers an important opportunity to provide education for patients and families, using culturally appropriate educational materials in the patient's first language. Video, audio and written resources translated into common Australian First Nations languages are available (See HealthInfoNet, KAMSC and Menzies School of Health Research).

Further education by local health staff to reinforce information about ARF is of critical importance once the patient has returned home. Evidence from a study conducted with Northern Territory First Nations peoples with a history of ARF or RHD shows that most initial education provided by healthcare providers did not result in any knowledge being imparted.[8] Genuine knowledge transfer occurs when information is repeated over time, in the person's first language, and in a culturally appropriate way – such as in an environment in which the person feels comfortable, drawing on local learning styles such as the use of metaphor to explain medical concepts.[9] It is also facilitated if the health professions work in collaboration with First Nations Health Workers, Health Practitioners and Liaison Officers to provide in-person support to allow people and their families to ask questions and alleviate the concerns.[10]

First Nations health workers and nurses often greet, triage, treat and support patients in primary care settings. Education, training, and empowerment of the First Nations health workforce will enable them to support patients and their families in line with clinical best practice.

Management of possible and probable ARF

Patients with ARF not fulfilling definite criteria are categorised as having **possible** or **probable ARF**, and treatment recommendations differ substantially. The distinction between possible and probable ARF depends to a certain extent on what the clinician thinks is most likely to be the diagnosis. In addition to the definitions provided in the ARF Diagnosis chapter, (See Chapter 6. Diagnosis of ARF, ARF categorised as definite, probable & possible) clinical judgement is needed in assigning a diagnostic category.

The proportion of individuals with probable ARF who progress to definite ARF and/or RHD is unclear pending further studies, but importantly, some individuals definitely do progress.[11] Therefore, the conservative approach is to ensure that people with **probable ARF** receive the same secondary prophylaxis regimen as people with definite ARF without RHD (Priority 3); that is, BPG for five years or until age 21, whichever is longer (Table 10.3).

The recommendation in **possible ARF** is for 12 months of BPG only, provided echocardiogram remains normal, with ongoing review for another 12 months thereafter (Table 10.3). Clinical discretion should apply when considering extension of the duration of secondary prophylaxis in high-risk individuals, such as people with a strong family history of RHD and significant epidemiological risk factors (Table 6.2). Assigning people with possible ARF to 12 months of treatment is a strategy that balances risks (personal and healthcare system costs of 28-day BPG injections) against benefits (avoiding further streptococcal infections during the highest-risk period for ARF recurrences, which is in the first 12 months after initial ARF).[12] It has been shown that regular BPG for ARF prophylaxis is associated with reduced mortality overall.[13] This highlights that for people living in high-risk settings where communicable penicillin-susceptible childhood diseases are common, including people who have not had ARF, there may be benefits of penicillin beyond ARF prevention alone.

Management according to priority classification

A priority classification system to grade disease severity has been in use in Australia for several decades for individuals diagnosed with ARF or RHD. This determines general principles of the care plan appropriate for that individual. This system was initiated in the Northern Territory in 2001 as a clinical tool to help healthcare providers recognise which patients required closest follow up, and to appropriately allocate resources according to need. Modifications to the priority classification system have been made, including further revisions in the current edition of the guideline. Management of ARF should align with the relevant classification, which should be assigned in accordance with Table 7.4.

Antibiotic treatment

People presenting with definite, probable or possible ARF require antibiotics for treatment of persisting streptococcal infection or asymptomatic respiratory tract infection.

Controlled studies have failed to show that treating ARF with large doses of penicillin affects the outcome of rheumatic valvular lesions one year later.[14,15] Despite this, most authorities recommend a course of penicillin, even if bacterial cultures for Strep A are negative, to ensure eradication of streptococci that may persist, for example in the upper respiratory tract. Although streptococci may not be present in high enough numbers to be culturable from the throat by the time of ARF presentation, findings from a recent study suggest that pathogenic Strep A may still be detectable in the throat using molecular tests which are more sensitive than culture (See Chapter 6. Diagnosis of ARF, Streptococcal A rapid diagnostics).[16]

Strep A (Streptococcus pyogenes) isolates are almost universally susceptible to penicillin and related beta lactam antibiotics, e.g. cephalosporins. The organism appears to lack capacity to express beta-lactamase that would confer resistance.[17] Mutations in penicillin-binding proteins conferring decreased susceptibility to some beta lactam antibiotics but not penicillin have been reported, but very rarely, and never in Australia.[18]

Strep A can, however, readily become resistant to macrolide antibiotics (azithromycin, roxithromycin, erythromycin etc) with marked geographical variation and variations over time for any region, e.g. 3% in some Australian studies, 30% in studies from Italy and South Korea.[17,19] Resistance to macrolide antibiotics generally also confers resistance to clindamycin.

Table 7.4. Priority classification and recommended follow-up (updated 2025)

DIAGNOSIS	RECOMMENDED FOLLOW-UP PLAN†
Priority 1 **Severe Stage C and all Stage D RHD†‡** High risk post-valve surgery patients§ ≥3 episodes of ARF within the last 5 years Pregnant women with RHD (of any severity) may be considered Priority 1 for the duration of the pregnancy Children ≤5 years of age with ARF or RHD	Specialist review: at least 6 monthly Echocardiogram: at least 6 monthly Medical review: at least 6 monthly Pregnant: see Figure 12.1 for care pathway Dental review: within 3 months of diagnosis, then 6 monthly
Priority 2 **Moderate Stage C RHD†‡** Moderate risk post-valve surgery patients§	Specialist review: 6 monthly – yearly Echocardiogram: 6 monthly – yearly Medical review: 6 monthly Dental review: within 3 months of diagnosis, then 6 monthly
Priority 3 **Any Stage A or Stage B RHD†‡** ARF without carditis or RHD, currently prescribed secondary prophylaxis¶ Low risk post-valve surgical patients§	Specialist review: 1 – 3 yearly Echocardiogram: children ≤21 years: 1–2 yearly, >21 years: 2–3 yearly Medical review: yearly Dental review: yearly
Priority 4 **History of ARF†** (possible, probable or definite) and completed secondary prophylaxis **Resolved RHD** (including Stage A) and completed secondary prophylaxis††	Specialist review: 1 year, 3 years and 5 years post cessation of secondary prophylaxis Echocardiogram: 1 year, 3 years and 5 years post cessation of secondary prophylaxis Medical review: yearly until discharge from specialist care and then as required Dental review: yearly or as required

† Frequencies in follow-up plans are based on RHD Severity Stage Category and can be varied and tailored to the individual in consultation between primary care and specialist teams. All patients should be given influenza vaccine annually and have completed pneumococcal vaccinations as per Australian Immunisation Handbook. Intervals for medical and specialist review and echocardiography are a guide and may vary for specific individuals. Medical and dental reviews may be combined with general health check-up. People with RHD require endocarditis prevention as indicated. (See Chapter 11. Management of RHD, Prevention of infective endocarditis).

‡ See Table 8.7 for definitions of RHD severity.

§ While post-surgical RHD is by definition severe RHD, post-surgical risk varies for individuals due to age, type of surgery, recurrence of ARF, adherence with secondary prophylaxis and other factors. Priority category for post-surgical RHD varies as listed in this Priority classification table and should be determined by specialist cardiologist/paediatrician/physician. (See Chapter 11. Management of RHD, Monitoring following valve surgery).

¶ See Table 10.2 regarding initial treatment of possible, probable and definite ARF with and without carditis. The priority table provides guidance on longer term established RHD based on Stage of disease once the acute illness has resolved.

†† A proportion of early RHD changes can resolve with no residual valve dysfunction. These cases are referred to as 'resolved RHD' and as such, may not need the longer-term follow-up required by Stage B/C/D disease.

NOTE: For Staging of RHD see Table 8.7. Staging of RHD as detected by echocardiography based on WHF 2023 guidelines.

Treatment of arthritis and arthralgia

Salicylates (aspirin) have traditionally been recommended as first-line treatment, because of the extensive historical experience with their use in ARF and an established evidence base.[5,20,21] However, there is increasing clinical experience with other NSAID therapy, particularly naproxen[22-25] and ibuprofen. These agents are now used in preference to aspirin in childhood inflammatory conditions (with the exception of Kawasaki disease) and have less toxicity than high-dose aspirin.[22-25]

Anti-inflammatory therapy should be commenced in patients with arthritis or severe arthralgia once the diagnosis of ARF has been made. During diagnostic workup of such cases, paracetamol should be used for initial pain relief (Table 7.1).

The arthritis of ARF has been shown in controlled trials to respond dramatically to salicylate or other NSAID therapy,[2-4] often within hours, and almost always within three days. If the symptoms and signs do not remit substantially within several days of commencing regular anti-inflammatory medication at an appropriate dose, alternative diagnoses should be considered. Having noted this, anecdotal experience especially of adults with ARF indicates that while improvement has occurred, limping and other functional impairment due to joint pain may persist for weeks.

The duration of treatment is dictated by the clinical response and improvement in inflammatory markers (ESR, CRP). Many patients need anti-inflammatory therapy for only one to two weeks (i.e. anti-inflammatory therapy can be stopped at two weeks if the patient is pain free with improved inflammatory markers). In some patients, joint symptoms may recur following the cessation of regular anti-inflammatory treatment (so-called 'rebound phenomenon'[26]); this does not indicate ARF recurrence and can be treated with another course of anti-inflammatory therapy.[27] Clinical practice differs in relation to the duration of anti-inflammatory therapy. Many patients have symptoms for a short duration only (less than one week) and only require symptomatic treatment with anti-inflammatory therapy for that period. Some patients who have persisting joint symptoms may require regular anti-inflammatory therapy for up to six weeks. In such cases, the anti-inflammatory dose can often be reduced after the initial one to two weeks.[28-30] As the dose is reduced, rebound symptoms may occur, as described earlier, and can be treated with a brief course of higher-dose anti-inflammatory therapy. The majority of ARF episodes have fully subsided within six weeks, and 90% resolve within 12 weeks.

Some clinicians are guided by inflammatory markers as well as symptoms in determining duration of NSAID therapy but there is no evidence that this changes outcome, and no parameters have been established for threshold CRP and ESR levels to guide cessation.

Approximately 1 in 10 patients will have joint symptoms persisting for more than three months.

Naproxen and Ibuprofen

The effectiveness of naproxen has been reported in a small retrospective review of 19 patients in the year 2000,[22] in an open-label comparative study of naproxen and aspirin in 33 children in 2003,[23] in a large retrospective cohort study of 338 children in 2016,[22] and in an observational case-control study (32 cases [given naproxen], 32 controls [given aspirin]) published in 2024.[31] In the 2023 open-label comparative study, efficacy was similar to aspirin, but gastrointestinal adverse effects were fewer with naproxen.[23] Similarly, in the large retrospective cohort, significantly fewer ARF patients who received naproxen developed gastric pain or hepatoxicity.[22] Thus, naproxen is advocated as a safer alternative to aspirin.[22,23] Naproxen also has the advantage of twice-daily dosing and is available in Australia as a suspension. Ibuprofen is a readily available NSAID and has also been used successfully in ARF at a dose of 30 mg/kg/day divided into three doses, although there are no published data to support its use in ARF.

Aspirin

Aspirin, when used, should be started at a dose of 50–60 mg/kg/day, up to a maximum of 80–100 mg/kg/day (4–8 g/day in adults) in four to five divided doses. If there is an incomplete response within two weeks, the dose may be increased to 125 mg/kg/day. At high doses, the patient should be carefully observed for features of salicylate toxicity (tinnitus, headache, hyperpnoea), gastritis and bleeding. Proton pump inhibitor (PPI) therapy may provide some gastric protection. If salicylate toxicity occurs, substitution with naproxen or ibuprofen should be considered, or the aspirin dose can be reduced to 60–70 mg/kg/day once symptoms are controlled, for the remainder of a several-week-long course.[29,32,33] There is a risk of Reye syndrome (encephalopathy with liver toxicity) in children receiving salicylates, particularly those who have an intercurrent viral infection such as influenza. Hepatotoxicity has also been described in up to 10% of children with ARF receiving high-dose aspirin therapy.[24] Annual influenza vaccination is part of the standard care plan for individuals with ARF or RHD of any priority classification but needs to be part of the acute management strategy for children prescribed aspirin during the influenza season.

Treatment of fever

Low-grade fever does not require specific treatment. Fever will usually respond to NSAID therapy. Fever alone, or fever with mild arthralgia or arthritis, may not require NSAIDs but can instead be treated with paracetamol.

Treatment of carditis and heart failure

An urgent cardiology assessment with chest X-ray and echocardiogram are recommended for all patients with heart failure. The mainstays of initial treatment are rest (see below for specific comments regarding bed rest) and diuretics. This results in improvement in most cases. In patients with more severe cardiac failure, corticosteroids can be considered (detailed below), and angiotensin-converting enzyme (ACE) inhibitors may be used, particularly if aortic regurgitation is present, for their role in afterload reduction.[20] Digoxin is usually reserved for patients with supraventricular tachycardias, and may be associated with excess mortality.[34] There is little experience with beta blockers in heart failure due to acute rheumatic carditis, and their use is not recommended. Nitrate therapy may be added for patients having limited or no response to diuretic therapy, whose systolic blood pressure is greater than 90 mmHg. Intravenous or topical glyceryl trinitrate may be used (See Chapter 11. Management of RHD, Management of RHD complications).

Corticosteroids for carditis

The use of corticosteroids and other anti-inflammatory medications in rheumatic carditis has been studied in two meta-analyses.[35,36] These studies were performed more than 40 years ago, preceded the availability of echocardiography, and did not use drugs that are in common use today. The meta-analyses failed to suggest any benefit of corticosteroids or intravenous immunoglobulin (IVIg) over placebo, or of corticosteroids over salicylates, in reducing the risk of long-term heart disease.

Also, the available evidence suggests that salicylates do not decrease the incidence of residual RHD.[2,4] Therefore, salicylates are not recommended to treat carditis.

Corticosteroids may be considered for patients with heart failure in whom acute cardiac surgery is not indicated. This recommendation is not well supported by evidence but is made because of the lack of recent trials using modern (echocardiographic) end points, and because many clinicians believe that corticosteroids may lead to a more rapid resolution of cardiac compromise, and even be lifesaving in severe acute carditis.[36,37] Some clinicians believe corticosteroid therapy can play a useful role in severe rheumatic carditis, particularly in rheumatic pericardial effusions, advanced atrioventricular (AV) block and/or when cardiac dimensions are increasing. If corticosteroids are used at immunosuppressive doses/durations (Table 7.5), screening for latent infections is required, followed by appropriate management of latent infections and prevention of opportunistic infections (Table 7.5).

Meta-analyses indicate a lack of benefit of corticosteroids in altering RHD outcome. However, all studies were performed prior to the availability of echocardiography. Expert opinion recommends their use in carditis causing heart failure. Corticosteroids are effective in reducing symptoms including pain associated with pericarditis; NSAIDs can usually be ceased. Proton pump inhibitors should be considered prophylactically with corticosteroids e.g. if long courses are anticipated or NSAIDs cannot be ceased.

Screening for, and management of, latent infections is required prior to or at commencement of immunosuppressive doses of steroids.

If corticosteroids are used, the drug of choice is oral prednisone or prednisolone (1–2 mg/kg/day, to a maximum of 80 mg once daily or in divided doses). Intravenous methylprednisolone may be given in very severe cases. If one week or less of treatment is required, the medication can be ceased when heart failure is controlled, and inflammatory markers improve. For longer courses (usually no more than three weeks is required), the dose may be decreased by 20–25% each week. Treatment should be given in addition to the other anti-failure treatments outlined. Mild to moderate carditis without cardiac failure does not warrant specific pharmacological treatment.

The potential major adverse effects of short courses of corticosteroids, including gastrointestinal bleeding and worsening of heart failure due to fluid retention, should be considered before they are used. Proton pump inhibitors should be considered prophylactically with steroids. Stress corticosteroid dosing should be considered for those with acute illness while on weaning doses of prednisone.

As corticosteroids will control joint pain and fever, salicylates can usually be discontinued, or the dose reduced, during corticosteroid administration. Salicylates may need to be recommenced after corticosteroids are discontinued to avoid rebound joint symptoms or fever.

Table 7.5. Prevention of opportunistic infections in immunosuppressed individuals

CORTICOSTEROID REGIMENS USED IN ARF
Prednisone or prednisolone, 1–2 mg/kg/day, to a maximum of 80 mg once daily or in divided doses. Intravenous methylprednisolone may be given in very severe cases.
CORTICOSTEROID REGIMENS CONSIDERED IMMUNOSUPPRESSIVE
High dose pulsed corticosteroids. In adults, prednisolone (or equivalent): ≥10 mg/day for ≥4 weeks or >20 mg/day for ≥2 weeks or total cumulative dose of 7 mg/kg within 1 month. In children, prednisolone (or equivalent): >0.5 mg/kg/day for ≥2 weeks.
EXAMPLES OF SCREENING TESTS REQUIRED PRIOR TO COMMENCING IMMUNOSUPPRESSIVE DOSES OF CORTICOSTEROID MEDICATION†
Tuberculosis: interferon gamma release assay or Tuberculin Skin Test (TST/Mantoux test). **Hepatitis B:** Hepatitis B serology with HBsAg, HBcAb and HBsAb. In patients with either a positive HBsAg or HBcAb, a hepatitis B DNA PCR should be ordered. **Hepatitis C:** Hepatitis C antibody. If positive, an HCV RNA viral load and genotype should be ordered. **HIV serology** **Melioidosis:** Melioidosis serology. If positive (an indirect haemagglutination titre of ≥1:40), swabs for melioidosis culture should be taken from throat, rectum and any wounds. Blood, urine and sputum (if any) should also be collected for melioidosis culture, and a chest X-ray performed. If cultures are positive, full treatment is required. **Strongyloidiasis:** Serology and if serology is positive or eosinophilia is present, also perform stool microscopy (single stool as a minimum, but 3 preferable). Treat with ivermectin. **Scabies:** Examine skin for evidence of scabies infection, with or without associated pyoderma. **Review of immunisation history:** provide any required immunisations when clinically appropriate to do so.
PREVENTION AND MANAGEMENT OF LATENT AND OPPORTUNISTIC INFECTIONS
Follow local guidelines regarding recommended actions guided by above results. Avoid live viral vaccines (e.g. measles/mumps/rubella, varicella) which are contraindicated in individuals receiving immunosuppressive doses / durations of corticosteroids.

† Depends on local epidemiology. Examples provided here are relevant to tropical northern Australia.

HBsAg, Hepatitis B surface antigen; HBcAb, Hepatitis B core antibody; HBsAb, Hepatitis B surface antibody; PCR; Polymerase chain reaction; RNA, Ribonucleic acid.

Role of surgery for ARF

Surgery is usually deferred until active inflammation of the heart has subsided. Valve leaflet or the rare occurrence of chordae tendineae rupture leads to severe regurgitation, necessitating emergency surgery. This can be safely performed by experienced surgeons, although the risk of adverse outcomes appears to be slightly higher than when surgery is performed after active inflammation has resolved.[38]

Valve replacement, rather than repair, is usually performed during the acute episode because of the technical difficulties of repairing friable, inflamed valvular tissue. Nevertheless, highly experienced surgeons may achieve good results with repair in this situation.

Bed rest

In the pre-penicillin era, prolonged bed rest in patients with rheumatic carditis was associated with a shorter duration of carditis, fewer relapses and less cardiomegaly.[39] Strict bed rest is no longer routinely recommended for patients with rheumatic carditis. Ambulation should be gradual, and as tolerated in patients with heart failure or severe acute valve disease, especially during the first four weeks. Some clinicians also use serum CRP and ESR as a guide to return to exercise. Patients with milder or no carditis should rest only as long as necessary to manage other symptoms, such as joint pain.

Treatment of Sydenham chorea

Sydenham chorea is a neuropsychiatric manifestation of ARF characterised variably by chorea, decreased muscle tone, and in some cases, psychiatric and behavioural symptoms such as obsessive-compulsive symptoms and hyperactivity.

Most cases of Sydenham chorea are mild, and resolve spontaneously within a few weeks, and almost all cases resolve within six months.[40] Rarely, symptoms may last two to three years with fluctuations in severity, particularly during times of stress or intercurrent illness.[41,42] Mild or moderate chorea does not require pharmacotherapy but benefits from rest and a calm environment. Overstimulation or stress can exacerbate the symptoms. Hospitalisation can be useful in confirming the diagnosis and ensuring an opportunity for education and disease notification as well as reducing the stress that families face in dealing with abnormal movements and emotional lability, or if children have significant functional impairment (for example, unable to eat, unsteady gait at risk of falls or injury). Aspirin does not influence the effect or duration of rheumatic chorea.[43,44]

Treatments to reduce the degree of choreiform movements chiefly comprise anti-convulsant medications. A 2023 systematic review of treatments identified six observational and five comparative studies, highlighting the limited evidence base to guide treatment.[45] An algorithm for the additive, stepwise use of anti-convulsant medications, neuroleptic agents, corticosteroids and experimental therapies, has been suggested.[46] Given the limited evidence base, this algorithm is not reproduced here, but the elements are discussed below.

Grading the severity of chorea

Severity ranges from very subtle choreiform movements to the patient being bed-bound. For clinical purposes, symptoms can be categorised as **mild** if involuntary moments or incoordination do not significantly interfere with daily activities; **moderate-severe** if there is functional impairment, unsteady gait, or difficulty attending to self-care activities; and **very severe** if there is persisting, significant impairment despite commencement of treatment. Chorea paralytica refers to most severe Sydenham chorea causing profound muscular atonia resulting in the patient being bed-bound and having features such as dysphagia and/or dysarthria.

For research purposes, response to therapy can be formally rated using the Universidade Federal de Minas Gerais (UFMG) Sydenham's Chorea Rating Scale (USCRS).[47,48] This tool provides a scale to grade the performance of daily living activities, behavioural abnormalities, and motor function of subjects with Sydenham chorea.

Table 7.6. Summary of Sydenham chorea management strategies

SYDENHAM CHOREA SEVERITY	STEP-WISE MANAGEMENT	MEDICATION DOSES
All cases	Antibiotic treatment (for preceding streptococcal infection and commencement of prophylaxis).	See Table 7.1
Mild – For example: Mild involuntary movements, incoordination &/or neuropsychiatric features. Mild hypotonia or weakness. Minimal functional impairment.	Supportive measures: Calm environment, avoidance of over-stimulation, rest, education about the condition.	None
Moderate – For example: Moderate functional impairment, slightly unsteady gait, some difficulty feeding and other self-care activities. Motor impersistence (inability to maintain or sustain actions such as handgrip, tongue protrusion or outheld hand / arms). Mood change, anxiety, reduced attention, hyperactivity, obsessive compulsive behaviour. Reduced / altered speech.	Above plus: Anticonvulsant therapy usually with **carbamazepine** or **sodium valproate** (if no risk of pregnancy).	Carbamazepine 3.5 to 10 mg/kg per dose orally, twice daily (max 200mg bd) **or** **If no risk of pregnancy e.g. male or pre-pubertal female:** Sodium valproate 7.5 to 10 mg/kg per dose orally, twice daily (max 500mg bd). If significant residual symptoms, consider treatment as for severe below.
Severe – For example: Severe functional impairment, unsteady gait, significant difficulty feeding and other self-care activities. Difficulty sitting. Dysarthria (marked reduced / altered speech). Marked mood change, anxiety, reduced attention, hyperactivity, obsessive compulsive behaviour. Chorea paralytica (bedbound, aphasic).	Above plus: There is some evidence for **corticosteroid** use (one of prednisone, prednisolone, or methylprednisolone) in Sydenham chorea or other autoimmune encephalopathy, but the ideal dose and duration is not established. **Haloperidol** has historically been used, but the adverse effects of excessive sedation and extrapyramidal side effects mean that its use is now largely discouraged. In very unwell children, consideration is needed of intravenous **immunoglobulin** or **plasma exchange.**	Corticosteroids for example: Prednisone/prednisolone 1 to 2 mg/kg up to a maximum of 80 mg orally, once daily or in divided doses **or** Methylprednisolone 30 mg/kg/day for 3 days, max 1g/day. Intravenous immunoglobulin 2 g/kg over 5 to 7 days. Plasmapheresis e.g. for 5 days.

Differential diagnoses of chorea

Other causes of chorea such as systemic lupus erythematosus (SLE) must be excluded. Some populations hyperendemic for ARF also have high rates of SLE, which mimics not only the joint symptoms of ARF, but also Sydenham chorea.[49] However, in high ARF-risk populations, most chorea presentations in children will be due to ARF, and neuroimaging is not needed routinely.[50]

After Sydenham chorea, recurrence may be triggered not by streptococcal infection but by other triggers such as hormonal changes (oral contraceptive use or pregnancy) – the latter termed chorea gravidarum.[51] Some authors postulate that this reflects permanent subclinical damage to the basal ganglia following the initial Sydenham chorea episode.[52]

Anti-convulsant agents

Carbamazepine is generally recommended as the first-line agent due to its preferable safety profile, followed by sodium valproate.[53,54] Haloperidol (a dopamine agonist) was previously considered the first-line medical treatment for chorea but is no longer in common use for this indication due to potential extra-pyramidal side effects, to which Sydenham chorea patients appear especially vulnerable.[46] A small (n=18), prospective comparison of carbamazepine, sodium valproate and haloperidol concluded that sodium valproate was the most effective.[55] Another small study (n=24) indicated that carbamazepine and sodium valproate had similar efficacy.[54] On balance, due to the potential for liver toxicity and teratogenicity with sodium valproate, carbamazepine is preferred first line. Sodium valproate should be avoided in pregnant women and all women of childbearing age. A single case report from South America describes successful use of levetiracetam for Sydenham chorea.[56] Levetiracetam also appears effective in other forms of chorea.[57] This agent could be an attractive option due to its favourable side-effect profile but requires further investigation.[46]

A response to treatment may not be seen for one to two weeks, and successful medication may only reduce, but not eliminate, the symptoms of Sydenham chorea. Medication should be continued for two to four weeks after chorea has subsided and then withdrawn. Recurrences of chorea during the ARF episode (i.e. within 3 months) are usually mild and can be managed conservatively or with commencement of medication as necessary.

Neuroleptic agents

In other settings, chlorpromazine has been reported as the preferred first-line agent for Sydenham chorea,[47] and other neuroleptic agents such as risperidone are recommended as an add-on agent for people failing anti-convulsant therapy.[46] Experience with these agents is limited in Australasia, and generally cases needing escalation of treatment beyond anticonvulsants receive corticosteroids as second-line treatment.

Corticosteroids for chorea

Systematic reviews recommend the use of corticosteroids for severe chorea. A review in 2017 identified 12 case reports or series and one comparative trial which included a total of 77 patients with Sydenham chorea who received steroids.[46] Seventy-six of the 77 individuals reportedly benefited, leading to the overall conclusion that steroids are an effective treatment of chorea. The trial reported faster time to reduction in chorea activity (one versus two weeks) and faster time to complete remission (54 versus 120 days) in 22 people treated with high-dose (2 mg/kg) prednisone compared with 15 individuals treated with placebo.[58] Examples of a case report and case series suggesting therapeutic success with corticosteroids (IV methylprednisolone and/or oral corticosteroid therapy) include a report of chorea paralytica,[59] and a series of five individuals with Sydenham chorea of varying severity,[60] all of whom were reported to improve after commencement of steroids.

If immunosuppressive medication is used in an individual with ARF, a pre-immunosuppression screen is needed, followed by appropriate management of latent infections and prevention of opportunistic infections (Table 7.5).

Other immunomodulatory agents for Sydenham chorea

A small study of intravenous immunoglobulin (IVIg) suggested more rapid recovery from chorea than placebo.[61] A systematic review of IVIg[62] identified two randomised, controlled trials with 38 participants.[63,64] Compared with other immunomodulatory therapies (steroids and plasma exchange), short-term benefit was seen with IVIg, and the side-effect profile is favourable. The authors concluded that use of a single 2 g/kg dose of IVIg in children with moderate-severe chorea associated with significant impairment, is reasonable. Expert advice also describes the use of IVIg 1 g/kg daily for 2 days or 400 mg/kg for 5 days as alternative dosing regimens. In addition to these trials there are also case reports of

successful IVIg use in severe chorea.[62] If IVIg is used, it should be noted that this may inhibit the immune response to some vaccines; there should be a delay in giving some vaccines afterwards (See Australian Immunisation Handbook).

Plasmapheresis (plasma exchange), which aims to remove antineuronal antibodies, has been trialed as an experimental immunotherapy in Sydenham chorea. A case report and one of the above-mentioned trials suggested that plasmapheresis can be successful for patients who have failed steroid therapy,[65] or can affect a faster resolution of chorea symptoms than steroids.[63]

Given the low-quality evidence base for experimental therapies, these are reserved for refractory cases.

A suggested algorithm for the approach to treatment for Sydenham chorea was developed by Dean and Singer.[46]

While additive therapy may be of benefit, the risks of polypharmacy, especially drowsiness from the combination of anticonvulsants and neuroleptic agents, need to be balanced against the severity of the chorea. Operational research to report on the outcome of different approaches is needed.

Monitoring response of Sydenham chorea symptoms to therapy

Response to therapy can be formally rated using the Universidade Federal de Minas Gerais (UFMG) Sydenham's Chorea Rating Scale (USCRS).[47,48] This research tool was designed to provide a detailed quantitative description of the performance of daily living activities, behavioural abnormalities, and motor function of subjects with Sydenham chorea. The scale comprises 27 items scored from 0 (no symptom or sign) to 4 (severe disability or finding).

Discharge from hospital is a critical point in the patient journey. A health management plan should be developed before discharge, and by a multidisciplinary team which includes the hospital medical officer, nurse, First Nations Liaison Officer, primary healthcare service, and the patient and family. Where possible, the first outpatient medical appointment should be booked prior to hospital discharge.

Monitoring and progress of ARF

The time course of ARF symptoms is highly variable within a given manifestation and across different manifestations. Clinical experience in northern Australia is that many individuals with the most common presentation of fever and low-grade joint symptoms are asymptomatic by the time they reach hospital. However, an estimated 10% of individuals have persisting joint symptoms more than three months after the start of an ARF episode, despite appropriate treatment. Chorea usually resolves spontaneously within a few weeks, almost all within six months,[40] but rarely, can persist for years.[41,42]

Recurrences of symptoms within 3 months of an ARF diagnosis are considered to be part of the same ARF episode, not a recurrence. See discussion of the rebound phenomenon in the Treatment of Arthritis and Arthralgia section.

Frequency of laboratory tests

Once the diagnosis has been confirmed and treatment commenced, inflammatory markers (ESR, CRP) should be measured once or twice weekly initially, then every one to two weeks, including after discharge, until they have been normal for one month. There is no evidence to support this; it is the general approach taken by those who regularly care for people with ARF. Salicylate levels may also be monitored, if the facilities are available, but most cases can be managed without this information.

Echocardiography should be repeated within a month if the initial diagnosis was not clear, carditis was severe, pericardial effusion was present or whenever a change in cardiovascular examination findings, such as resting heart rate, blood pressure or auscultatory findings, is detected. Access to echocardiography can be very limited in remote areas where the majority of ARF cases occur. Cases of severe carditis with heart failure may need more frequent echocardiographic assessments, ECG and chest X-rays, according to their clinical course (Table 7.4)

Discharge from hospital

Planning for discharge and follow-up should consider the presence and severity of cardiac valve damage and the potential for ongoing valvulitis due to continuing rheumatic inflammation, which sometimes leads to cardiac failure appearing, or worsening, in the weeks after discharge. Normally, discharge should only be considered for patients who are asymptomatic or only mildly symptomatic, in whom the manifestations of ARF have stabilised, and in whom inflammatory markers (particularly CRP) are clearly improving.

If patients come from remote communities or other settings with infrequent access to medical care, it is advisable to discuss discharge timing with the patient, family and local primary healthcare team. Particularly in those with significant carditis, it is prudent to wait until inflammatory markers are near-normal. Most ARF patients with no, or only mild, carditis can be discharged from hospital within two weeks. Those with moderate or severe carditis may require longer admission. (See Treatment of arthritis and arthralgia with regards to duration of NSAIDs and rebound phenomenon)

Regardless of the timing of discharge, follow-up by the local medical practitioner or community clinic should be scheduled for within a week of discharge, when clinical evaluation (Table 7.3) and repeat CRP should be undertaken to exclude evidence of recrudescence. Planning follow up before discharge is critical to optimise long-term outcomes. This involves coordination between the community clinic, specialist services and the community pharmacy, in consultation with the patient and family. Most fatalities from ARF and RHD among young First Nations peoples occur in circumstances where such coordination has been difficult or inadequate.

The hospital medical practitioner should provide a written discharge summary and make direct contact with the community medical staff, so that they are aware of the diagnosis, the need for secondary prophylaxis and any other specific follow-up requirements.

Commencement of long-term preventative measures

Secondary prevention

By the time of hospital discharge, ensure that patients and their families have a good understanding of how to reduce the future risk of ARF recurrence.

Commencement of secondary prevention activities for ARF includes antibiotic prophylaxis, plus a suite of measures to reduce an individual's risk of Strep A infection (e.g. hygiene measures, see Chapter 4), or consequences of Strep A infection (early recognition and treatment, see Chapter 6).

Organising dental checks and ongoing dental care is critical in the prevention of endocarditis. As patients without rheumatic valve damage may still be at long-term risk of developing RHD, particularly in the event of recurrent episodes of ARF, dental care is essential, regardless of the presence or absence of carditis (Table 7.2) (See Chapter 11. Management of RHD, Prevention of infective endocarditis).

Patients and their families should be provided with clear information about how secondary prophylaxis works, and the risk of recurrent ARF and its consequences if they do not receive treatment as prescribed. This may require an interpreter, language-appropriate written material, and culturally appropriate conversation.

Patients require clear information about where they can receive secondary prophylaxis, details about the date and location of future appointments, and contact details for their local health centre or hospital.

Immunisations

Ensure routine immunisations are up to date and if not, administer these at discharge from hospital.

Annual influenza immunisation is advised for all patients with ARF/RHD, and especially important in the following groups including people with severe carditis, people taking aspirin, and pregnant women. Influenza immunisation is not funded by the Australian Government for non-Indigenous people with ARF unless they are pregnant.

Patients and families should be encouraged to phone or visit their local health service or hospital if they have any questions concerning their follow-up or secondary prophylaxis. Long-term care is very important, and there are often many care providers involved. The ongoing social and economic circumstances in which some First Nations peoples live often require support beyond the health system. Culturally appropriate education for patients, families and communities needs to be ongoing and tailored to changing needs over time. Self-management support should be provided by primary care staff, acknowledging that a new diagnosis of ARF is an important chronic disease diagnosis for a young person and their family. People with ARF need close engagement with the health system for many years.

REFERENCES

1 Hardie K, de Dassel J. Beyond Secondary Prevention of Rheumatic Heart Disease. Communicable Disease Control Conference. Canberra: Public Health Association; 2019.

2 Illingworth R, Lorber J, Holt KS, et al. Acute rheumatic fever in children: a comparison of six forms of treatment in 200 cases. The Lancet. 1957;273(6997):653-659.

3 Dorfman A, Gross JI, Lorincz AE. The treatment of acute rheumatic fever. Pediatrics. 1961;27:692-706.

4 Bywaters E, Thomas GT. Bed rest, salicylates and steroid in rheumatic fever. British Medical Journal. 1961;1:1628-1634.

5 World Health Organization. Rheumatic fever and rheumatic heart disease: report of a WHO expert consultation, Geneva, 29 October–1 November 2001. WHO technical report series 923. 2004.

6 Rodieux F, Vutskits L, Posfay-Barbe KM, et al. When the Safe Alternative Is Not That Safe: Tramadol Prescribing in Children. Frontiers in Pharmacology. 2018;9(148).

7 Lin I, Green C, Bessarab B. 'Yarn with me': applying clinical yarning to improve clinician–patient communication in Aboriginal health care. Australian Journal of Primary Health. 2016;22:377-382.

8 Mitchell AG, Belton S, Johnston V, et al. "That Heart Sickness": Young Aboriginal People's Understanding of Rheumatic Fever. Medical Anthropology. 2019;38(1):1-14.

9 Haynes E, Marawili M, Marika BM, et al. Community-based participatory action research on rheumatic heart disease in an Australian Aboriginal homeland: Evaluation of the 'On track watch' project. Evaluation and Program Planning. 2019;74:38-53.

10 Australian Commission of Safety and Quality in Healthcare. Consumer health information needs and preferences: Perspectives of culturally and linguistically diverse and Aboriginal and Torres Strait Islander people. April 2017 ISBN: 978-1-925224-85-86.

11 Goddard L, Kaestli M, Makalic E, Ralph AP. Outcomes of possible and probable rheumatic fever: A cohort study using northern Australian register data, 2013-2019. PLOS Glob Public Health. 2024;4(1):e0002064.

12 Lawrence JG, Carapetis JR, Griffiths K, et al. Acute Rheumatic Fever and Rheumatic Heart Disease: Incidence and Progression in the Northern Territory of Australia, 1997 to 2010. Circulation. 2013;128(5):492-501.

13 de Dassel JL, de Klerk N, Carapetis JR, Ralph A P. How Many Doses Make a Difference? An Analysis of Secondary Prevention of Rheumatic Fever and Rheumatic Heart Disease. Journal of the American Heart Association. 2018;7(24):e010223.

14 Carter M, Bywaters EGL, Thomas GTG. Rheumatic fever treated with penicillin in bactericidal dosage for six weeks. British Medical Journal. 1962;1(5283):965-967.

15 Mortimer E Jr, Vaisman S, Vignau A, et al. The effect of penicillin on acute rheumatic fever and valvular heart disease. New England Journal of Medicine. 1959;260(3):101-112.

16 Ralph AP, Holt DC, Islam S, et al. Potential for Molecular Testing for Group A Streptococcus to Improve Diagnosis and Management in a High- Risk Population: A Prospective Study. Open Forum Infectious Diseases. 2019;6(4):ofz097.

17 Horn DL, Zabriskie JB, Austrian R, et al. Why have group A streptococci remained susceptible to penicillin? Report on a symposium. Clinical Infectious Diseases. 1998;26(6):1341-1345.

18 Vannice KS, Ricaldi J, Nanduri N, et al. Streptococcus pyogenes pbp2x Mutation Confers Reduced Susceptibility to □-Lactam Antibiotics. Clinical Infectious Diseases. 2020;71(1):201-204.

19 Ralph AP, Carapetis JR. Group A streptococcal diseases and their global burden. Current Topics in Microbiology and Immunology. 2013;368:1-27.

20 Thatai D, Turi DG. Current guidelines for the treatment of patients with rheumatic fever. Drugs. 1999;57(4):545-555.

21 Silva N, Pereira BA. Acute rheumatic fever: still a challenge. Rheumatic Disease Clinics of North America. 1997;23(3):545-568.

22 Uziel Y, Hashkes PJ, Kassem E, Padeh S, Goldman R, Wolach B. The use of naproxen in the treatment of children with rheumatic fever. Journal of Pediatrics. 2000;137:269-271.

23 Hashkes PJ, Tauber T, Somekh E, et al. Naproxen as an alternative to aspirin for the treatment of arthritis of rheumatic fever: a randomized trial. Journal of Pediatrics. 2003;143(3):399-401.

24 Çetin II, Ekici F, Kocabaş A, et al. The efficacy and safety of naproxen in acute rheumatic fever: The comparative results of 11-year experience with acetylsalicylic acid and naproxen. The Turkish Journal of Pediatrics. 2016;58(5):473-479.

25 Eccleston C, Cooper TE, Fisher E, et al. Non-steroidal anti-inflammatory drugs (NSAIDs) for chronic non-cancer pain in children and adolescents. Cochrane Database of Systematic Reviews. 2017;8(8):CD012537.

26 Osowicki J, Carr JP, Steer AC. Rheumatic fever: The rebound phenomenon returns. Journal of Paediatrics and Child Health. 2018;54(6):685-688.

27 Holt K. The rebound phenomenon in acute rheumatic fever. Archives of Disease in Childhood. 1956;31(160):444-451.

28 Taranta A. Relation of isolated recurrences of Sydenham's chorea to preceding streptococcal infections. New England Journal of Medicine. 1959;260(24):1204-1210.

29 Stollerman G., Glick S, Patel DJ, et al. Determination of C-reactive protein in serum as a guide to the treatment and management of rheumatic fever. American Journal of Medicine. 1953;15(5):645-655.

30 Maia D, Teixeira AL Jr, Quintao Cunningham MC, et al. Obsessive compulsive behavior, hyperactivity, and attention deficit disorder in Sydenham chorea. Neurology. 2005;64(10):1799-1801.

31 Sadiq M, Ahmad I, Kazmi T, et al. Comparative Study of Oral Naproxen and Aspirin for Acute Rheumatic Fever Treatment: Safety And Efficacy Analysis. Pak Heart J [Internet]. 2024;57(2):153-158.

32 Ayoub E, Wannamaker LW. Streptococcal antibody titers in Sydenham's chorea. Pediatrics. 1966;38(6):846-956.

33 Centers for Disease Control. Acute rheumatic fever - Utah. MMWR Morbidity Mortal Weekly Report. 1987;36(8):108-110.

34 Karthikeyan G, Devasenapathy N, Zühlke L, et al. Digoxin and clinical outcomes in the Global Rheumatic Heart Disease Registry. Heart. 2019;105(5):363-369

35 Albert D, Harel L, Karrison T. The treatment of rheumatic carditis: a review and meta-analysis. Medicine (Baltimore). 1995;74(1):1-12.

36 Cilliers A, Adler AJ, Saloojee H. Anti-inflammatory treatment for carditis in acute rheumatic fever. Cochrane Database of Systematic Reviews. 2015; 5:CD003176.

37 Rheumatic Fever Working Party of the Medical Research Council of Great Britain and the Subcommittee of Principal Investigators of the American Council on Rheumatic Fever and Congenital Heart Disease, American Heart Association. The natural history of rheumatic fever and rheumatic heart disease: ten-year report of a cooperative clinical trial of ACTH, cortisone and aspirin. Circulation. 1965;32(3):457-476.

38 al Kasab S, al Fagih MR, Shahid M, et al. Valve surgery in rheumatic heart disease. Chest. 1988;94:830-833.

39 Taran L. The treatment of acute rheumatic fever and acute rheumatic heart disease. Medical Clinics of North America. 1947;31(3):557-580.

40 Lessof M, Bywaters EGL. The duration of chorea. British Medical Journal. 1956;1(4982):1520-1523.

41 Carapetis J, Currie BJ. Rheumatic chorea in northern Australia: a clinical and epidemiological study. Archives of Disease in Childhood. 1999;80(4):353-358.

42 al-Eissa A. Sydenham's chorea: a new look at an old disease. British Journal of Clinical Practice. 1993;47(1):14-16.

43 Markowitz M, Gordis L. Rheumatic fever, in Major problems in clinical pediatrics, Vol 2. A. Schaffer, Editor. 1973, WB Saunders: Philadelphia.

44 Barash J, Margalith D, Matitiau, A. Corticosteroid treatment in patients with Sydenham's chorea. Pediatriac Neurology. 2005;32(3):205-207.

45 Tariq S, Niaz F, Waseem S, et al. Managing and treating Sydenham chorea: A systematic review. Brain and Behavior. 2023;13:e3035.

46 Dean SL, Singer HS. Treatment of Sydenham's Chorea: A Review of the Current Evidence. Tremor and Other Hyperkinetic Movements. 2017;7(456).

47 Teixeira AL Jr, Maia DP, Cardoso F. [The initial testing and the discrimination property of the UFMG Sydenham's Chorea Rating Scale (USCRS)]. Arquivos de Neuro-Psiquiatria. 2005;63(3B):825-827.

48 Teixeira AL, Maia DP, Cardoso F. UFMG Sydenham's chorea rating scale (USCRS): reliability and consistency. Movement Disorders. 2005;20:585-591.

49 Eades L, Hoy AY, Liddle R et al. Systemic lupus erythematosus in Aboriginal and Torres Strait Islander peoples in Australia: addressing disparities and barriers to optimising patient care. The Lancet Rheumatology. 2024;6(10):e713-e726.

50 Zomorrodi A, Wald ER. Sydenham's chorea in western Pennsylvania. Pediatrics. 2006;117(4):e675-e679.

51 Teixeira AL, Vasconcelos LP, Nunes MDCP, Singer H. Sydenham's chorea: from pathophysiology to therapeutics. Expert Rev Neurother. 2021;21(8):913-922.

52 Korn-Lubetzki I, Brand A, Steiner I. Recurrence of Sydenham chorea: implications for pathogenesis. Arch Neurol. 2004;61(8):1261-1264.

53 Daoud A, Zaki M, Shakir R, et al. Effectiveness of sodium valproate in the treatment of Sydenham's chorea. Neurology. 1990;40(7):1140-1141.

54 Genel F, Arslanoglu S, Uran N, et al. Sydenham's chorea: clinical findings and comparison of the efficacies of sodium valproate and carbamazepine regimens. Brain and Development. 2002;24(2):73-76.

55 Pena J, Mora, E Cardozo J, et al. Comparison of the efficacy of carbamazepine, haloperidol and valproic acid in the treatment of children with Sydenham's chorea. Arquivos de Neuro-Psiquiatria. 2002;60(2B):374-377.

56 Şahin S, Cansu A. A new alternative drug with fewer adverse effects in the treatment of Sydenham chorea: levetiracetam efficacy in a child. Clinical Neuropharmacology. 2015;38(4):144-146.

57 Zesiewicz TA, Sullivan KL, Hauser RA, Sanchez-Ramos J. Open-label pilot study of levetiracetam (Keppra) for the treatment of chorea in Huntington's disease. Movement Disorders. 2006;21:1998-2001.

58 Paz JA, Silva CA, Marques-Dias MJ. Randomized double-blind study with prednisone in Sydenham's chorea. Pediatric Neurology. 2006;34:264-269.

59 El Otmani H, Moutaouakil F, Fadel H, Slassi I. Chorea paralytica: a videotape case with rapid recovery and good long-term outcome. Acta Neurologica Belgica. 2013;113(4):515-517.

60 Fusco C, Spagnoli C. Corticosteroid treatment in Sydenham's chorea. European Journal of Paediatric Neurology. 2018;22(2):327-331.

61 Voss L, Wilson NJ, Neutze JM, et al. Intravenous immunoglobulin in acute rheumatic fever: a randomized controlled trial. Circulation. 2001;103(3):401-406.

62 Mohammad SS, Nosadini M, Grattan-Smith P, Dale RC. Intravenous immunoglobulin in acute Sydenham's chorea: A systematic review. Journal of Paediatrics and Child Health. 2015;51(12):1235-1238.

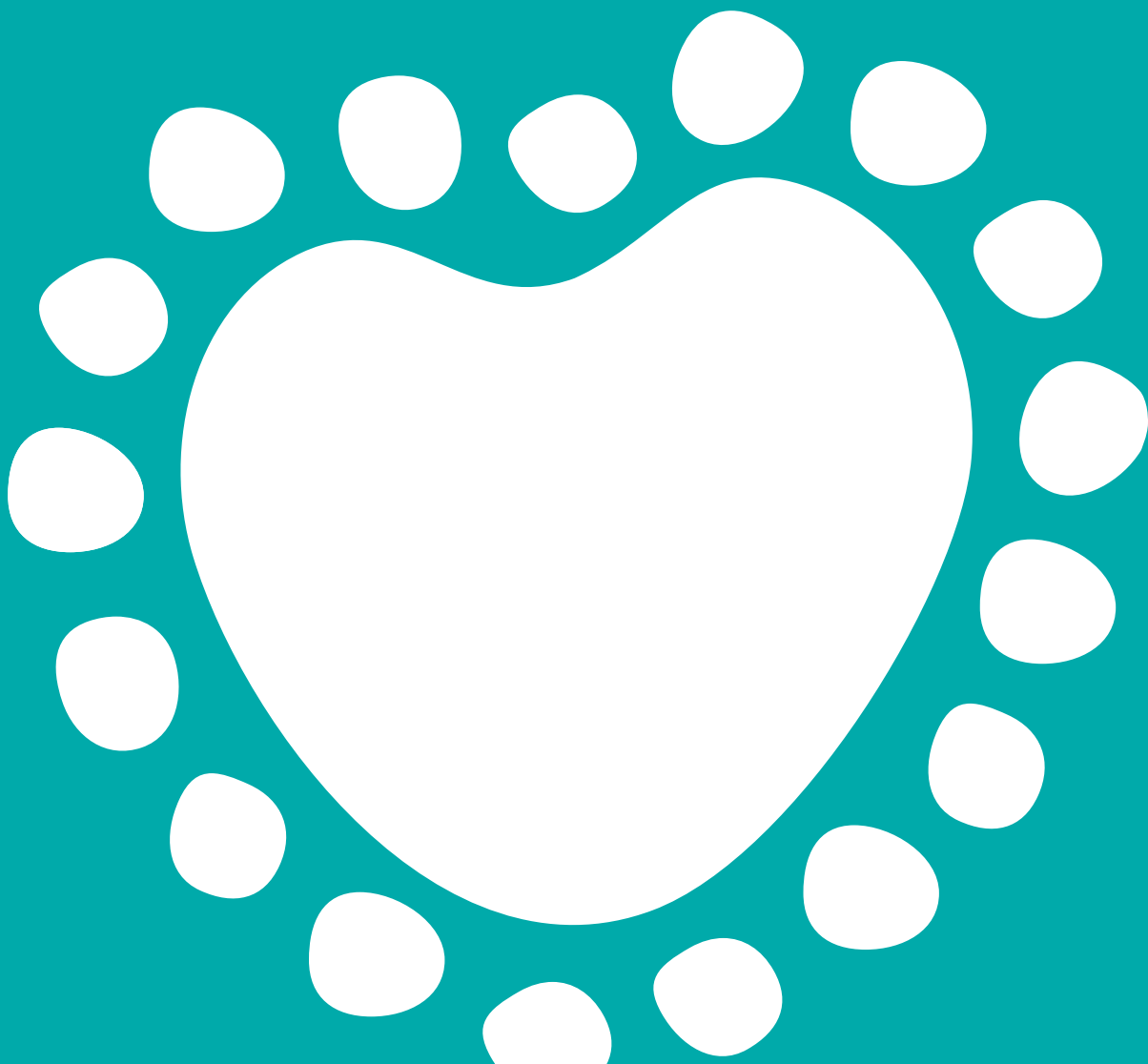
63 Garvey MA, Snider LA, Leitman SF, et al. Treatment of Sydenham's chorea with intravenous immunoglobulin, plasma exchange, or prednisone. Journal of Child Neurology. 2005;20:424-429.

64 Walker K, Brink A, Lawrenson J, Mathiassen W, Wilmshurst JM. Treatment of Sydenham chorea with intravenous Immunoglobulin. Journal of Child Neurology. 2012;27:147-155.

65 Miranda M, Walker RH, Saez D, Renner V. Severe Sydenham's chorea (chorea paralytica) successfully treated with plasmapheresis. Journal of Clinical Movement Disorders. 2015;2(2).

CHAPTER 8

Diagnosis of rheumatic heart disease



Diagnosis of rheumatic heart disease

IMPORTANT CHANGES IN THIS CHAPTER

Addition of Summary of Recommendations with GRADE Level of Evidence (Table 8.1)

Integration of the 2023 World Heart Federation (WHF) diagnostic morphological features for RHD (Table 8.5)

Integration of the 2023 WHF guidelines for pathological valvular regurgitation and stenosis (Table 8.6)

Integration of the 2023 WHF guidelines staging criteria (with removal of definite and borderline definitions) (Table 8.7)

Updated reference for 2023 WHF guidelines and explanation of the staging criteria

Addition of 2023 WHF echocardiographic screening criteria (Table 8.8)

KEY INFORMATION

- In Australia, approximately 87% of rheumatic heart disease (RHD) occurs in First Nations peoples (depending on the dataset used).
- RHD has a female predominance of 2:1 and the prevalence peaks in the third and fourth decade of life.
- RHD should be considered in individuals from high-risk populations (Table 6.1) with reduced exercise tolerance or breathlessness noting that most RHD is asymptomatic.
- Reduced exercise tolerance or breathlessness in a pregnant woman from a high-risk population should not only be attributed to pregnancy or anaemia; consider and investigate for RHD.
- Exercise testing or stress echocardiography is recommended when severity of symptoms and echocardiographic findings are discordant.
- Transoesophageal echocardiography may help clarify valve morphology and severity to plan surgical intervention or when transthoracic echo is inconclusive.
- The first edition of the WHF guidelines on the echocardiographic diagnosis of RHD, published in 2012, have now been revised and published as the 2023 WHF guidelines.
- The 2023 WHF guidelines on echocardiographic diagnosis provide criteria to distinguish pathological RHD from physiological changes in children and adults (Table 8.6).
- The mitral valve is the most common valve involved in RHD.
- Many adult patients will have mixed or multi-valvular disease.
- Symptoms may not reflect severity of disease. Many patients will appear asymptomatic until advanced stages of disease develop.
- Patients may present with complications of valve disease including stroke, infective endocarditis, heart failure or arrhythmia.

Table 8.1. Summary of recommendations with GRADE Level of Evidence

RECOMMENDATION	GRADE
RHD should be considered in individuals from high-risk populations with reduced exercise tolerance or breathlessness.	1C
Echocardiography is the gold standard diagnostic tool for RHD and should be performed in any patient suspected of having RHD.	1A
All patients with murmurs suggestive of possible valve disease, a positive screening echocardiogram, or a history of ARF, require a formal echocardiography to confirm the diagnosis.	1A
Transoesophageal echocardiography may help clarify valve morphology and severity to plan surgical intervention or when transthoracic echo is inconclusive.	1B
In adults, transoesophageal echocardiography can help clarify severity and mechanism of valve lesions, particularly in cases of mixed and multi-valvular disease.	1B
Exercise testing or stress echocardiography is recommended when severity of symptoms and echocardiographic findings are discordant.	1B
The 2023 WHF guidelines for echocardiographic diagnosis of RHD provide criteria to distinguish pathological RHD from physiological changes in children and adults.	1B
Trivial regurgitation of the mitral or aortic valves that does not meet all four criteria for pathological regurgitation should be considered normal.	1C
Isolated morphological changes, such as valvular thickening, which occurs without pathological stenosis or regurgitation should be considered normal.	1C
Coronary angiography is indicated prior to valve surgery to exclude concurrent coronary disease requiring intervention.	1C
For First Nations peoples, invasive angiography is recommended over computed tomography in those over the age of 25 years.	2C
Right heart catheterisation may aid in clarifying valve lesion severity when echocardiographic data are inconclusive.	1C
Right heart catheterisation may be used to determine the predominant cause of pulmonary hypertension when there is clinical ambiguity.	1C

Table 8.2. Clinical features of common valve lesions

VALVE LESION	SYMPTOMS †	SIGNS	COMPLICATIONS
Mitral regurgitation (MR)	Dyspnoea on exertion Fatigue Weakness Orthopnoea, paroxysmal nocturnal dyspnoea	Mid/pan-systolic murmur at apex, radiating laterally (occasionally medially/ posteriorly) Displaced apex beat in severe MR	Congestive cardiac failure Atrial arrhythmia Pulmonary hypertension
Mitral stenosis (MS)	Exertional dyspnoea (symptoms sensitive to increase in heart rate) Orthopnoea, paroxysmal nocturnal dyspnoea Haemoptysis	Low-pitch, diastolic murmur at apex with patient in left lateral position Murmur duration correlates with severity	Atrial arrhythmia Pulmonary hypertension Systemic embolism (stroke, peripheral arterial occlusion)
Aortic regurgitation (AR)	Dyspnoea on exertion Angina Orthopnoea, paroxysmal nocturnal dyspnoea	Blowing decrescendo diastolic murmur at left sternal edge Systolic murmur due to increased flow Mitral diastolic murmur (Austin Flint) Wide pulse pressure	Congestive cardiac failure
Aortic stenosis (AS)	Dyspnoea, angina, presyncope and syncope all associated with exertion	Ejection systolic murmur over aortic region, radiating to neck Slow-rising pulse	Heart failure with preserved or reduced ejection fraction Atrial arrhythmia
Tricuspid regurgitation (TR)	Peripheral oedema Abdominal distention and discomfort	Pan-systolic murmur at left parasternal edge Elevated jugular venous pressure (JVP) with prominent V-waves. Pulsatile liver Right ventricular heave	Right-sided heart failure
Tricuspid stenosis (TS)	Fatigue Abdominal discomfort Anorexia	Soft, high-pitch diastolic murmur at left parasternal edge Abdominal ascites Hepatomegaly Giant A-waves in JVP	Anasarca Hepatomegaly and hepatic dysfunction

† Note that mild to moderate valve dysfunction is most often asymptomatic.

Table 8.3. Echocardiographic features of RHD

CHARACTERISTIC FEATURES	MARKERS OF SEVERE DISEASE
Mitral valve features • Anterior leaflet override • Thickened leaflet tips • Restricted posterior leaflet motion • Chordal thickening • Leaflet calcification • Diastolic doming of anterior leaflet with restriction of the tip ("dog leg" or "hockey stick" appearance)	Mitral regurgitation • Large central jet (>50% of LA) or eccentric wall impinging jet of variable size • CW Doppler jet is pansystolic/dense/triangular • Mitral inflow E-wave dominance (>1.2 m/s) • Vena contracta ≥0.7 cm • Regurgitant volume ≥60 mL/beat • Regurgitant fraction ≥50% • EROA ≥0.40 cm^2 Mitral stenosis: • Valve area by planimetry ≤1.5 cm^2 • Diastolic pressure half-time ≥150 ms • Mean pressure gradient ≥10 mmHg (in the absence of significant MR)
Aortic valve features • Cusp prolapse • Cusp thickening • Rolled cusp edges • Cusp restriction • Cusp fibrosis, retraction, calcification	Aortic regurgitation • Jet width ≥65% of LVOT • Vena contracta ≥0.6 cm • Pandiastolic flow reversal in the proximal abdominal aorta • Regurgitant volume ≥60 mL/beat • Regurgitant fraction ≥50% • EROA ≥0.3 cm^2 • Evidence of LV dilatation Aortic stenosis† • Aortic valve Vmax ≥4 m/s • Mean pressure gradient ≥40 mmHg • Valve area ≤1.0 cm^2
Tricuspid valve features • Leaflet thickening, calcification • Leaflet restriction, retraction • Chordal shortening	Tricuspid regurgitation • Large central jet (≥50% of RA) • Vena contracta width ≥0.7 cm • EROA ≥0.4 cm^2 • Regurgitant volume ≥45 mL/beat • CW Doppler jet is dense, triangular with early peak • Systolic flow reversal in hepatic vein Tricuspid stenosis • Mean pressure gradient ≥5 mmHg • Pressure half-time ≥190 ms • Valve area ≤1.0 cm^2

† Scenarios of low-flow, low-gradient and normal flow, low-gradient severe AS exist. Expert input is advised.
LA, left atrium; EROA, Effective regurgitant orifice area; LVOT, Left Ventricular Outflow Tract; LV, left ventricular; CW, Continuous wave; RA, right atrium.

Table 8.4. Role of cardiac investigations in the diagnosis of RHD

INVESTIGATION	ROLE
Transthoracic echocardiography† (TTE)	Baseline investigation (including screening for RHD) Assessment of valve pathology Assessment of cardiac function and chamber size Surveillance of valve pathology and cardiac function over time
Transoesophageal echocardiography (TOE)	Pre-surgical planning Anatomical assessment for valve repair Exclusion of LA thrombus and significant MR prior to percutaneous balloon mitral valvuloplasty or direct current cardioversion Assessment of valve severity when TTE non-confirmatory
Electrocardiogram†	Identify arrhythmias that may complicate RHD (e.g. atrial fibrillation) Identify structural changes of RHD (e.g. left ventricular hypertrophy, p-mitrale)
Exercise stress test	Objective assessment when valve severity discordant from symptoms
Stress echocardiogram	Objective assessment when valve severity discordant from symptoms Use in MS for assessing change in gradient and pulmonary arterial systolic pressure with exercise
Right heart catheterisation	Assessment of valve severity in cases when TTE/TOE is non-confirmatory Assessment and classification of pulmonary hypertension in setting of valvular disease
Coronary angiography	Exclude concomitant coronary disease pre-surgery (over age 25 years)
Computed tomography coronary angiogram	Exclude concomitant coronary disease pre-surgery (younger than 25 years)
Cardiac magnetic resonance imaging	Role in assessing aetiology of cardiomyopathy and quantifying chamber size and function Quantification of regurgitant volumes
Erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) and anti-streptococcal titres†	In cases of newly diagnosed RHD to exclude possible ARF episode
B-type natriuretic peptide (BNP), pro-NT BNP	Role in assessment of heart failure presentation (See NHFA/CSANZ heart failure guidelines)

† Compulsory in diagnostic work-up

Table 8.5. Diagnostic morphological features of RHD (based on WHF 2023 guidelines)

VALVE	MORPHOLOGICAL FEATURES
Mitral valve	Valve apparatus thickening category (defined by the presence of either or both):
	Anterior leaflet thickening†‡
	Chordal thickening§
	Valve mobility abnormalities category (defined by the presence of either or both):
	Restricted anterior or posterior leaflet motion in diastole¶
	Excessive anterior leaflet tip motion during systole††
Aortic valve	Cusp thickening‡‡
	Cusp prolapse
	Restricted cusp motion
	Coaptation defect in diastole

† Anterior mitral valve leaflet (AMVL) thickness should be measured during diastole at the full excursion. Measurement should be taken at the thickest portion of the leaflet, including focal thickening, beading and nodularity. Ideally, the measurement should be performed on a frame with maximal separation of chordae from the leaflet tissue.

‡ Abnormal thickening of the AMVL is age-specific and defined as follows: ≥3.0 mm for individuals aged ≤20 years, ≥4.0mm for individuals aged 21–40 years and ≥5.0 mm for individuals aged >40 years.

§ Chordal thickening might range from individual chordae tendineae to multiple chordae tendineae fusion and calcification. The structures of papillary muscles, chordae tendineae and margins of leaflets might not be clearly distinguishable. Assessment is subjective; however, in most cases, chordal thickening is attributable to fusion of two or more chordae and is seen as an echo-bright structure near to the leaflet tip insertion. Chordal thickening is typically associated with other morphological features.

¶ Restricted leaflet motion of either the AMVL or the posterior mitral valve leaflet is usually the result of chordal shortening or fusion, commissural fusion or leaflet thickening.

†† Excessive leaflet tip motion results from elongation of the primary chords and is defined as displacement of the tip or edge of an involved leaflet towards the left atrium, resulting in abnormal coaptation and regurgitation. Excessive leaflet tip motion does not need to meet the standard echocardiographic definition of mitral valve prolapse disease, given that they refer to different disease processes. This characteristic applies only to those aged <35 years.

‡‡ In the parasternal short-axis view, the right and non-coronary aortic cusp closure line often presents as echogenic (thickened) in healthy individuals, which should be considered normal. Image optimization for valve thickness and morphology, including harmonic imaging, should be individualized on the basis of echocardiography devices and those performing echocardiograms.

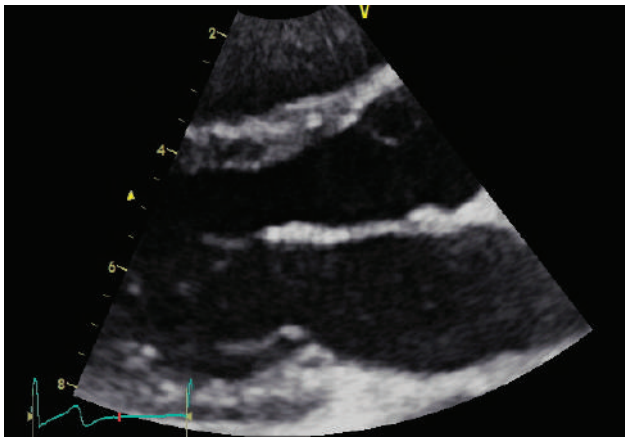


Figure 8.1a. Rheumatic mitral valve; appearance with harmonics 'on', note anterior mitral valve thickness.

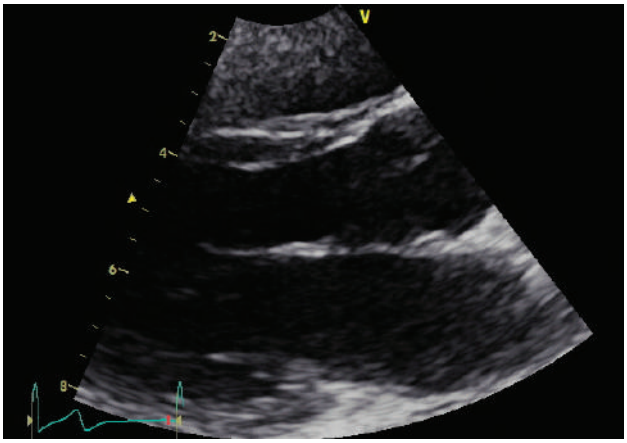


Figure 8.1b. Rheumatic mitral valve; appearance with harmonics 'off', note anterior mitral valve thickness Harmonics should be turned off (Box 8.1)

Table 8.6. Criteria for pathological valve dysfunction (based on WHF 2023 guidelines)

Pathological (at least mild) mitral regurgitation: (ALL criteria to be met) 1. Seen in at least two views. 2. In at least one view, jet length measures ≥1.5 cm (<30 kg) or ≥2.0 cm (≥30 kg)†‡ 3. Velocity ≥3 m/s for one complete envelope§¶ 4. Pan-systolic jet in at least one envelope¶†† Pathological (at least mild) aortic regurgitation: (ALL criteria to be met) 1. Seen in at least two views. 2. In at least one view, jet length ≥1 cm‡ 3. Velocity ≥3 m/s in early diastole¶ 4. Pan-diastolic jet in at least one envelope¶
Mitral stenosis: (ALL criteria to be met)‡‡ 1. Restricted leaflet motion with reduced valve opening 2. Mean PG ≥4 mmHg

† Cutoff is based on expert consensus. If weight is not available, then an age cutoff of ≤10 years or >10 years can be applied).

‡ A regurgitant jet length should be measured from the vena-contracta to the last pixel of regurgitant colour (blue or red).

§ Body of the pansystolic envelope should be ≥3 m/s.

¶ It is reasonable to use separate Continuous Wave Doppler traces seen in different views to document the pan-systolic / pan-diastolic envelope and jet velocity.

†† Given the difficulty in aligning spectral Doppler through eccentric regurgitant jets, it is reasonable to use an appearance of a jet being pan-systolic based on qualitative assessment, such as a colour jet seen throughout systole.

‡‡ 2D evidence of reduced mitral valve orifice area is adequate when spectral Doppler is unavailable.

Note: It is essential to exclude other common causes of mild valvular regurgitation, including mitral valve prolapse and bicuspid aortic valve, before diagnosing RHD.

PG: pressure gradient, 2D: 2 dimensional

Box 8.1. Echocardiography machine settings for confirmatory echocardiograms

- Nyquist limits for colour Doppler should be set at 50 – 70 cm/s to avoid overestimation of jet length.[1]
- Images for the assessment of valvular and chordal thickness should be acquired with harmonics turned off and probes with variable frequency set on ≥2 MHz. Low-frequency settings and harmonics exaggerate valve and chordal thickness.
- The room should be as dark as possible for echocardiography, because it impacts on gain settings. Gain settings should be adjusted to achieve optimal resolution. Images acquired with an over-gained setting will not be suitable for objective valve thickness measurements.
- All other settings (including depth, sector size and focus) should be optimised to achieve maximal frame rate and resolution.

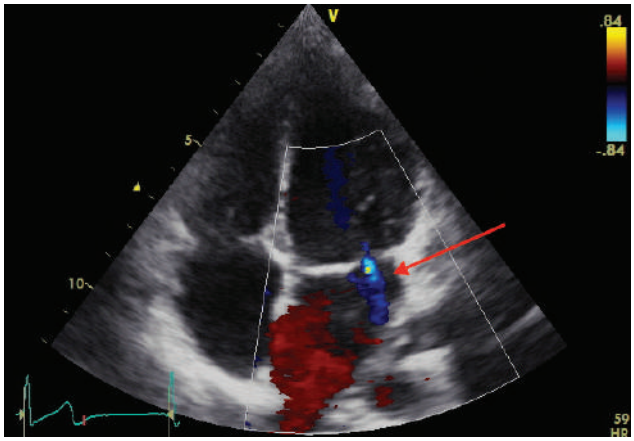


Figure 8.2. Rheumatic mitral valve; mitral regurgitant jet needs to measure at least 2 cm on colour Doppler (if patient weighs over 30 kg) to meet RHD diagnostic criteria for pathological regurgitation (red arrow). (See Table 8.6)

Table 8.7. Staging of RHD as detected by echocardiography based on WHF 2023 guidelines†‡

INVESTIGATION
Stage A: Minimum echocardiographic criteria for RHD (previously termed Borderline RHD) • This only applies to individuals ≤20 years old. • Echocardiographic features: The presence of mild§ mitral OR aortic regurgitation WITHOUT morphological features. • Clinical risk: **May be at risk** for valvular heart disease progression.
Stage B: Mild RHD (previously termed definite RHD) • Can apply to any age. • Echocardiographic features: Evidence of mild§ valvular regurgitation AND at least 1 morphological category in ≤20 years old and at least 2 morphological categories in >20 years old¶; OR mild regurgitation of BOTH mitral and aortic valves • Clinical risk: **At moderate or high risk** of progression and at risk of developing symptoms of valvular heart disease.
Stage C: Advanced RHD at risk of clinical complications • Can apply to any age. • Echocardiographic features: Moderate/severe MR, moderate/severe AR, any MS or AS†† +/- associated pulmonary hypertension, dilated cardiac chambers, decreased LV systolic function. • Clinical risk: **At high risk** of developing clinical complications needing medical and/or surgical intervention.
Stage D: Advanced RHD with clinical complications • Can apply to any age. • Echocardiographic features: Moderate/severe MR, moderate/severe AR, any MS or AS††+/- associated pulmonary hypertension, dilated cardiac chambers, decreased LV systolic function. • Clinical risk: **Established clinical complications** including cardiac surgery, heart failure, arrhythmia, stroke, and infective endocarditis.

† To be applied in high-risk settings (RHD all-age prevalence is >2/1000 RHD or ARF incidence >30/100,000 per year in 5–14-year-olds)[3,16] and requires other causes of valvular heart disease to have been excluded.

‡ Following the application of the confirmatory echocardiographic criteria, diagnostic categories may include a) 'Normal'; and b) 'Other' – congenital heart disease, cardiomyopathies, pericardial effusion, etc.

§ Fulfilling the confirmatory criteria for pathological regurgitation (Table 8.6).

¶ This cut-off is based on expert consensus.

†† Aortic stenosis is defined as per international guidelines on valvular heart disease. A diagnosis of rheumatic aortic stenosis requires the exclusion of other causes including bicuspid aortic valve and degenerative calcific aortic stenosis.

MR: mitral regurgitation, AR: aortic regurgitation, MS: mitral stenosis, AS: aortic stenosis, LV: left ventricle

"Just because you have RHD does not mean you have to stop living. Drive RHD. Don't let RHD drive you."

RHD Champion, 2019

Echocardiography is the gold standard diagnostic tool for RHD and should be performed in any patient suspected of having RHD.

RHD is often asymptomatic. Critical symptoms that should raise the suspicion of RHD are breathlessness or reduced exercise tolerance, especially in a pregnant woman from a high-risk setting.

RHD is damage to one or more heart valves resulting from the effects of carditis during ARF. The diagnosis of RHD often occurs late and in the advanced stages of disease when patients are most symptomatic.[2] This may include presentations with complications of valve dysfunction, including heart failure, arrhythmias, stroke, infective endocarditis or maternal complications of pregnancy.[2] There is a significant latent period of asymptomatic valvular heart disease and the majority of patients do not have a documented history of ARF.[2] In Australia, more than 79% of RHD cases occur in First Nations populations.[3] Consideration of a possible RHD diagnosis in high-risk populations is imperative (Table 6.2); diagnosis in the early stages of disease has the best chance to inhibit progression through delivery of secondary prophylaxis and prevent complications through appropriately timed medical and surgical intervention.

First Nations peoples with RHD often present to the health system in an advanced stage of disease.

Communication and knowledge transfer between the health workforce and people at high risk of RHD are critical for timely and accurate diagnosis.

Interpreters and family members should be engaged to support people with RHD where indicated; to help relay information on behalf of the patient, and to help explain diagnostic testing and procedures.

First Nations health staff (including First Nations Liaison Officers, Health Workers, Health Practitioners and nurses) should be engaged as early as possible to support patients and their families.

Cultural and language appropriate resources can assist with timely and accurate diagnosis.

Health assessments and enhanced primary care should be incorporated into health services for First Nations peoples. This includes care planning and team care arrangements.

Natural history of RHD

The natural history of RHD was documented in the pre-penicillin and pre-echocardiography era (up to the 1950s) by Bland and Duckett Jones.[4] They observed 87 patients with ARF who had clinical signs of isolated rheumatic MR for 20 years. They found that in one-third of their patients, MR resolved; in one-third it persisted; and in one-third it progressed to severe disease, MS or resulted in death. Following the wide availability of penicillin in the 1950s, Tompkins et al reported that 70% of their patients with MR had no clinical evidence of heart disease at nine years after initial diagnosis.[5] This clinical resolution of MR in two-thirds of patients on secondary prophylaxis within 5–10 years of diagnosis is also supported by the findings of Kassem and Lue.[6,7]

The progression to mitral stenosis is variable. In some populations, there is often a latent period of 20–40 years between episodes of ARF and a presentation with MS.[8] In the First Nations population, MS progresses rapidly, and patients become symptomatic at a young age, although this is rare below 10 years of age. Approximately 30% of First Nations people with RHD in the Northern Territory aged 10–19 years have MS, and the mean age of all patients with MS is 33 years.[9] In India, this trend is more marked, where MS is common in children aged under 10 years. This rapid progression may be due to undetected recurrences of ARF. Once MS becomes symptomatic, the long-term prognosis without cardiac intervention is poor, with 10-year survival ranging from 34% to 61%.[8,10,11] The progression of RHD and the need for subsequent intervention is related to the severity of disease at diagnosis and the presence of ARF recurrences.[6,12–14] Australian RHD register data show that of people with severe disease, 50% require surgery within two years and 10% die within six years.[15]

Diagnostic aspects of RHD

A thorough and comprehensive clinical assessment is vital in a patient with possible RHD. This provides information regarding severity of symptoms and clinical signs of valve disease and related complications. However, echocardiography is the gold standard diagnostic tool; (Table 8.6) it is substantially more accurate than clinical auscultation and should be made available to all people with RHD, regardless of their location.[16]

Clinical assessment of RHD

It is important to note that many patients with RHD will be asymptomatic or at least appear asymptomatic. Furthermore, many patients with RHD have no documented history of ARF.[2] Assessment of medical history and current symptoms can be challenging due to language barriers, cultural factors and some patients may self-regulate their physical activity and thus not report symptoms, despite advancing disease. Furthermore, valve lesions may be difficult to detect by auscultation, particularly mild lesions or mitral stenosis. Echocardiography is significantly more sensitive and specific than auscultation for detecting and evaluating valve lesions.

First Nations women may be identified in an advanced stage of disease during pregnancy. Given the importance and impact of personal and cultural supports at the time of diagnosis, there is a critical need for culturally appropriate knowledge transfer and communication. Potential language barriers should be addressed through the use of interpreters.

It is also important to note that many patients will have either mixed valvular disease (e.g. mitral regurgitation and mitral stenosis) or multi-valvular disease (e.g. aortic regurgitation and mitral regurgitation). In adults, mixed and multi-valvular disease are the most common presentations of RHD.[17,18] Although there may be a dominant lesion responsible for symptoms, clinical presentation can relate to both. Both mixed and multi-valvular disease will affect the echocardiographic assessment of lesion severity. Mixed moderate valve disease may have a similar prognosis to severe single valve disease, making management decisions challenging.[19,20]

There is considerable overlap in symptomatology for different valvular lesions. Exercise limitation, dyspnoea and fatigue can occur with any advanced valve lesions. Other symptoms are specific to the type and severity of valve lesions (Table 8.2).

Aside from symptoms directly due to valvular disease, patients may also present with symptoms reflecting complications of RHD. These most commonly include congestive heart failure, atrial fibrillation, pulmonary hypertension, predominant right heart failure, stroke, or other systemic thromboembolism.[2,17]

Heart failure may result from acute valvulitis in children and younger adults as well as any chronic severe valve lesions, particularly mitral and aortic regurgitation.

Symptoms include exercise intolerance, and shortness of breath on exertion in mild and moderate cases and at rest in advanced disease. Paroxysmal nocturnal dyspnoea, orthopnoea and peripheral oedema may develop in more advanced disease.

Atrial fibrillation (AF) is more commonly associated with mitral valve disease and subsequent left atrial dilatation in older adolescent and adult populations.[21] It is rarely seen in children below the age of 15 years but becomes more common between 15–25 years of age. In younger adults, it is usually symptomatic and associated with a high ventricular rate. Those with mitral stenosis are particularly vulnerable and new-onset AF may be the first clinical presentation of advanced disease, precipitating acute decompensation due to the tachyarrhythmia. In these cases, patients may present with acute pulmonary oedema, haemoptysis, hypotension and cardiogenic shock. Subacute symptoms of AF include exercise intolerance and palpitations.

Pulmonary hypertension may develop as a consequence of left ventricular (LV) systolic dysfunction in the setting of valvular disease or directly due to mitral valve disease, particularly mitral stenosis.[22] It may be difficult to distinguish symptoms of the primary valve disease or LV dysfunction from those of pulmonary hypertension. Furthermore, pulmonary hypertension may occur in this population due to other pathology, such as rheumatological disorders. In these cases, further investigations including serological markers and right heart catheterisation may be useful to distinguish the predominant pathology.

Unfortunately, stroke and other systemic arterial embolisation remain an uncommon but tragic first presentation of RHD.[2] This usually reflects mitral stenosis with or without the complication of atrial fibrillation. RHD should be considered in any young patient from a high-risk population (Table 6.2) presenting with stroke or arterial thromboembolism.

Clinical features of specific valve lesions

Mitral valve disease

The mitral valve is the most commonly involved valve in RHD.[17] Examples of echocardiographic images of rheumatic mitral valve pathology are shown in Figure 8.1 to Figure 8.7. Acute valvulitis and subsequent early RHD is characterised by pure mitral regurgitation (MR).[17] With recurrent episodes of ARF and subsequent fibrosis and scarring, mixed mitral valve disease develops. This is the most common RHD valve lesion seen in the adult population,[17] while pure mitral stenosis is uncommon.

In patients with mild to moderate MR, the left ventricular apex will not be displaced, and there will be a mid- or pan-systolic murmur heard best at the apex, which may radiate laterally or medially, depending on the direction of the regurgitant jet (Table 8.2).[23] Patients with moderate or more severe MR will have an apex beat displaced to the anterior or mid-axillary line, and a loud pan-systolic murmur maximal at the apex. There may be an associated diastolic murmur of MS or a mid-diastolic murmur from increased trans-mitral flow.

The murmur of mitral stenosis (MS) is a low-pitched, diastolic rumble heard best at the apex, with the patient in the left lateral position. It may be difficult to hear, especially if the ventricular rate is rapid. This murmur may be particularly difficult to detect in the resting patient and manoeuvres such as leg raises to increase heart rate and trans-mitral flow may aid in accentuating the murmur. The duration of the murmur correlates with the severity of MS. If the patient is in sinus rhythm there will be presystolic accentuation, but this is lost once AF occurs. It may be possible to palpate a right ventricular heave in the left parasternal region due to right ventricular systolic hypertension resulting from elevated pulmonary pressures from significant mitral stenosis.

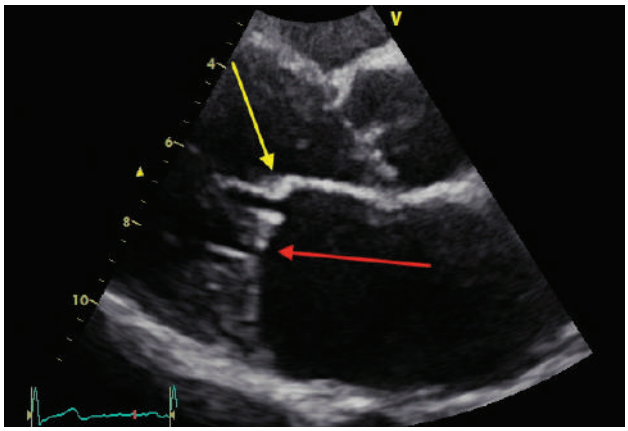


Figure 8.3. Rheumatic mitral valve; thickened and restricted posterior leaflet (red arrow), thickened anterior leaflet tip with diastolic doming (yellow arrow) resulting in stenosis

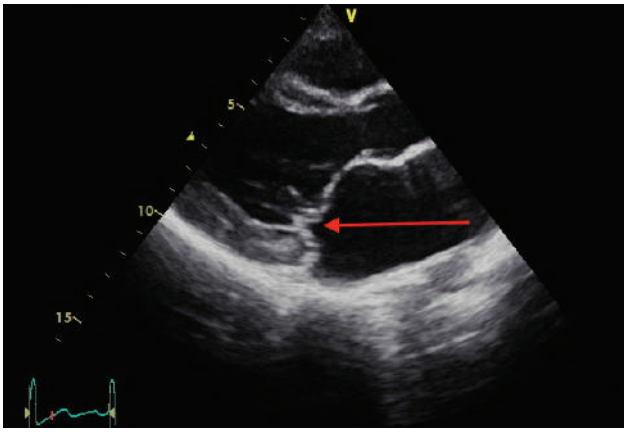


Figure 8.4. Rheumatic mitral valve; restricted posterior leaflet with loss of coaptation (red arrow) leads to eccentric posteriorly directed regurgitation

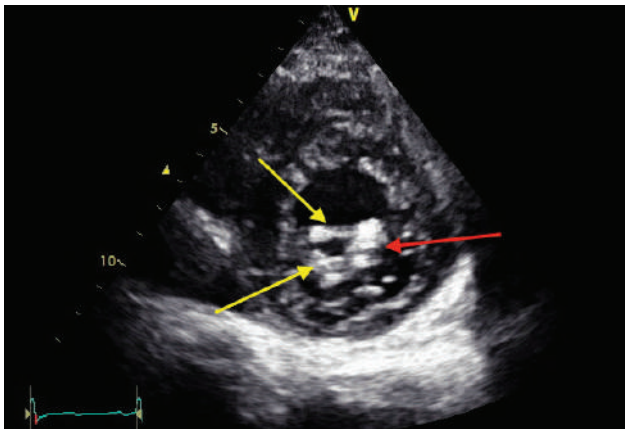


Figure 8.5. Rheumatic mitral valve; significant bileaflet thickening and calcification (yellow arrow) with fused commissure (red arrow) resulting in reduced orifice area

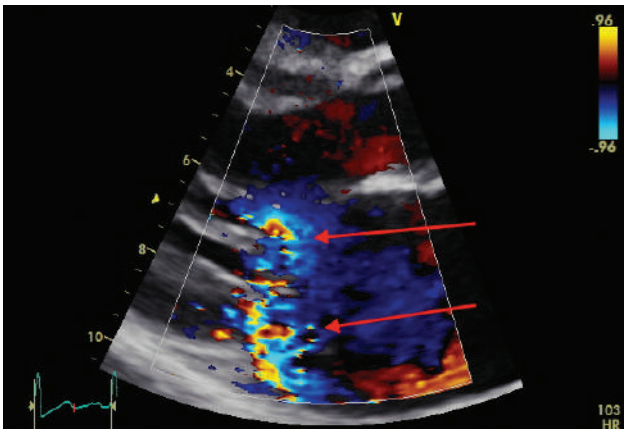


Figure 8.6. Rheumatic mitral valve; mitral regurgitation due to RHD is commonly eccentric with a posteriorly directed jet seen on colour Doppler (red arrows)

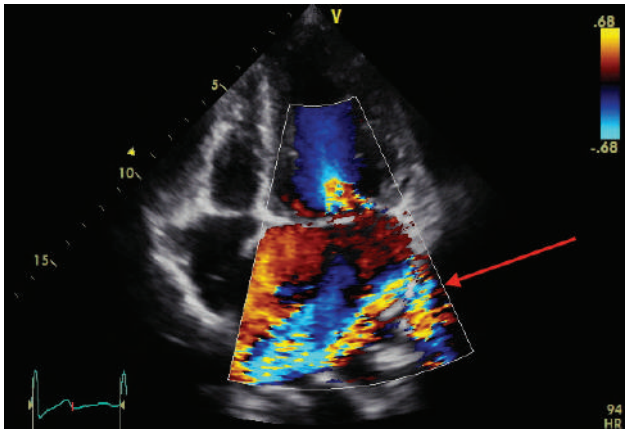


Figure 8.7. Rheumatic mitral valve; severe eccentric mitral regurgitation demonstrated with colour Doppler. The regurgitation follows the posterior wall and fills multiple pulmonary veins (red arrow)

Aortic valve disease

Rheumatic aortic valve disease is less common than mitral valve disease and rarely occurs in isolation. The typical lesion is AR. Examples of echocardiographic images of rheumatic aortic valve pathology are shown in Figures 8.8 to 8.11. Aortic valve disease may be due to other conditions other than RHD, and the probability of these conditions (including connective tissue disease, aortitis and hypertension) increases with age.[24] RHD is a rare cause of AS and therefore other causes, including degenerative and bicuspid aortic valve, should be excluded prior to labelling the valve rheumatic.

The typical murmur of AR is a diastolic, blowing decrescendo murmur best heard at the left sternal border, with the patient sitting upright at the end of expiration (Table 8.2). The length of the murmur correlates with severity (except in acute aortic valvulitis), with more severe cases producing a pan-diastolic murmur. There is usually an associated systolic murmur, even in the absence of AS, due to the increased forward flow across the aortic valve, and in occasional cases, a mitral diastolic (Austin Flint) murmur. Examination may reveal a forceful LV apical impulse, which may be displaced laterally and downwards. A water-hammer pulse at the brachial artery and a collapsing carotid pulse are clinical indications of at least moderate AR.

The characteristic clinical finding in AS is a loud, mid-systolic ejection murmur, best heard in the aortic area, radiating to the neck and the apex.[25] In patients with haemodynamically significant AS, useful physical signs are a slowed and reduced carotid pulse upstroke, and the presence of a thrill in the suprasternal notch.

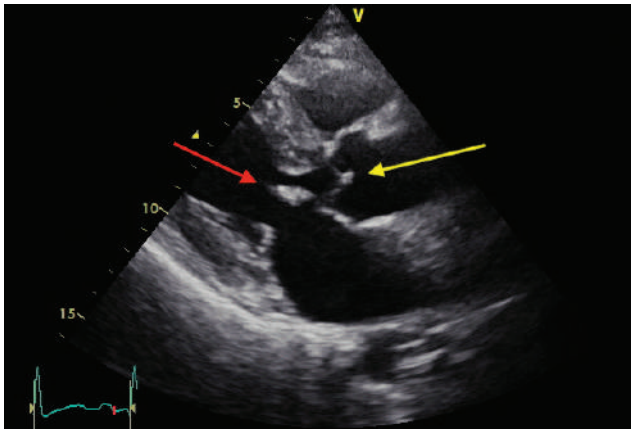


Figure 8.8. Mixed rheumatic valve disease; aortic cusp thickening and rolled edges (yellow arrow), thickened anterior mitral valve leaflet (red arrow)

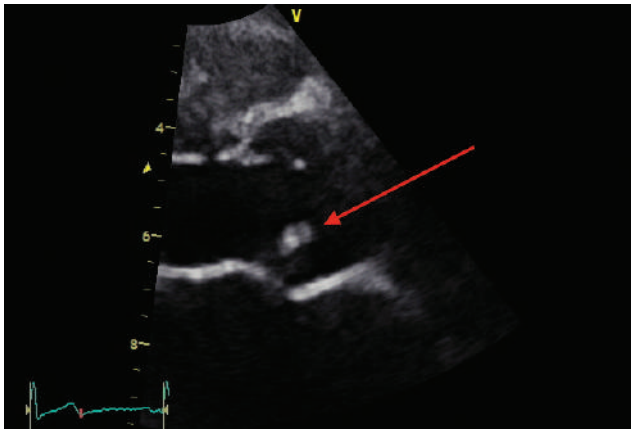


Figure 8.9. Rheumatic aortic valve; cusp thickening and restriction (red arrow)

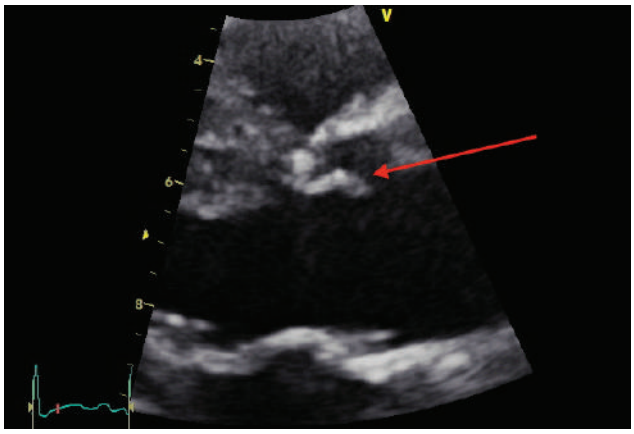


Figure 8.10. Rheumatic aortic valve; restricted cusp with rolled edges (red arrow)

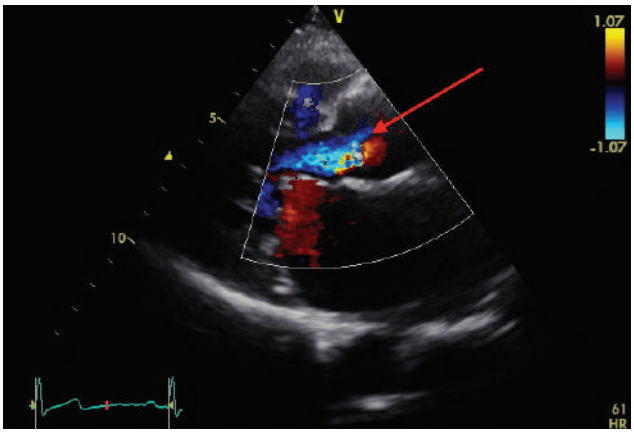


Figure 8.11. Rheumatic aortic valve with colour Doppler demonstrating regurgitation (red arrow)

Tricuspid valve disease

Classical teaching advises that tricuspid regurgitation (TR) is best distinguished by the associated peripheral signs. These include prominent V waves in the jugular venous waveform, with a steep y descent and systolic hepatic pulsation with hepatomegaly. The murmur of TR may be difficult to auscultate, particularly if there is concomitant MR. The murmur is mid- or pan-systolic heard at the left sternal border, which may increase on inspiration.

Tricuspid stenosis is rare but, if present, is nearly always due to RHD. A soft, high-pitched diastolic murmur may be heard at the left lower sternal edge. Like TR, tricuspid stenosis may be identified by other associated signs which include abdominal distention, ascites, hepatomegaly, profound peripheral oedema and giant A-waves in the jugular venous waveform.

Echocardiography and RHD diagnosis

Echocardiography is the primary clinical tool for the detection and diagnosis of RHD.

All patients with murmurs suggestive of possible valve disease, a positive screening echocardiogram, or a history of ARF, require a formal echocardiography to confirm the diagnosis. This will detect any valvular lesion and allow assessment of its severity and of cardiac function. Serial echocardiography plays a crucial role in the diagnosis and follow-up of rheumatic valve disease, allowing objective monitoring of any change in the severity of valve lesions, left and right chamber sizes, ventricular function, and any increase in pulmonary artery pressure. These objective echocardiographic data are essential in helping to determine the timing of any possible intervention.

The 2023 WHF guidelines on the echocardiographic diagnosis of RHD (Table 8.6) provide diagnostic criteria for identifying and distinguishing RHD in both children and adults.[24] The WHF guideline aims to:

a. Make echocardiography reporting simple, reproducible and consistent worldwide, and hence, to facilitate echocardiographic screening for RHD, specifically in school aged children

b. Aid physicians with the diagnosis of RHD in those patients who do not have a documented history of ARF. The criteria were modified so that they are also applicable to adult patients >20 years of age.

The WHF guidelines specify that echocardiography should be interpreted in conjunction with the individual's clinical findings and risk or likelihood of having RHD. Other aetiologies (congenital, acquired or degenerative) of valvular pathology should be excluded based on clinical context and echocardiography findings before a diagnosis of RHD is made.

Criteria for morphological features of RHD and pathological regurgitation are detailed in Table 8.5 and Table 8.6 respectively. Trivial regurgitation of the mitral or aortic valves – that does not meet all four criteria for pathological regurgitation – is common,[26-29] and should be considered normal or physiological (Table 8.5 and Table 8.6). The same can be said for isolated morphological changes, such as valvular thickening, which occurs without pathological stenosis or regurgitation.[4]

The revised 2023 WHF guidelines have removed the previous terms "definite" and "borderline" RHD and replaced them with a staged-based classification. This reflects the heterogenous natural history of RHD and incorporates up to date evidence in the understanding of disease progression and the role of secondary antibiotic prophylaxis.

Distinguishing RHD from other valve pathology

Although the echocardiographic features of RHD are quite distinctive, it is important to distinguish them from other forms of valve pathology. Functional mitral regurgitation refers to MR occurring in the presence of a structurally normal valve apparatus.[30] This may result from dilated cardiomyopathy in which there is apical displacement of the papillary muscles resulting in tethering of both leaflets apically, thus limiting normal coaptation. This typically causes a central regurgitation jet. Ischaemia may result in MR, most commonly seen in inferior wall ischaemia or infarction resulting in restricted motion of the posterior mitral valve leaflet and tethering of normal motion. This typically results in an eccentric, posteriorly directed regurgitant jet but can be distinguished from rheumatic disease as the valve leaflets themselves are thin and freely mobile. Degenerative disease of both the mitral and aortic valve becomes more common with age and is a more common cause of aortic stenosis than RHD. Degenerative changes typically involve diffuse leaflet or cusp thickening with calcification that is predominantly at the annulus and leaflet base. Mitral valve annular calcification may be associated with left ventricular inflow obstruction. In rheumatic valve disease, this process commences at the leaflet tips. Myxomatous mitral valve disease may be confused with RHD in its appearance of leaflet thickening with or without leaflet prolapse. However, myxomatous disease may have significant redundant leaflet tissue and lack the typical leaflet restriction and tethering seen in more advanced rheumatic mitral valve disease. Finally, carcinoid syndrome can present with tricuspid stenosis with marked leaflet thickening and restriction. This may be distinguished from RHD due to the lack of left-sided valve involvement.

Specific valve features on echocardiography

A summary of valve characteristics and parameters are found in Table 8.3.

Mitral valve disease

Early RHD is distinguished by pure mitral regurgitation. With chronicity, mixed mitral valve disease develops followed by predominantly stenotic lesions in older adults. The two-dimensional (2D) echocardiographic images of a rheumatic mitral valve are quite characteristic and can help confirm a diagnosis of RHD.[31] The main echocardiographic feature of pure mitral regurgitation in young people is overriding or prolapse of the anterior (less commonly of the posterior) mitral valve leaflet, due to elongation of chordae leading to a typically posteriorly directed jet.[32–34] In more severe cases, chordal rupture can lead to flail leaflet.[34] Dilatation of the posterior mitral annulus, although not specific to RHD, is also a common finding.[33,34]

Valvular thickening and chordal thickening and tethering of either or both leaflets can be present, even in mild disease, and is the predominant mechanism of MR in the adult population.[35] The combination of valvular thickening, restricted leaflet motion, and doming gives rise to the characteristic 'dog leg' (or 'hockey stick') appearance of the anterior mitral leaflet. This abnormality is especially common if there is a degree of associated mitral stenosis. Leaflet and annular calcification tend to be a late development and is unusual in young patients.

Rheumatic mitral regurgitation is often associated with eccentric jets, making accurate quantification difficult. Continuous wave and colour flow mapping in the left atrium allow a semiquantitative estimate of the severity of the central mitral regurgitant jet. This is done by grading the area of the regurgitant jet in relation to the area of the left atrium, and by examining the spectral intensity of the jet by continuous wave Doppler.[26] Milder degrees of regurgitation may be missed, unless 'sweeping' scans of the left atrium and mitral valve from parasternal and apical windows are used. The WHF guideline outlines how to differentiate trivial/physiological regurgitation from pathologic regurgitation. Complete Doppler assessment, including E wave velocity, pulmonary vein sampling and measurement of flow convergence radius, enables more accurate evaluation of severity. Quantitative assessment of mitral regurgitation includes calculating regurgitant volume and effective regurgitant orifice area. However, these calculations may be inaccurate due to the eccentricity or multiplicity of regurgitant jets (Table 8.3).

Mitral stenosis severity is best determined by planimetry of the mitral valve area. This allows for dynamic changes relating to loading situations and heart rate. Planimetry is measured in the parasternal short axis view in mid diastole at the leaflet tips and therefore requires adequate 2D imaging. The use of three-dimensional (3D) echo may improve accuracy of this measurement. The calculated mitral valve area from the diastolic pressure half-time is also recommended, although it is important to note that this is influenced by left ventricular and left atrial compliance.[36] Continuous-wave Doppler trans-mitral gradient has been the mainstay of severity assessment previously. This continues to be used during invasive measures of mitral valve area and pre- and post-percutaneous balloon mitral valvuloplasty. However, this measurement is dependent on transvalvular flow and diastolic filling period, and can vary greatly with changes in heart rate, circulating volume or the presence of mitral regurgitation. Left ventricular systolic function is usually preserved even in severe mitral stenosis. However, significant left atrial dilatation can develop as well as pulmonary hypertension with associated right ventricular dilatation and dysfunction.

2D echo features aid in determining appropriateness for percutaneous balloon mitral valvuloplasty. While several scoring systems exist, the Wilkins score[37] based on four echocardiographic criteria – leaflet thickening, leaflet mobility, leaflet calcification, and sub valvular thickening and calcification – is most commonly employed, with a lower score predicting a more favourable outcome.

Aortic valve disease

Morphological rheumatic changes of the aortic valve consist initially of cusp prolapse. With time, the cusps become thick and the edges roll, resulting in a coaptation defect. This typically results in aortic regurgitation or mixed aortic valve disease, as opposed to pure aortic stenosis which is rarely due to RHD.

Isolated rheumatic **aortic valve disease** is rare in the adult population, however 2–10% of children will have isolated AR.[38] The extent of AR is examined with colour flow mapping in the left ventricle.[39,40] The spatial extent of the colour flow jet in the LV outflow tract is an approximate guide to the severity of AR. If the area is at least two-thirds or more of the LV outflow tract, the regurgitation is in the moderate to severe range. The depth of the jet in the left ventricle is also of some value, although it may be obscured by turbulent mitral valve inflow, particularly in cases of associated MS.

Further assessment of AR includes pressure half-time of the regurgitation jet with a measurement of >500 m/s usually indicating mild regurgitation, whilst <200 m/s is consistent with severe AR. However, additional factors such as heart rate and LV end-diastolic pressure, can affect pressure half-time.[39,40] Complete quantification of AR may include calculation of regurgitation volume, flow convergence measurement and regurgitation orifice area as well as measurement of left ventricular dimensions. A useful method for assessing the severity of AR is to sample diastolic flow in the descending thoracic aorta from the suprasternal notch position. The length and velocity of the reversed flow is proportional to the severity of regurgitation. Pandiastolic-reversed flow, particularly with increased velocity, is indicative of moderate or severe regurgitation, while in more severe cases, there may be reversal of diastolic flow in the abdominal aorta.

RHD is a rare cause of aortic stenosis and therefore other aetiology should be excluded. 2D echocardiography demonstrates thickened and restricted aortic valve cusps, often with visible calcification of the cusps. The peak and mean velocity across the valve can be measured and are the most commonly used marker for severity. The aortic valve orifice area can also be calculated to help determine severity and is especially useful when the LV function is reduced, making the aortic velocity gradient less reliable.[41] In these circumstances, an aortic valve orifice area <1 cm^2 indicates severe disease. Left ventricular size and systolic function can be assessed quantitatively and are usually preserved even in very late disease.

Right-sided valve disease

Tricuspid valve regurgitation in RHD more commonly occurs as a complication of left sided valve disease and subsequent pulmonary hypertension and right ventricular dilatation. However, primary tricuspid valve RHD can also occur. In these cases, the most frequent findings are retraction of the leaflet free edge with thickening, calcified foci and some degree of fusion and thickening of the commissures and sub-valvular apparatus. Tricuspid stenosis features are like those of MS and there may be thickening and leaflet restriction, with doming of the tricuspid valve leaflets. The severity of regurgitation is assessed by Doppler and colour flow mapping whilst measurement of transvalvular gradient and pressure half-time gives data to quantify severity of stenosis.

Adjunctive investigations in RHD diagnosis

Transoesophageal echocardiography

In adults, transoesophageal echocardiography (TOE) has several roles. It can help clarify severity and mechanism of valve lesions, particularly in cases of mixed and multi-valvular disease. This is particularly important in pre-surgical planning and may aid in determining appropriateness for valve repair rather than replacement. In cases of mitral stenosis, TOE is used to exclude left atrial appendage and left atrial thrombus prior to percutaneous balloon mitral valvuloplasty and 3D TOE can be used to clarify mitral valve area by planimetry in cases of poor transthoracic imaging. It is also used to investigate for infective endocarditis in patients with rheumatic valve disease.

In children, TOE is reserved for guidance during or just prior to cardiac surgery. This is due to the need for a general anaesthetic to perform TOE in children.

Exercise stress testing and stress echocardiography

Exercise stress testing is useful in cases where symptoms are discordant to echocardiographic data. This applies particularly in patients who deny symptoms despite severe valvular heart disease. In these cases, exercise testing may give objective evidence of true exercise tolerance, either by inducing symptoms or conversely proving a lack of symptoms. This data may be used to support appropriate timing of intervention. Stress echocardiography may provide further information in cases of mitral stenosis. Due to the influence of heart rate and left atrial compliance, some patients may report only exercise-induced symptoms despite echo demonstrating non-severe stenosis. In these cases, stress echocardiography may be helpful as significant elevation in pulmonary artery pressure (≥60 mmHg) and trans-mitral gradient (>15 mmHg in exercise and >18 mmHg with dobutamine) is associated with poor outcomes and supports consideration of early intervention.

Angiography and right heart catheterisation

Coronary angiography is indicated prior to valve surgery to exclude concurrent coronary disease requiring intervention. The choice of invasive coronary angiography versus computed tomography (CT) coronary angiography is determined by the likelihood of patients having established disease and access to testing. In the First Nations population, invasive angiography is recommended in those over the age of 25 years.

Right heart catheterisation may aid in clarifying valve lesion severity when echocardiographic data are inconclusive.[36,42,43] It also may be used to determine the predominant cause of pulmonary hypertension when there is clinical ambiguity.[44]

New echocardiography technology and its role in diagnosis

Since its development in 2012, the WHF guidelines[45] (Table 8.6) have been used across many countries in various echocardiographic screening studies. Their sensitivity and specificity in high- and low-risk populations have been clarified.[45,46] During this time, there has been significant development of portable and hand-held echocardiography technology. In 2012, hand-held technology had limited functionality and therefore the 2012 WHF criteria were not for application with these machines. However, the capacity of hand-held machines has progressed significantly, and this had led to their use in screening programs in Australia, and globally. A study by Beaton et al[47] demonstrated that, compared to standard echocardiography, hand-held echo was highly sensitive and specific when performed by an expert operator. However, it was limited regarding certain aspects of the WHF criteria, including morphological abnormalities. As such, researchers have suggested modifications to the WHF criteria to better accommodate findings from hand-held echo.

Further simplification of echo diagnosis for RHD has also been studied. The use of single echocardiographic criteria that can be assessed by portable echo machines, hand-held devices, and operators with limited training, has shown promise. A 2012 study assessed the use of a single echocardiographic view on a standard echo machine and compared an MR jet ≥2.0 cm versus a modified criteria, demonstrating a positive predictive value of 92%, although four out of 15 cases of RHD were missed.[48] A more recent study performed in Timor-Leste using a modified parasternal view involving a whole sweep through the heart showed 100% sensitivity and 95% specificity for borderline and definite RHD in a paediatric population when performed by a cardiologist on a portable standard echocardiogram machine.[49] Further research in Australia and Timor-Leste has investigated the use of hand-held devices operated by non-expert practitioners, showing that non-expert practitioner interpretation of images achieves sub-optimal sensitivity[50, 51] but the addition of offsite expert review of images improved sensitivity of this approach to screening to 88%, with specificity of 77%.[51] Due to this emerging evidence for task-sharing approaches to the early detection of RHD, the 2023 WHF guidelines have included screening criteria that can be applied for the use of hand carried ultrasound by non-expert sonographers. These should be used when screening echocardiography is being implemented using hand carried ultrasound, and individuals who have a positive screening test should be referred for a formal, confirmatory echocardiogram. Table 8.8 outlines the criteria for a positive screening echocardiogram, which should prompt further review with a formal echocardiogram before a diagnosis of RHD is finalised based on the diagnostic criteria outlined in Table 8.6 and Table 8.7.

Table 8.8. Screening criteria using hand carried ultrasound for the echocardiographic detection of RHD in individuals ≤20 years old (based on the 2023 WHF guidelines)

SCREENING CRITERIA
Mitral regurgitation (requires ALL of the following): 1. In <30 kg: MR jet length ≥1.5 cm. In ≥30 kg: MR jet length ≥2 cm†. 2. MR jet is seen in at least one view. 3. MR jet seen in ≥2 consecutive frames.
Aortic regurgitation (requires ALL of the following): 1. Any aortic regurgitation . 2. Seen in at least one view. 3. Seen in ≥2 consecutive frames.
Mitral stenosis: 1. Restricted leaflet motion with reduced valve opening.

† Cut-off is based on expert consensus. If weight is not available, then an age cut-off of <10 years or ≥10 years can be applied.

Note: Positive screen includes presence of ANY of the defined MR, AR, or MS; Negative screen is the absence of ANY of the defined MR, AR, or MS.

REFERENCES

1 Zoghbi WA, Adams D, Bonow RO, et al. Recommendations for noninvasive evaluation of native valvular regurgitation: a report from the American Society of Echocardiography developed in collaboration with the Society for Cardiovascular Magnetic Resonance. Journal of the American Society of Echocardiography. 2017;30(4):303-371.

2 Zühlke L, Karthikeyan G, Engel ME, et al. Clinical Outcomes in 3343 Children and Adults with Rheumatic Heart Disease From 14 Low- and Middle-Income Countries: Two-Year Follow-Up of the Global Rheumatic Heart Disease Registry (the REMEDY Study). Circulation. 2016;134(19):1456-1466.

3 Australian Institute of Health and Welfare. Acute rheumatic fever and rheumatic heart disease in Australia 2023. catalogue number CVD 100, AIHW, Australian Government. 2024

4 Bland E, Duckett Jones T. Rheumatic fever and rheumatic heart disease; a twenty-year report on 1000 patients followed since childhood. Circulation. 1951;4(6):836-843

5 Tompkins D, Boxerbaum BMD, Liebman JMD. Long-term prognosis of rheumatic fever patients receiving regular intramuscular benzathine penicillin. Circulation. 1972;45(3):543-551.

6 Kassem A, el-Walili TM, Zaher SR, et al. Reversibility of mitral regurgitation following rheumatic fever: clinical profile and echocardiographic evaluation. The Indian Journal of Pediatrics. 1995;62(6):717-713.

7 Lue H, Wu MH, Wang JK, et al. Long-term outcome of patients with rheumatic fever receiving benzathine penicillin G prophylaxis every three weeks versus every four weeks. [Clinical Trial Comparative Study Randomized Controlled Trial Research Support, Non-US Govt]. Journal of Pediatrics. 1994;125(5):812-816.

8 Olesen KH. The natural history of 217 patients with mitral stenosis under medical treatment. British Heart Journal. 1962;24:349-357.

9 Carapetis J. Ending the heartache: the epidemiology and control of acute rheumatic fever and rheumatic heart disease in the Top End of the Northern Territory. 1998, PhD thesis. University of Sydney: Sydney.

10 Boyle D. A comparison of medical and surgical treatment of mitral stenosis. British Heart Journal. 1961;23(4):377-382.

11 Grant R. After histories for ten years of a thousand men suffering from heart disease. A study in prognosis. Heart Asia. 1933;16(275):1931.

12 Meira Z, Goulart EMA, Colosimo EA, Mota CC. Long term follow up of rheumatic fever and predictors of severe rheumatic valvar disease in Brazilian children and adolescents. Heart. (British Cardiac Society) 2005;91(8):1019-1022.

13 Marcus R, Sareli P, Pocock WA, et al. The spectrum of severe rheumatic mitral valve disease in a developing country. Correlations among clinical presentation, surgical pathologic findings, and hemodynamic sequelae. Annals of Internal Medicine. 1994;120(3):177-183.

14 Enriquez-Sarano M, Basmadjian AJ, Rossi A, et al. Progression of mitral regurgitation: a prospective Doppler echocardiographic study. Journal of the American College of Cardiology. 1999;34(4):1137-1144.

15 Cannon J, Roberts K, Milne C, Carapetis JR. Rheumatic Heart Disease Severity, Progression and Outcomes: A Multi-State Model. Journal of the American Heart Association. 2017;6(3):e003498.

16 Roberts KV, Brown AD, Maguire GP, et al. Utility of auscultatory screening for detecting rheumatic heart disease in high-risk children in Australia's Northern Territory. The Medical Journal of Australia. 2013;199(3):196-199.

17 Reményi B, El Guindy A, Smith SC, et al. Valvular aspects of rheumatic heart disease. The Lancet. 2016;387:1335-1346.

18 Zühlke L, Engel ME, Karthikeyan G, et al. Characteristics, complications, and gaps in evidence-based interventions in rheumatic heart disease: The Global Rheumatic Heart Disease Registry (the REMEDY study). European Heart Journal. 2015;36(18):1115-1122a.

19 Unger P, Rosenhek R, Dedobbeleer C, et al. Management of multiple valve disease. Heart. 2011;97(4):272-277.

20 Zilberszac R, Gabriel H, Schemper M, et al. Outcome of Combined Stenotic and Regurgitant Aortic Valve Disease. Journal of the American College of Cardiology. 2013;61(14):1489-1495.

21 Pourafkari L, Ghaffari S, Bancroft GR, et al. Factors associated with atrial fibrillation in rheumatic mitral stenosis. Asian Cardiovascular and Thoracic Annals. 2015;23(1):17-23.

22 Simonneau G, Montani D, Celermajer DS, et al. Haemodynamic definitions and updated clinical classification of pulmonary hypertension. European Respiratory Journal. 2019;53(1):1801913.

23 Rodriguez L, Gillinov AR. Mitral valve disease. In: Textbook of Cardiovascular Medicine. Philadelphia, USA: Lippincott Williams & Wilkins; 2007.

24 Rwebembera J, Marangou J, Mwita JC, et al. 2023 World Heart Federation guidelines for the echocardiographic diagnosis of rheumatic heart disease. Nat Rev Cardiol. 2024;21(4):250-263.

25 Munt B, Legget ME, Kraft CD, et al. Physical examination in valvular aortic stenosis: correlation with stenosis severity and prediction of clinical outcome. American Heart Journal. 1999;137(2):298-306.

26 Yoshida, K., Yoshikawa, J, Shakudo, M, et al. Color Doppler evaluation of valvular regurgitation in normal subjects. Circulation. 1988;78(4):840-7.

27 Choong C, Abascal VM, Weyman J, et al. Prevalence of valvular regurgitation by Doppler echocardiography in patients with structurally normal hearts by two-dimensional echocardiography. American Heart Journal. 1989;117(3): 636-642.

28 Wilson N, Neutze JM. Echocardiographic diagnosis of subclinical carditis in acute rheumatic fever. Int Journal of Cardiology. 1995;50(1):1-6.

29 Webb R, Gentles T, Stirling J, et al. Echocardiographic findings in a low risk population for rheumatic heart disease (RHD): implications for screening (Abstract). in XVIII Lancefield International Symposium, Italy, 2011.

30 Feigenbaum H, Armstrong WF, Ryan T. Feigenbaum's echocardiography, 6th edition. Vol 1. 2005, Philadelphia: Lippincott Williams & Wilkins.

31 Pandian NG, Kim JK, Arias-Godinez JA, et al. Recommendations for the use of echocardiography in the evaluation of rheumatic heart disease: a report from the American Society of Echocardiography. Journal of the American Society of Echocardiography. 2023;36(1):3-28.

32 Camara E, Neubauer C, Camara GF, et al. Mechanisms of mitral valvar insufficiency in children and adolescents with severe rheumatic heart disease: an echocardiographic study with clinical and epidemiological correlations. Cardiology in the Young. 2004;14(5):527-532.

33 Kamblock J, N'Guyen L, Pagis B, et al. Acute severe mitral regurgitation during first attacks of rheumatic fever: clinical spectrum, mechanisms and prognostic factors. The Journal of Heart Valve Disease. 2005;14(4):440-446.

34 Marcus R, Sareli P, Pocock WA, et al. Functional anatomy of severe mitral regurgitation in active rheumatic carditis. American Journal of Cardiology. 1989;63(9):577-584.

35 Chauvaud S, Fuzellier JF, Berrebi A, et al. Long-term (29 years) results of reconstructive surgery in rheumatic mitral valve insufficiency. Circulation. 2001;104(12 Suppl 1):112-115.

36 Nishimura RA, Otto CM, Bonow RO, et al. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. The Journal of Thoracic and Cardiovascular Surgery. 2014;148(1):e1-e132

37 Wilkins GT, Weyman AE, Abascal VM, Block P C, Palacios IF. Percutaneous balloon dilatation of the mitral valve: an analysis of echocardiographic variables related to outcome and the mechanism of dilatation. British Heart Journal. 1988;60(4):299-308.

38 Chockalingam A, Gnanavelu G, Elangovan S, et al. Clinical spectrum of chronic rheumatic heart disease in India. Journal of heart Valve Disease. 2003;12(5):577-581.

39 Jaffe W, Roche AH, Coverdale HA, et al, Clinical evaluation versus Doppler echocardiography in the quantitative assessment of valvular heart disease. Circulation. 1988;78(2):267-275.

40 Perry G, Helmcke F, Nanda NC, et al. Evaluation of aortic insufficiency by Doppler color flow mapping. Journal of the American College of Cardiology. 1987;9(4):952-959.

41 Stewart W, Carabello B. Chronic aortic valve disease, in Textbook of cardiovascular medicine, E. Topol, Editor. 2007, Lippincott, Williams & Wilkins: Philadelphia.

42 Gorlin WB, Gorlin R. A generalized formulation of the Gorlin formula for calculating the area of the stenotic mitral valve and other stenotic cardiac valves. Journal of the American College of Cardiology. 1990;15:246-247.

43 Nishimura RA, Carabello BA. Hemodynamics in the cardiac catheterization laboratory of the 21st century. Circulation. 2012;125:2138-2150.

44 Galiè N, Humbert M, Vachiery J, et al. 2015 ESC/ERS Guidelines for the Diagnosis and Treatment of Pulmonary Hypertension. Revista Espanola De Cardiologia. (English Ed) 2016;69(2):177.

45 Clark BC, Krishnan A, McCarter R, et al. Using a Low-Risk Population to Estimate the Specificity of the World Heart Federation Criteria for the Diagnosis of Rheumatic Heart Disease. Journal of the American Society of Echocardiography. 2016;29(3):253-258.

46 Roberts K, Maguire G, Brown A, et al. Echocardiographic screening for rheumatic heart disease in high and low risk Australian children. Circulation. 2014;129(19):1953-1961.

47 Beaton A, Aliku T, Okello E, et al. The utility of handheld echocardiography for early diagnosis of rheumatic heart disease. Journal of the American Society of Echocardiography. 2014;27(1):42-49.

48 Mirabel M, Celermajer DS, Ferreira B, et al. Screening for rheumatic heart disease: evaluation of a simplified echocardiography-based approach. European Heart Journal Cardiovascular Imaging. 2012;13(12):1024-1029.

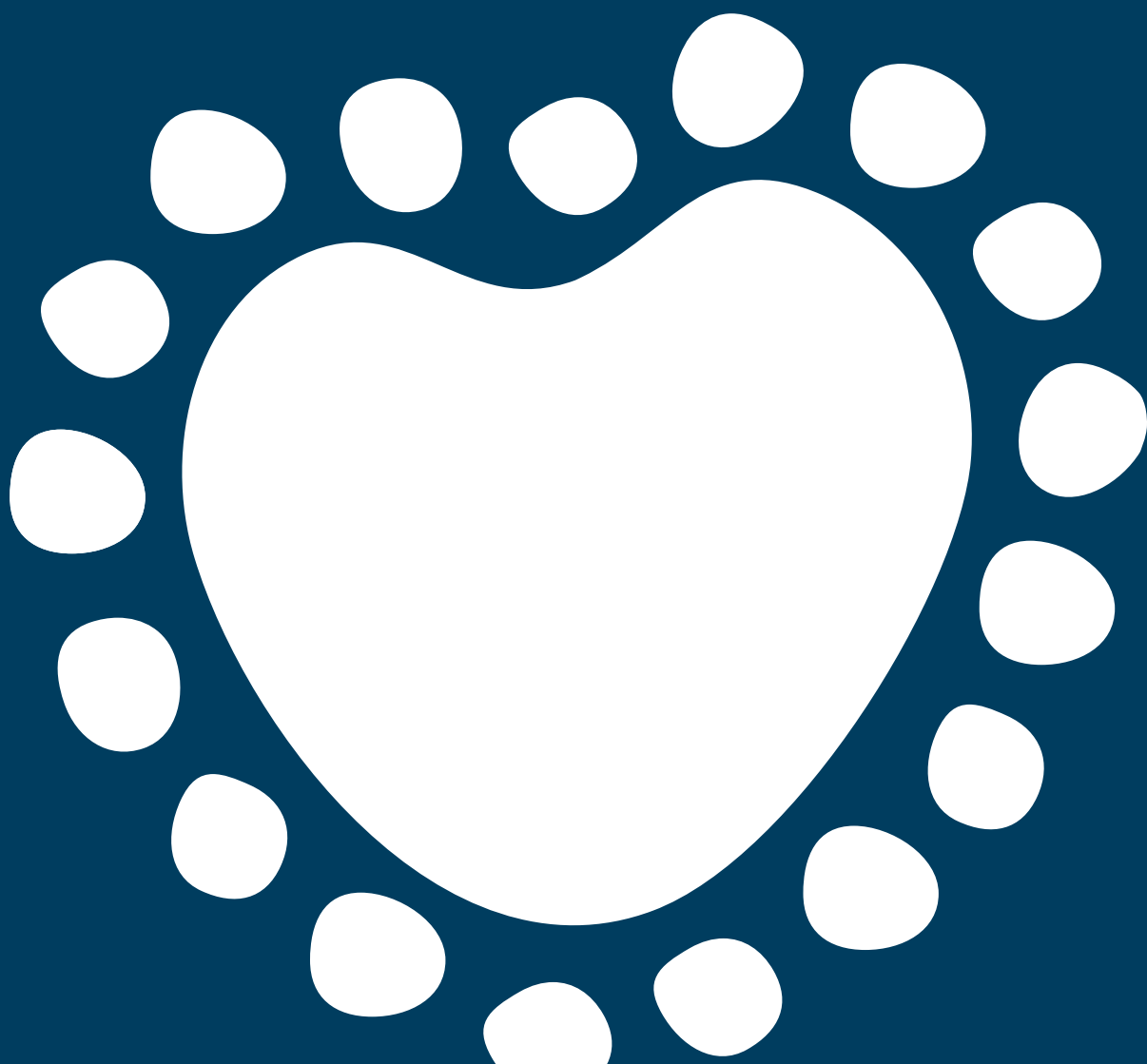
49 Reményi B, Davis K, Draper A, et al. Single Parasternal-Long-Axis-View-Sweep Screening Echocardiographic Protocol to Detect Rheumatic Heart Disease: A Prospective Study of Diagnostic Accuracy. Heart Lung and Circulation. 2020;29(6):859-866.

50 Francis JR, Whalley GA, Kaethner A, et al. Single-View Echocardiography by Nonexpert Practitioners to Detect Rheumatic Heart Disease: A Prospective Study of Diagnostic Accuracy. Circ Cardiovasc Imaging. 2021;14(8):e011790.

51 Francis JR, Fairhurst H, Yan J, et al. Abbreviated Echocardiographic Screening for Rheumatic Heart Disease by Nonexperts with and without Offsite Expert Review: A Diagnostic Accuracy Study. J Am Soc Echocardiogr. 2023;36(7):733-745.

CHAPTER 9

Screening for rheumatic heart disease



Screening for rheumatic heart disease

IMPORTANT CHANGES IN THIS CHAPTER

- Addition of Summary of Recommendations with GRADE Level of Evidence (Table 9.1)
- Integration of the WHF 2023 echocardiographic diagnosis of rheumatic heart disease (RHD) guidelines including screening and confirmatory criteria
- Integration of new evidence including randomised controlled trial data on prophylaxis of early echocardiography detected RHD

KEY INFORMATION

- Echocardiographic screening for RHD has been widely used in Australia and internationally, in research settings to estimate burden of disease, and as part of community-led initiatives aimed at early detection and treatment of RHD.
- Screening procedures have evolved over time, using different technologies and using operators with varying levels of expertise.
- Population-based screening using auscultation is not accurate for detecting undiagnosed RHD so is not recommended.
- Screening using echocardiography can accurately detect previously undiagnosed RHD.
- Echocardiographic screening for RHD meets public health criteria for community screening for disease (Table 9.2).
- The role for echocardiographic screening at community level and in pregnancy is increasingly favoured as technology evolves.
- Communities with high rates of ARF and RHD should be prioritised but are often the ones where resources and access to health care are most limited. Sustained national and regional funding and coordination are required to support echocardiographic screening and follow-up care for those at highest risk.
- Targeted screening of particular highest-risk groups (including 5 to 20 year olds in high risk settings) may be appropriate under certain circumstances; factors to take into consideration are presented in this chapter.
- Screening activities may be effectively used to estimate disease prevalence, and have the potential to improve community awareness, foster local champions and galvanise support for better RHD control.

Table 9.1. Summary of recommendations with GRADE Level of Evidence

RECOMMENDATION	GRADE
Population-based screening using auscultation is not accurate for detecting undiagnosed RHD so is not recommended.	1A
Echocardiographic active case finding can accurately detect previously undiagnosed RHD.	1A
The 2023 WHF guidelines should be applied when diagnosing RHD by echocardiography.	1A
Populations most likely to benefit from echocardiography active case finding are young people <20 years of age and pregnant women.	1C
Screening programs should prioritise communities with a high prevalence of RHD.	1B
Echocardiography detected cases of early RHD benefit from secondary prophylaxis	1A
Echocardiography active case finding for RHD should only be performed in settings with access to appropriate follow-up and management.	1B
Task-sharing echocardiography active case finding by non-expert operators is supported in a two-stage protocol under the supervision of experts.	1B
Highly abbreviated echocardiography screening protocols should only be used in settings where confirmatory echocardiography is available to diagnose RHD.	1B
Individuals with echocardiography screen detected RHD benefit from secondary prophylaxis to prevent disease progression.	1B
RHD screening programs should consider the benefits and risk to individuals, community and health services prior to implementation.	1B

DISCUSSION

"Your whole life changes. I felt like my whole life just stopped but after that day in his room, I thought, I can't sit here and not do anything, especially knowing that there's other young people going through the same thing."

RHD Champion, 2019

General principles of screening

Screening is a public health strategy that aims to identify asymptomatic individuals with latent forms of disease. Disease screening programs aim to improve patient outcomes by intervening with effective treatment during this latent period.

In the case of RHD, it is established that effectively delivered secondary prophylaxis can reduce the progression of disease in clinically diagnosed acute rheumatic fever (ARF) or RHD by preventing ARF recurrence,[1] and may allow for improvement (regression) or resolution of early RHD. In well-resourced settings, early diagnosis of severe RHD also provides the opportunity for earlier surgical intervention and improved surgical outcomes.[2,3]

For a disease to be considered suitable for screening at a population level, there are several criteria which must be satisfied (Table 9.2).[4]

Table 9.2. Suitability of early RHD for screening

CRITERION	RELEVANCE FOR RHD
Evidence of a significant burden of disease	The prevalence of RHD among First Nations peoples in northern Australia is one of the highest in the world[6,7] RHD is a cause of significant morbidity and mortality in this population.[8]
Condition must have a latent stage	RHD has an asymptomatic phase when valvular damage can be detected before symptoms are evident.
The latent stage must be detectable by simple, accessible and sensitive tests	Echocardiography is highly accurate at detecting early, asymptomatic RHD. The predictive value of echocardiography for RHD screening depends on the screening protocol used, the screening device used, the operator and the population screened. Echocardiography is a painless, non-invasive procedure which appears to be acceptable in First Nations communities where it has been used.[7]
The early stage of disease must be treatable with adequate therapy	The natural history of screen detected RHD is similar to the history of clinically diagnosed ARF, with similar degrees of valvular dysfunction.[9] Early evidence from cohort studies suggests that some screen-detected valve lesions improve (regress), some remain stable, and some progress to clinically significant RHD. The World Heart Federation (WHF) criteria for echocardiography diagnosis define RHD by stages that inform risk of disease progression. In general, asymptomatic people with Stage B RHD on screening echo, and people with Stage A RHD from high-risk settings, are presumed to be at risk of valve disease progression and should receive secondary prophylaxis (Table 10.3).[10, 11]
Early intervention must improve prognosis	A single randomised controlled trial[11] has demonstrated a reduction in disease progression for people with screening detected RHD who are treated with secondary antibiotic prophylaxis. This has informed the updated Australian guidelines and the WHF 2023 guidelines which now recommend secondary prophylaxis for early RHD detected by echocardiography.

Adapted from the END RHD Centre for Research Excellence 'Endgame Strategy' https://endrhd.thekids.org.au/RHD-Endgame-Strategy/

Brief history of RHD screening

The importance of early RHD detection has long been recognised. The World Health Organization initiated pilot mass screening using cardiac auscultation in the 1980s, but these programs were not sustained.[12] While initial screening protocols relied on auscultation for the detection of heart murmurs, the emergence and adoption of echocardiography has conclusively demonstrated that auscultation is inaccurate for detection of latent RHD, and should no longer be used.[6,13–15] Auscultation remains an important tool in the clinical setting, but has limited diagnostic utility for screening. Screening echocardiography has been shown to detect approximately 10 times as many cases of RHD compared to auscultation, revealing a much greater burden of disease than previously estimated.[16] More than 20 countries have now undertaken echocardiographic screening activities to estimate the burden of RHD.

There have been significant advances in ultrasound technology, including the development of small portable echocardiogram devices and the advent of hand-held machines. Improved portability makes screening more accessible in remote communities, including in clinics, schools and homes. Research has also explored training non-expert operators (nurses, community health workers) to obtain the limited images required to detect RHD.[7,17,18] The results of these studies are promising and may offer a more accessible and cost-effective way to screen for RHD. Such an initiative also has the potential to provide local employment opportunities, empowering communities affected by RHD.

World Heart Federation diagnostic criteria for RHD

As the use of echocardiography for RHD screening became more widespread, the need for standardised diagnostic criteria was recognised. In 2012, the WHF published its guideline for the echocardiographic diagnosis of RHD in the absence of a previous history of ARF.[19] These criteria were the first evidence-based definitions that included both morphological features and functional aspects of mitral and aortic valve disease due to rheumatic carditis. The WHF criteria are now widely accepted as the reference standard for RHD diagnosis in patients without a history of ARF and provide clear diagnostic criteria for RHD as well as features of an echocardiogram classified as normal.

In 2023, revised WHF guidelines were published.[20] This revision updated the diagnostic criteria based on the prior decade of research using the original 2012 guidelines and led to several key changes. These changes address the emerging role of task-sharing for RHD echocardiographic screening, echocardiographic predictors of disease progression and integration with randomised control trial data supporting the use of secondary antibiotic prophylaxis for early, echocardiography detected RHD. The 2023 guidelines now provide two sets of diagnostic criteria, screening (Table 8.8) and confirmatory. The confirmatory criteria include both morphological features (Table 8.5) and functional features (Table 8.6).

A key change has been the removal of the borderline and definite RHD categories which have been replaced with a stage-based classification (Table 8.7). This allows for the spectrum of early disease as well as evidence regarding features that predict progression of disease. The stage-based classification also links into evidence-based treatment guidelines.

Natural history of screen detected RHD

Echocardiographic screening allows the detection of valvular changes before clinical symptoms develop.

Natural history data from echocardiographic screening studies which have used the 2012 WHF criteria are now available.[7,21–23] These data have several limitations, including short duration of follow-up (from 4–60 months), small cohorts, variable implementation of secondary prophylaxis and variable definitions of progression/regression of valve changes.

Results of follow-up studies demonstrate the heterogeneity of this group, with some participants progressing, some regressing, and many others remaining stable.[7,21–23] Only two studies have specifically looked at the risk of ARF in those with screening-detected mild RHD, and results are also inconclusive, due to variable uptake of secondary prophylaxis.[22,24]

In a large cohort of latent RHD describing 227 children from Uganda, 10% of children with borderline RHD showed progression, while 25% of children with mild definite RHD showed progression over a median of 2.3 years.[25] Comparatively, 45% of children with mild definite RHD demonstrated improvement in echocardiographic findings in that period. Children with moderate/severe RHD at time of screening did substantially worse; an observation consistent with data from Fiji showing that >80% of this group demonstrated persistence or progression of RHD, including death.[26] The authors propose that children with screen detected, moderate/severe RHD be considered as 'missed clinical RHD', and treated in accordance with local recommendations for clinically detected RHD.

Amongst the mild RHD cases, it is not currently possible to confidently predict which individuals are more likely to progress or regress. The Ugandan study suggested that younger age at diagnosis, and the presence of pathological aortic regurgitation or morphological mitral valve features at diagnosis were independent risk factors for unfavourable outcomes but these criteria for progression have not been replicated in all cohorts.[22,27]

A randomised control trial to determine the impact of secondary prophylaxis on the progression of latent RHD was published in 2022.[11] There was a significant difference between the two groups with 3 (0.8%) children in the prophylaxis group having echocardiographic progression at two years, compared with 33 (8.2%) in the control group. These results support the use of secondary prophylaxis for the treatment of all screen detected RHD.

Potential approaches to implementation of RHD screening with echocardiography

Screening activities are being undertaken in different settings, and the rest of this chapter outlines factors to be considered when planning an echocardiographic screening program, including recommendations about the management of screen-detected RHD. (See Recommendations of management of echocardiogram screening-detected RHD).

The role for echocardiographic screening at a community level and in pregnancy is increasingly favoured as technology evolves to support use by non-experts in remote locations. Communities with high rates of ARF and RHD should be prioritised, and targeted screening initiatives may be considered. National and regional funding and coordination are required to support echocardiographic screening with a focus on regions where resources and access to healthcare are most limited. People living in these locations have the highest risk of RHD development and progression.

Target population

It is appropriate to consider screening in high-risk populations. Screening activities can be targeted to those who are most likely to benefit from earlier detection and treatment of disease. In Australia, it is assumed that all First Nations peoples living in rural or remote areas are at high risk, but regional data would suggest that risk can be further stratified within this heterogeneous cohort[6] with some communities demonstrating 'hyper-endemic' rates of disease.[7]

The contribution of RHD screening to understanding of epidemiology of RHD in Australia is discussed in Chapter 3 Burden of ARF and RHD (also see Figure 3.2).

The optimal age and frequency of screening has not been determined. Globally, the most common approach to date has been to use school-aged cohorts, typically aged 5–20 years. While a school-based screening approach has practical advantages, priority children (including those not attending school) may not be adequately reached, and alternative ways of accessing this group need to be considered.

Another high-risk group that may benefit from screening is pregnant women at risk of RHD, given the significantly increased demands on the cardiovascular system during pregnancy and delivery (See Chapter 12. Women and Girls with RHD, Screening). International studies have

demonstrated a high burden of previously undetected disease, and an association with adverse fetal and maternal outcomes.[11,28-30]

Non-technical considerations

A number of further issues need careful consideration before commencing screening activities for RHD (Table 9.5). This is not an exhaustive list but highlights challenges that have been faced by different groups who have undertaken screening for RHD in different international settings.

Different models of screening

Varying models of echocardiographic screening have been undertaken internationally; key differences are summarised in Table 9.4.

Personnel

Historically, screening programs have relied on expert teams, frequently led by cardiologists providing direct, on-site support. As screening has evolved in resource-limited settings, shortage of physicians has led to increasing interest in training non-expert operators (nurses, community health workers) to perform echocardiography screening. As well as increasing testing capacity, engagement of local community members to do echocardiograms brings cultural authority and local knowledge to the screening process. Teams have been variable in terms of personnel, including:

- Cardiac expert model (cardiologist or physician with echocardiography expertise performs screening and diagnosis).[7,28]
- Technical expert model (cardiac sonographer with on-site or off-site cardiologist support for diagnostic confirmation).[6]
- Non-expert model (trained health worker with on-site or off-site cardiologist support for diagnostic confirmation).[7,17,18]

Whilst most training of non-experts requires face-to-face instruction and demonstration; freely available online training packages have also been developed and implemented with success.[31]

Task-sharing is appealing where availability of expertly trained operators is limited, however individuals with abnormal screening echocardiograms still require cardiology review. For example, screen-positivity is estimated to be about 10-30%, depending on protocols, resulting in a large number of children requiring a repeat echocardiogram for diagnostic confirmation.[13,32] Models requiring off-site expert review face certain challenges including delays in diagnostic confirmation, delays in decisions regarding treatment, and potentially loss to follow-up prior to treatment instigation. Positive screening results may lead to anxiety, and exclusion from daily activities whilst awaiting diagnostic assessment. Technologies including cloud-servers permit same-day expert review of studies, which enables immediate decision-making.[17] While this is particularly useful for screening performed in remote areas, there are slow internet connections and limited access to mobile phone reception in some areas.

Equipment

Ultrasound technology has continued to evolve, with increasing processing power in smaller consoles, providing different options for RHD screening (Table 9.4). Portability and functionality (including the ability to perform Doppler imaging), 2D image resolution, screen size, battery capacity, storage of images (including file format), and the ability to transfer images are important considerations.[10] Equipment quality has a direct impact on the accuracy of study outcomes.

Despite superior imaging quality, traditional large-format machines are usually not appropriate for screening due to their cumbersome size and lack of portability. Portable echocardiography machines have reduced in size and have sophisticated functions, but they remain expensive. Hand-carried ultrasound devices and newer ultrasound probes that are compatible with smartphones and tablets are more affordable, portable and provide adequate image quality.[33] However, many of these devices are limited by lack of pulse-wave and continuous wave Doppler, precluding the performance of confirmatory echocardiography. Modified criteria for hand-held devices have been used in research settings.[17,27,34,35] The updated 2023 WHF criteria include screening criteria that do not require pulse-wave or continuous-wave Doppler and can be applied using hand-carried devices.

Table 9.3. Considerations for screening

ETHICAL CONSIDERATIONS	
Availability of treatment	• Is there a reliable supply of BPG and a means of administering it for potentially many years? • Is immediate cardiac medical and/or surgical treatment available for severe RHD or congenital heart disease detected by screening?
Community leadership	• Has the community requested screening? • Are principles of self-determination met? • Are First Nations peoples involved in leadership of the program? • Do First Nations peoples have sovereignty of their data?
Culturally appropriate, informed consent	• Are educational resources available in local language? • Should interpreters be used and are they available? • Who is the most appropriate person to provide consent? • How is consent obtained, and what is the age of consent? • Have First Nations Health Workers and Health Practitioners been engaged in the process? • Are the potential impacts of a positive screening test able to be conveyed with the chosen consenting procedure?
WORKFORCE CONSIDERATIONS	
Resources available to conduct screening	• Who will perform the screening? • Who will perform the usual duties of that person(s) if they are assigned to screening activities? • Is additional training required? • Who will provide that training? • Will it be sustainable? • Who will maintain quality standards? • Is there support for community-based workers?
Resources available to confirm diagnosis	• Is there access to rapid cardiology review of abnormal screens? • Is there capacity within local cardiology services to review individuals with abnormal screens if needed? • How will the result and recommendations be transmitted to the patient and local health service?
Resources available to provide education	• Do local health facilities have the capacity to deliver education to people diagnosed with RHD and their families? • Is there capacity to support First Nations health staff to provide education and support? • Are specific resources available to engage adolescents?
Resources available to treat confirmed cases	• Do local health facilities have capacity to provide ongoing secondary prophylaxis? • Is there capacity within the local primary healthcare and cardiology services to provide clinical follow-up? • Is there an RHD register/control program to monitor follow-up?
ECONOMIC CONSIDERATIONS	
Additional resources will be required	• Cost of resources required will depend on screening model used • Equipment and consumables. • Staff, including training. • Travel. • Estimated number of people to be screened.
Cost effectiveness is affected by many variables[40]	• Health economic analyses suggest that echocardiographic screening for RHD is cost-effective in high-risk populations in Australia. • Cost effectiveness will increase as the number of new cases detected per population screened increases, i.e. o in high-prevalence populations (high pre-test probability). o in settings with poor disease surveillance (resource-poor settings). o if large cohorts can be screened at one time (e.g. large target population, high screening attendance). • Factors that make screening less cost effective include: • High number of screens requiring cardiology review (poor specificity of the screening test/model). • High travel costs associated with remoteness.†

† Combining screening activities in rural and remote areas with specialist cardiology visits may reduce costs and result in timely diagnosis and treatment planning.

Table 9.4. Models of echocardiographic screening

	CARDIAC EXPERT MODEL (Cardiologist, Physician)	TECHNICAL EXPERT MODEL (Cardiac sonographer)		NON-EXPERT MODEL† (Trained local health worker)	
		Direct support	Indirect support	Direct support	Indirect support
Screening personnel	Cardiologist	Cardiac sonographer	Cardiac sonographer	Briefly trained healthcare worker	Briefly trained healthcare worker
Diagnostic confirmation	Cardiologist	On-site cardiologist	Off-site cardiologist	On-site cardiologist	Off-site cardiologist
Availability of staff	✠	✠✠	✠✠✠	✠✠	✠✠✠
Echocardiographic equipment	Portable	Portable	Portable	Handheld	Handheld
Screening protocol	Abbreviated Full screen Confirmatory	Abbreviated Full screen Confirmatory	Abbreviated Full screen Confirmatory	Abbreviated	Abbreviated
Sensitivity of RHD detection	✠✠✠	✠✠✠	✠✠✠	✠✠	✠
Specificity of RHD detection	✠✠✠	✠✠✠	✠✠✠	✠✠	✠
Detection of congenital heart defects	✠✠✠	✠✠✠	✠✠✠	✠	–
Time to confirm diagnosis	Immediate	Immediate	Delayed	Immediate	Delayed

† Operators with limited training using handheld devices have lower sensitivity and specificity than qualified technicians using portable machines; a greater proportion will require a subsequent definitive scan by an expert, increasing the final cost.

✠: poor, ✠✠: good, ✠✠✠: excellent

Local healthcare workers have established relationships within the community and a connection with language and culture. Use of trained healthcare workers recognises these qualities and builds community capacity.

Involvement of local consumer and youth representatives helps to facilitate better access for local young people.

Table 9.5. General specifications and functionality of different categories of echocardiogram machines

SPECIFICATION	HIGH-END MACHINE	PORTABLE MACHINE	HAND-HELD MACHINE
Technical capabilities			
-2D Image Quality	+++	+++	+++
-Colour Doppler	+++	+++	++
-Pulsed Wave/ Continuous Wave Doppler	+++	+++	-
-Measurements – linear	+++	+++	+
-Measurements – volume	+++	+++	-
Affordability	+	++	+++
Console size and portability	-	++	+++
Screen size/resolution	+++	++	++
Battery capacity	-	++	++
Additional probes	+++	++	-/+
Storage and transfer of images	+++	++	++

+++: superior quality, ++: good quality, +: limited quality, -/+: quality not determined, -: unavailable

Screening protocols

The choice of screening protocol will depend on community preference, the goals of the screening activity and the resources available. For example, preference for screening performed by local Aboriginal health workforce may be a driver for selection of a two-stage screening approach. Application of the confirmatory 2023 WHF criteria (Table 8.5) requires more time and a higher level of training and is usually limited to cardiologists and cardiac sonographers with portable or high-end equipment. This approach is effectively employing a diagnostic-standard evaluation as a screening test, which is accurate but resource-intensive.

An alternative is a two-stage screening approach, using an abbreviated screening test with a portable or handheld machine. Several groups have evaluated the performance of simplified screening protocols using limited views, obtained by operators with varying levels of training, comparing single echocardiographic criteria (e.g. mitral regurgitation jet length ≥2 cm, presence of any aortic regurgitation) with the WHF criteria.[17,18,36,39] Sensitivity for detection of any RHD (borderline or definite) varies from 75-85% and specificity 80-90%. The 2023 WHF guidelines has taken this evidence into account and developed a set of screening criteria that can be applied using a two-stage screening approach (Figure 9.1) (Table 8.8).

Diagnostic confirmation

If a two-stage screening model is used, each positive or abnormal echocardiogram will require diagnostic confirmation and treatment decisions to be made by a cardiologist. This might be achievable using the images obtained during screening, or a second, more detailed echocardiogram may be required. The latter increases complexity and the risk of loss to follow-up if the cardiologist is off-site and does not have immediate access to echocardiographic data. Following cardiologist review of the images and/or patient, a diagnosis of RHD (or congenital heart disease), and treatment and follow-up recommendations should be made (Table 11.2).

Echocardiographic screening performed by experienced cardiac sonographers has the added benefit of detecting previously undiagnosed congenital heart defects which may also benefit from cardiology review and intervention. The prevalence of incidental congenital heart disease detected during echo screening for RHD is consistently around 1%,[6,13,28] and a management pathway for these cases needs to be available.

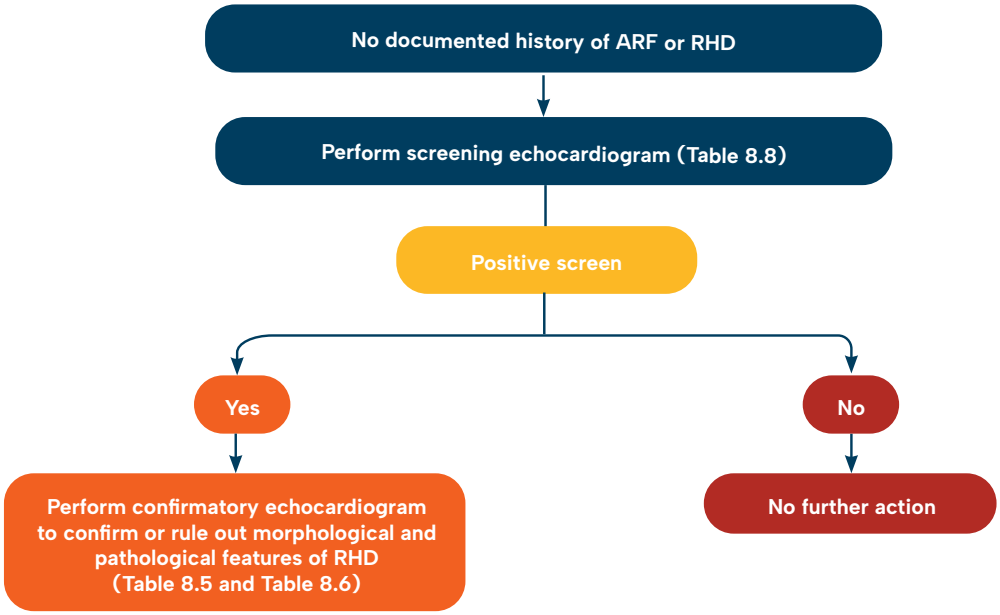


Figure 9.1. Screening pathway

Recommendations for management of echocardiogram screening detected RHD

The 2023 WHF guidelines provide a stage-based diagnosis, reflecting risk of disease progression. The stage-based diagnosis replaces the previous two categories of 'borderline' and 'definite' RHD, reflecting the continuous spectrum of early RHD valve changes. These have been incorporated into the Priority table (Table 11.2) and duration of secondary prophylaxis table (Table 10.3). Asymptomatic people with Stage B RHD on screening echocardiogram, and people with Stage A RHD from high-risk settings, are presumed to be at risk of valve disease progression and should receive secondary prophylaxis.[11,20,21]

Management should include culturally appropriate patient and family education, reinforcing the importance of environmental prevention of Strep A infections, symptoms of possible Strep A infection or ARF, and presenting early to a health facility for investigation and treatment (Table 11.2) (See Chapter 4).

Potential benefits of screening

Benefits at an individual level

If an individual is diagnosed with definite RHD through screening, they will have the opportunity to receive secondary prophylaxis which may prevent their progression to clinical disease. In a minority of cases, screening may detect moderate or severe RHD requiring urgent medical or surgical treatment and lead to improved outcomes.

Benefits at a community level

RHD screening activities, particularly when conducted at scale within communities, have been effective at raising community awareness about the disease and providing opportunities for community education. These activities may lead to changes in health-seeking behaviour. Community engagement, trust, cultural safety, education delivered in first language, and local governance and ownership are factors that are likely to increase the long-term impact of a program.[41] The Australian experience in the Pedrino and Recardina studies found that the community embraced RHD screening.[17,18,42] Local RHD champions were identified who were vital to the success of the screening activity and as ongoing advocates for RHD control.

Benefits at a health-system level

Echocardiographic screening is the most accurate method to estimate the prevalence and burden of RHD within a population. High-quality, local disease data is a powerful tool that can be used for local community planning, advocacy and government engagement, and is essential to enable rational health policy decision-making. Local data should be provided to community for interpretation based on principles of data sovereignty and data governance.

Health economic analyses suggest there may be considerable economic benefits from reduced morbidity and mortality, and improved productivity.

Potential risks of screening

Risks to the individual

If an individual is identified by screening as having RHD requiring secondary prophylaxis and/or medical or surgical treatment, but cannot access or be provided with that care, then there is no benefit from screening. This is more likely to be the case in resource-poor settings and raises obvious ethical questions about the appropriateness of screening in that instance.

Limited data are available about the impact of echocardiographic screening for RHD on asymptomatic children and their communities. One inherent risk of screening is that of misdiagnosis – a false positive screening test, even if subsequent diagnostic evaluation is normal – may create health-related anxiety and has been reported to adversely impact quality of life, despite a lack of symptoms.[43] Appropriate counselling and education in communities can mitigate the impact.[43,44]

Risks to the health system

Population-based screening programs require infrastructure and additional, ongoing resources. How health resources are allocated is a decision for public health policy. In some settings, the opportunity costs of screening have been raised as a concern: human resources devoted to echocardiography screening may reduce capacity to deliver other strategies to prevent new cases of Strep A infection and ARF, or to deliver clinical care to individuals already known to have RHD. The cost to the health system of screening and delivering secondary prophylaxis to those who may not actually need it cannot be quantified until the natural history of screen-detected RHD is better understood.

CASE STUDIES

Screening is an effective way to identify previously undiagnosed RHD in high-risk populations. Screening priorities should be led by the community, and local health services need to be adequately resourced to provide care for people identified with RHD.

South Australian Childhood RHD Screening Project (SACRHD), 2016-2018

SACRHD, conducted by the South Australian Health and Medical Research Institute, reached 2077 First Nations children across South Australia for echocardiography screening by accredited cardiac sonographers. The aims of the study were to:

- Determine the prevalence of RHD among First Nations children in South Australia.
- Evaluate the suitability of cloud technology in transferring echocardiographic images.

Children were enrolled primarily through schools, and male and female sonographers were used where necessary in line with cultural expectations, and a First Nations research assistant led community engagement in traditional areas.

Scans noted by sonographers as being suspicious for RHD were uploaded to a cloud server, often from very remote locations, for review by an off-site paediatric cardiologist. Seven (0.3%) children were identified to have definite RHD and 17 (0.8%) with Stage A RHD. Several children were also identified with congenital heart disease. All children were referred to outreach paediatric cardiology services for assessment and further management where indicated.

The use of accredited cardiac sonographers to perform echocardiographic screening for RHD was efficient and reduced demands on local cardiologists. The use of cloud technology for scan transfer from regional and remote areas to central specialist services enabled the study team to provide timely feedback to families, schools and local health services. A low prevalence of RHD was found in this population.

Pedrino Screening Research Project, 2017-2018

Pedrino, a study based out of the Menzies School of Health Research in the Northern Territory (NT), conducted echocardiographic screening of 1975 children in Timor-Leste (urban and regional settings), and 615 First Nations children in Maningrida, a remote community in the NT. The study was designed to investigate an ultra-abbreviated echocardiography protocol, using trained non-expert health workers, as well as to determine the burden of RHD in the communities screened.

Investigators found that the trained health worker approach used in the study was not adequately sensitive to detect definite RHD. The study demonstrated an extremely high prevalence of definite RHD in the Maningrida cohort (32/615; 5.2%),[18] and detected a high proportion of previously undiagnosed cases, including severe cases requiring surgical management, illustrating the potential impact of active case finding in hyper-endemic settings such as this.

A subsequent study, Recardina study,[17] modified the training for the non-experts. This extended the training period with more supervised scans and a logbook of 100 cases. With this change in training, an improvement in sensitivity and specificity of non-expert screening was seen. The accuracy of the screening was further improved by having the non-expert acquired images be interpreted by an expert (cardiologist), which may be a viable strategy for implementing broader echocardiographic screening for RHD. All cases identified as part of screening were linked into the NT RHD register and local health service, ensuring ongoing guideline based management.

Deadly Heart Trek, 2021-2023

Between 2021 and 2023 the Deadly Heart Trek program screened nearly 4000 school-aged children at 37 sites across the Top End of the Northern Territory, Queensland and Central Australia. Screening was performed by specialist cardiologists with support from paediatric and skin health teams.

Overall, 4.2% of children screened had new or existing RHD. The highest rates were in the remote areas around Alice Springs and the far north of South Australia (5.5%), and the lowest rates were in Alice Springs township (2.6%).

It is estimated that 8000 children, family, and other community members received education about RHD and skin health. All medical treatments and diagnoses are documented and followed up and where necessary, treatment is commenced. The program works in combination with local health services, ensuring continuality of care after the screening event concludes.

REFERENCES

1 de Dassel JL, de Klerk N, Carapetis JR, Ralph A P. How Many Doses Make a Difference? An Analysis of Secondary Prevention of Rheumatic Fever and Rheumatic Heart Disease. Journal of the American Heart Association. 2018;7(24):e010223.

2 Reményi B, Webb R, Gentles T, et al. Improved long-term survival for rheumatic mitral valve repair compared to replacement in the young. World Journal for Pediatric and Congenital Heart Surgery. 2013;4(2):155-164.

3 McGurty D, Reményi B, Cheung M, et al. Outcomes After Rheumatic Mitral Valve Repair in Children. Annals of Thoracic Surgery. 2019;108(3):792-797.

4 Council of Europe Council of Ministers. Recommendation No. R (94) 11 on Screening as a Tool of Preventive Medicine. 1994.

5 Department of Health and Aged Care. Standing Committee on Screening. Population based screening framework, 2018. ISBN: 978-1-76007-370-1

6 Roberts K, Maguire G, Brown A, et al. Echocardiographic screening for rheumatic heart disease in high and low risk Australian children. Circulation. 2014;129(19):1953-1961.

7 Francis JR, Fairhurst H, Hardefeldt H, et al. Hyperendemic rheumatic heart disease in a remote Australian town identified by echocardiographic screening. Med J Aust. 2020;213(3):118-123.

8 Australian Institute of Health and Welfare. Acute rheumatic fever and rheumatic heart disease in Australia. Cat. no: CVD 100. Australian Institute of Health and Welfare, Canberra, 2024

9 Engelman D, Mataika RL, Ah Kee M, et al. Clinical outcomes for young people with screening detected and clinically-diagnosed rheumatic heart disease in Fiji. International Journal of Cardiology. 2017;240:422-427.

10 Nascimento BR, Beaton AZ, Nunes MCP, et al. Echocardiographic prevalence of rheumatic heart disease in Brazilian schoolchildren: Data from the PROVAR study. International Journal of Cardiology. 2016;219:439-445.

11 Beaton A, Okello E, Rwebembera J, et al. Secondary antibiotic prophylaxis for latent rheumatic heart disease. N Engl J Med. 2022;386:230-240.

12 Nordet P. WHO programme for the prevention of rheumatic fever/rheumatic heart disease in 16 developing countries: report from Phase I (1986-90). Bull World Health Organ. 1992.

13 Webb RH, Gentles TL, Stirling JW, et al. Valvular regurgitation using portable echocardiography in a healthy student population: implications for rheumatic heart disease screening. Journal of the American Society of Echocardiography. 2015;28(8):981-988.

14 Carapetis J, Hardy M, Fakakovikaetau T, et al. Evaluation of a screening protocol using auscultation and portable echocardiography to detect asymptomatic rheumatic heart disease in Tongan schoolchildren. Clinical Research. 2008;5(7):411-417.

15 Marijon E, Ou P, Celermajer DS, et al. Prevalence of rheumatic heart disease detected by echocardiographic screening. New England Journal of Medicine. 2007;357:470-476.

16 Rothenbühler M, O'Sullivan CJ, Stortecky S, et al. Active surveillance for rheumatic heart disease in endemic regions: a systematic review and meta-analysis of prevalence among children and adolescents. The Lancet Global Health. 2014;2(12):e717-e726.

17 Francis JR, Fairhurst H, Yan J, et al. Abbreviated Echocardiographic Screening for Rheumatic Heart Disease by Nonexperts with and without Offsite Expert Review: A Diagnostic Accuracy Study. J Am Soc Echocardiogr. 2023;36(7):733-745.

18 Francis JR, Whalley GA, Kaethner A, et al. Single-View Echocardiography by Nonexpert Practitioners to Detect Rheumatic Heart Disease: A Prospective Study of Diagnostic Accuracy. Circ Cardiovasc Imaging. 2021;14(8):e011790.

19 Reményi B, Wilson N, Steer A. et al. World Heart Federation criteria for echocardiographic diagnosis of rheumatic heart disease—an evidence-based guideline. Nature Review Cardiology. 2012;9:297-309

20 Rwebembera J, Marangou J, Mwita JC, et al. 2023 World Heart Federation guidelines for the echocardiographic diagnosis of rheumatic heart disease. Nat Rev Cardiol. 2024;21(4):250-263.

21 Zühlke LJ, Engel ME, Nkepu S, Mayosi BM. Evaluation of a focused protocol for hand-held echocardiography and computer-assisted auscultation in detecting latent rheumatic heart disease in scholars. Cardiology in The Young. 2016;26(6):1097-1106.

22 Rémond MG, Maguire GP. Echocardiographic screening for rheumatic heart disease-some answers, but questions remain. Translational Pediatrics. 2015;4(3):206-209.

23 Bertaina G, Rouchon B, Huon B, et al. Outcomes of borderline rheumatic heart disease: A prospective cohort study. International Journal of Cardiology. 2017;288:661-665.

24 Mirabel M, Fauchier T, Bacquelin R, et al. Echocardiography screening to detect rheumatic heart disease: A cohort study of schoolchildren in French Pacific Islands. International Journal of Cardiology. 2015;188:89-95.

25 Beaton A, Aliku T, Dewyer A, et al. Latent Rheumatic Heart Disease: Identifying the Children at Highest Risk of Unfavorable Outcome. Circulation. 2017;136(23):2233-2244.

26 Engelman D, Wheaton GR, Mataika RL, Kado JH, Colquhoun SM, Remenyi B, Steer AC. Screening-detected rheumatic heart disease can progress to severe disease. Heart Asia. 2016;8(2):67-73.

27 Nunes MCP, Sable C, Nascimento BR, et al. Simplified Echocardiography Screening Criteria for Diagnosing and Predicting Progression of Latent Rheumatic Heart Disease. Circulation Cardiovascular Imaging. 2019;12(2):e007928.

28 Davis K, Remenyi B, Draper AD, et al. Rheumatic heart disease in Timor-Leste school students: an echocardiography-based prevalence study. Med J Aust. 2018;208(7):303-307.

29 Otto H, Saether SG, Banteyrga L, et al. High prevalence of subclinical rheumatic heart disease in pregnant women in a developing country: An echocardiographic study. Echocardiography. 2011;28(10):1049-1053.

30 Sullivan E, Vaughan G, Li Z, et al. The high prevalence and impact of rheumatic heart disease in pregnancy in First Nations populations in a high-income setting: a prospective cohort study. BJOG: An International Journal of Obstetrics & Gynaecology. 2020;127:47-56.

31 WiRED International. Echocardiographic diagnosis of rheumatic heart disease

32 Ploutz M, Lu J, Scheel J, et al. Screening for Rheumatic Heart Disease: Accuracy of Non-Physicians Using Handheld Echocardiography. Journal of the American Society of Echocardiography. 2015;28(6, B58):1-152.

33 Beaton A, Aliku T, Okello E, et al. The utility of handheld echocardiography for early diagnosis of rheumatic heart disease. Journal of the American Society of Echocardiography. 2014;27(1):42-49.

34 Diamantino A, Beaton A, Aliku T, Oliveira K. A focussed single-view hand-held echocardiography protocol for the detection of rheumatic heart disease. Cardiology in the Young. 2018;28(1):108-117.

35 Reményi B, Davis K, Draper A, et al. Single Parasternal-Long-Axis-View-Sweep Screening Echocardiographic Protocol to Detect Rheumatic Heart Disease: A Prospective Study of Diagnostic Accuracy. Heart Lung and Circulation. 2020;29(6):859-866.

36 Colquhoun SM, Kado JH, Reményi B, et al. Echocardiographic screening in a resource- poor setting: Borderline rheumatic heart disease could be a normal variant. International Journal of Cardiology. 2014;173(2):284-289.

37 Lu JC, Sable C, Ensing GJ, et al. Simplified rheumatic heart disease screening criteria for handheld echocardiography. Journal of the American Society of Echocardiography. 2015;28(4):463-469.

38 Mirabel M, Fauchier T, Bacquelin R, et al. Echocardiography screening to detect rheumatic heart disease A cohort study of schoolchildren in French Pacific Islands. International Journal of Cardiology. 2015;188:89-95.

39 Dougherty S, Khorsandi M, Herbst P. Rheumatic heart disease screening: Current concepts and challenges. Annals of Pediatric Cardiology. 2017;10(1):39-49.

40 Roberts K, Cannon J, Atkinson D, et al. Echocardiographic Screening for Rheumatic Heart Disease in Indigenous Australian Children: A Cost– Utility Analysis. Journal of the American Heart Association. 2017;6(3):e004515.

41 Haynes E, Marawili M, Marika BM, et al. Community-based participatory action research on rheumatic heart disease in an Australian Aboriginal homeland: Evaluation of the 'On track watch' project. Evaluation and Program Planning. 2019;74:38-53.

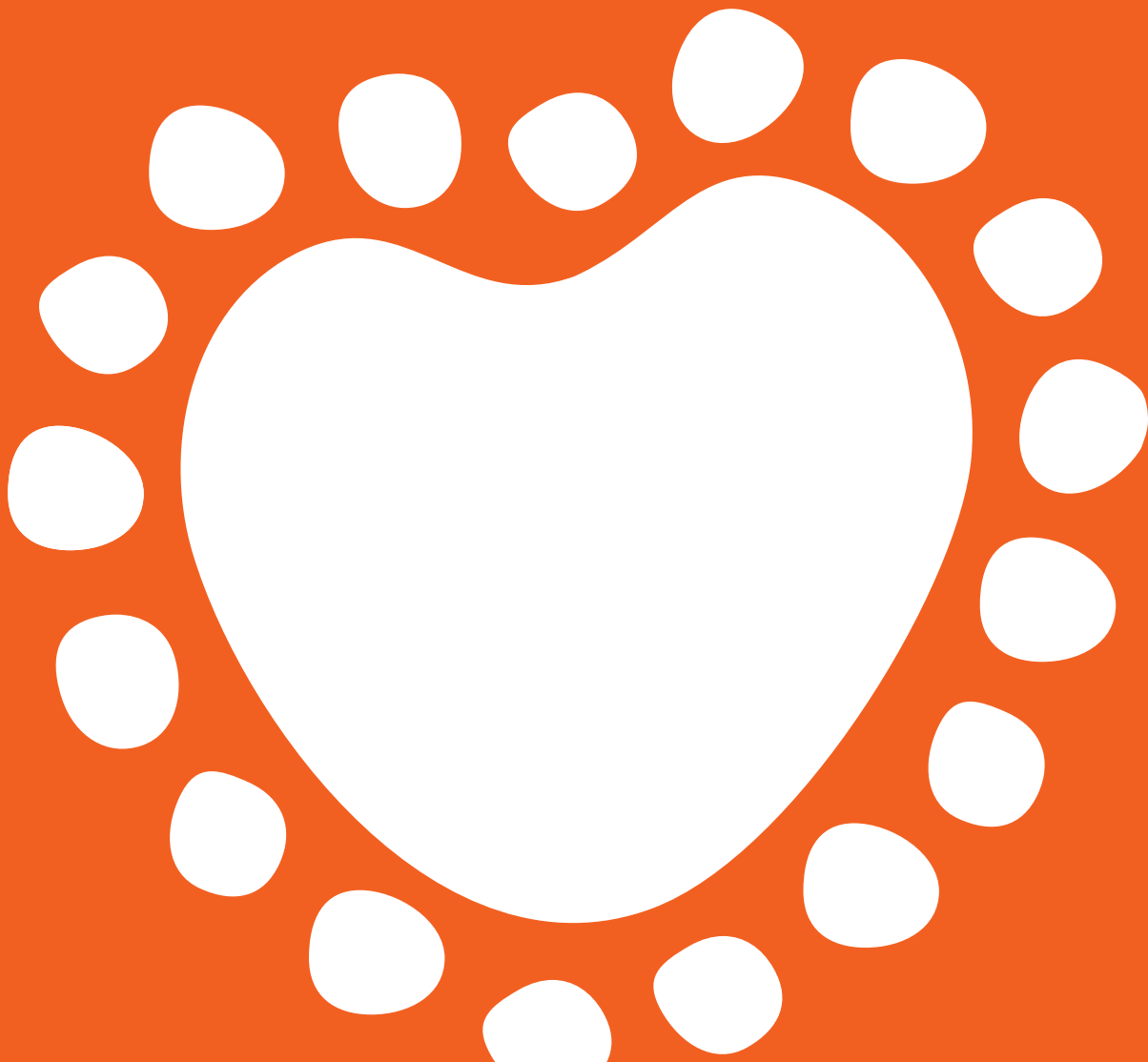
42 Carapetis JR, Brown A. Community leadership and empowerment are essential for eliminating rheumatic heart disease. Med J Aust. 2020;213(3):116-117.

43 Bradley-Hewitt T, Dantin A, Ploutz M, et al. The impact of echocardiographic screening for rheumatic heart disease on patient Quality of Life. Journal of Pediatrics. 2016;175(1):123-129.

44 Perelini F, Blair N, Wilson N, et al. Family acceptability of school-based echocardiographic screening for rheumatic heart disease in a high-risk population in New Zealand. Journal of Paediatrics and Child Health. 2015;51(7):682-688.

CHAPTER 10

Secondary prophylaxis



Secondary prophylaxis

IMPORTANT CHANGES IN THIS CHAPTER

Footnote edited in Table 10.3 Recommended duration of secondary prophylaxis to clarify need for specialist review prior to ceasing secondary prophylaxis (Updated October 2026)

Checklist added to highlight steps required prior to ceasing secondary prophylaxis (page 160) (Updated October 2026)

Addition of Summary of Recommendations with GRADE Level of Evidence (Table 10.1)

Updated recommendations for duration of secondary prophylaxis (Table 10.3)

Addition of guidance for managing long-acting penicillin (BPG) supply interruptions

Addition of technique for administering BPG injections

Updated strategies to manage injection pain (Figure 10.1)

Guidance for BPG administration in people who may be at high risk of vasovagal syncope (fainting)

Consideration of oral antibiotic prophylaxis rather than intramuscular injections for the small subset of people who may be at high risk of vasovagal syncope (fainting)

Recommended clinical discretion for duration of antibiotic prophylaxis after surgery in people aged over 40 years

Addition of calculation for days at risk

Updated priority definitions in Table 10.3 to align with definitions in Table 7.4 and Table 11.2 (Updated August 2025)

KEY INFORMATION

- Secondary prevention of ARF and RHD comprises secondary prophylaxis with an antibiotic (discussed here), plus holistic measures including enhance primordial and primary preventive activities targeted for individuals and households affected by ARF and/or RHD (discussed in Chapters 2, 4 and 5).
- Secondary prophylaxis of ARF is the consistent and regular administration of antibiotics to people who have had ARF or rheumatic heart disease (RHD), to prevent future group A beta-haemolytic streptococcus (Strep A) infections and recurrent ARF.
- Long-acting intramuscular benzathine benzylpenicillin G (BPG) used for ARF prophylaxis should not be confused with short-acting intravenous benzylpenicillin.
- Strep A is fully sensitive to penicillin. Failure of penicillin prophylaxis (i.e. breakthrough ARF recurrence despite receiving all prophylaxis with no days at risk) is not thought to be attributable to organism resistance but rather, to low serum or tissue concentrations of penicillin due to individual host differences in pharmacokinetic-pharmacodynamic properties.
- BPG injections should be delivered no later than 28 days after the last injection (or no later than 21 days for those prescribed a 21-day regimen) (Table 10.2).
- Starting from the first dose, administration of BPG should be patient centred, with appropriate technique and pain management to help reduce the risk of needle phobia developing, particularly in children.
- Single doses of BPG for the treatment of Strep A infection (i.e. primary prevention, Tables 5.3 and 5.4) differ slightly from regular doses of BPG for regular secondary prophylaxis of ARF. For example, small children under the age of five living in high-risk settings who frequently develop Strep A infections but rarely develop ARF, are recommended to receive weight-adjusted dosing to avoid excessively large BPG doses. A simpler strategy of two dose options with a single weight cut-off at 20 kg is used for secondary prophylaxis of ARF for pragmatic reasons (Table 10.2).

Table 10.1. Summary of recommendations with GRADE Level of Evidence

RECOMMENDATION	GRADE
Intramuscular penicillin is the most effective pharmacological strategy for ARF prevention	1B
Group A Streptococcal is fully sensitive to BPG	1A
BPG should be administered no later than 28 days after the last injection	1B
The internationally accepted standard dose of BPG for the secondary prevention of ARF in adults is 1,200,000 units	1B
Children weighing less than 20 kg should receive 600,000 units of BPG to prevent recurrent ARF	1C
People who have ARF despite receiving all BPG injections on time, may be indicated for a 21-day regimen	2B
If a confirmed severe allergic reaction to penicillin is revealed, a non-beta lactam antimicrobial such as erythromycin should be used for secondary prophylaxis of ARF	1B
Caution is advised in the small subset of people who have severe pulmonary hypertension (mean pulmonary arterial pressure >50 mmHg) and right ventricular failure and/or severe valve disease who are not eligible for valve replacement or repair. These patients may be prescribed oral penicillin following specialist review	2B
Penicillin and erythromycin are safe for mother and child during pregnancy and breastfeeding and should continue if indicated	1B
Oral penicillin prescribed for the same duration as BPG it is not as effective as BPG at preventing Strep A infections and subsequent recurrences of ARF	2B
BPG injections should be continued in patients receiving anticoagulation unless there is evidence of uncontrolled bleeding, or the international normalised ratio (INR) is greater than 4.5	1B
The duration of secondary prophylaxis following ARF is determined by the presence and/or severity of RHD	1A
Before ceasing secondary prophylaxis, it must be confirmed that there is no symptomatic deterioration, and that any existing valve lesions are stable	1A
Patients of all ages should have control over where and how they receive their injection	1B
Lidocaine (lignocaine) can reduce pain during injection and in the 24 hours after injection	1C
Withhold BPG pending specialist review in patients with severe pulmonary hypertension (mean pulmonary arterial pressure >50 mmHg) and right ventricular failure and/or severe valve disease OR moderate RHD plus progressive symptoms suggesting progression or new complications since last echocardiogram	2C

Table 10.2. Recommended antibiotic regimens for secondary prophylaxis

ANTIBIOTIC	DOSE	ROUTE	FREQUENCY
First line			
Benzathine benzylpenicillin G (BPG)	1,200,000 units (≥20 kg) 600,000 units (<20 kg)†	Deep intramuscular injection	Every 28 days‡ Every 21 days for selected groups§
Second line (if intramuscular route is not possible or consistently declined)			
Phenoxymethylpenicillin (penicillin V)	250 mg	Oral	Twice a day
Following documented severe penicillin allergy			
Erythromycin	250 mg	Oral	Twice a day

† For children weighing less than 10 kg, a dose of 600,000 units is still generally recommended but seek paediatric advice for careful planning of the secondary prophylaxis regimen.

‡ People on 28-day regimens can be recalled from day 21 to help ensure that injections are given by day 28.

§ BPG given every 21 days may be considered for a) patients who have breakthrough ARF despite complete adherence to a 28-day regimen, or b) are at high risk of adverse consequences if ARF occurs (have severe RHD or a history of heart valve surgery).

NOTE: Amoxycillin 250 mg twice daily for all ages is a pragmatic oral penicillin alternative that is preferred by some clinicians because of adequate absorption even when the stomach is not empty.

Table 10.3. Recommended duration of secondary prophylaxis, updated 2025

DIAGNOSIS	DEFINITION	DURATION OF PROPHYLAXIS	CONDITIONS FOR CEASING PROPHYLAXIS†	TIMING OF MEDICAL REVIEW AND ECHOCARDIOGRAPHY AFTER CESSATION‡
Possible ARF (no cardiac involvement)	Incomplete features of ARF with normal echocardiogram and normal ECG§ throughout ARF episode	12 months (then reassess)	No signs and symptoms of ARF within the previous 12 months Normal echocardiogram	At 1 year
Probable ARF (no cardiac involvement)	Highly suspected ARF (with or without prolonged PR interval on ECG)§ with normal echocardiogram	Minimum of 5 years after most recent episode of probable ARF, or until age 21 years (whichever is longer), then reassess	No probable or definite ARF within the previous 5 years Normal echocardiogram	At 1, 3 and 5 years
Definite ARF (no cardiac involvement)	ARF with normal echocardiogram and normal ECG§ throughout ARF episode (including with a background of Stage A)	Minimum of 5 years after most recent episode of ARF, or until age 21 years (whichever is longer), then reassess	No probable or definite ARF within the previous 5 years Normal echocardiogram	At 1, 3 and 5 years

Table 10.3. Recommended duration of secondary prophylaxis, updated 2025 (continued)

DIAGNOSIS	DEFINITION	DURATION OF PROPHYLAXIS	CONDITIONS FOR CEASING PROPHYLAXIS†	TIMING OF MEDICAL REVIEW AND ECHOCARDIOGRAPHY AFTER CESSATION‡
Definite ARF (with cardiac involvement)	ARF with carditis or RHD on echocardiogram, or with atrioventricular conduction abnormality on ECG§ during ARF episode (including with a background of Stage A)	If AV conduction abnormality: Minimum of 10 years or until age 21 (whichever is longer), then reassess OR	No probable or definite ARF within the previous 5 years Normal echocardiogram	At 1, 3 and 5 years
		If RHD on echocardiogram, according to relevant RHD priority classification		
Priority 3 Applies only to people ≤20 years of age (Previously borderline RHD)	**Stage A RHD** The presence of mild mitral OR aortic regurgitation WITHOUT morphological features of RHD on echocardiogram AND without a documented history of ARF	In a high-risk setting: Minimum of 2 years following diagnosis, then reassess *If Stage A RHD still present at 2 years and still ≤20 years of age, continue for further 2 years and reassess. Consider specialist input*	No probable or definite ARF within the previous 10 years Normalisation of echocardiogram after a minimum of 2 years follow up	At 1–2 years
Priority 3 RHD††	Definite ARF with a prior diagnosis of Stage A RHD **Any Stage B RHD** by echocardiogram: Evidence of mild‡ valvular regurgitation **AND** at least 1 morphological category in ≤20 years old and at least 2 morphological categories in >20 years old† OR Mild regurgitation of BOTH mitral and aortic valves	If documented history of ARF: Minimum of 10 years after the most recent episode of ARF, or until age 21 years (whichever is longer), then reassess If NO documented history of ARF and aged <35 years:‡‡ Minimum of 5 years following diagnosis of RHD or until age 21 years (whichever is longer), then reassess	No probable or definite ARF within the previous 10 years, no progression of RHD Stable echocardiographic features for 2 years	At 1, 3 and 5 years
Priority 2 RHD†† §§	**Moderate Stage C RHD:** Moderate MR, moderate AR, any non-severe MS or AS +/- associated pulmonary hypertension, dilated cardiac chambers, decreased LV systolic function **WITHOUT** evidence of clinical complications including cardiac surgery, heart failure, arrhythmia, stroke, and infective endocarditis	If documented history of ARF: Minimum of 10 years after the most recent episode of ARF or until age 35 years (whichever is longer), then reassess noting that some individuals may require extended duration If no documented history of ARF and aged <35 years:‡‡ Minimum of 5 years following diagnosis of RHD or until age 35 years (whichever is longer), then reassess	No probable or definite ARF within the previous 10 years Stable echocardiographic features for 2 years	Initially every 12 months

Table 10.3. Recommended duration of secondary prophylaxis, updated 2025 (continued)

DIAGNOSIS	DEFINITION	DURATION OF PROPHYLAXIS	CONDITIONS FOR CEASING PROPHYLAXIS†	TIMING OF MEDICAL REVIEW AND ECHOCARDIOGRAPHY AFTER CESSATION‡
Priority 1 RHD§§ ¶¶	**Severe Stage C RHD:** Severe MR, Severe AR, any severe MS or AS +/- associated pulmonary hypertension, dilated cardiac chambers, decreased LV systolic function. **WITHOUT** evidence of clinical complications including cardiac surgery, heart failure, arrhythmia, stroke, and infective endocarditis **All Stage D RHD:** Moderate/severe MR, moderate/severe AR, any MS or AS +/- associated pulmonary hypertension, dilated cardiac chambers, decreased LV systolic function. **PLUS** Evidence of clinical complications including cardiac surgery,‡‡‡ heart failure, arrhythmia, stroke, and infective endocarditis	If documented history of ARF: Minimum of 10 years after the most recent episode of ARF or until age 40 years (whichever is longer), then reassess noting that some individuals may require extended duration If no documented history of ARF:††† Minimum of 5 years following diagnosis of RHD or until age 40 years (whichever is longer), then reassess	Stable valvular disease / cardiac function on serial echocardiogram for 3 years OR Patient or family preference to cease due to advancing age and/or end of life care	Initially every 6 months

† **Prior to cessation, all people receiving secondary prophylaxis require an echocardiogram and a comprehensive clinical assessment by a medical specialist with experience and expertise in ARF and RHD management.** Risk factors including future exposure to high Strep A burden environments need to be considered.

‡ Echocardiography may be more frequent based on clinical status and specialist review.

§ Normal ECG means no atrioventricular (AV) conduction abnormality during the ARF episode – including first-degree heart block, second degree heart block, third-degree (complete) heart block or accelerated junctional rhythm.

†† Prophylaxis may be considered for longer in women considering pregnancy who are at high risk of recurrent ARF (Table 6.2).

‡‡ If diagnosed with mild or moderate RHD and aged ≥35 years (without a documented history of ARF), secondary prophylaxis is not recommended.

§§ Rarely, moderate or severe RHD may improve on echocardiogram without valve surgery. In these cases, the conditions for ceasing prophylaxis can change to follow the most relevant severity category. For instance, if moderate RHD improves to mild on echocardiogram, recommendations for mild RHD can then be instigated.

††† If diagnosed with severe RHD and aged ≥40 years (without a documented history of ARF), specialist input is required to determine the need for secondary prophylaxis.

‡‡‡ There may be clinician discretion regarding duration of prophylaxis following surgery for people aged >40 years based on continued exposure to Strep A infections, ongoing risk of ARF recurrence, and type of valve surgery (repaired native valves are at higher risk of damage; replaced mechanical valves are lower risk).

DISCUSSION

"I've been travelling a lot now, for sport and work. I've been to many different communities, but I never forget about this needle. No matter where I go, I never think, "I'll wait till I go back [home]", nah, wherever I go I just get it."

RHD Champion, 2019.

Overview

Secondary prophylaxis is the regular and ongoing administration of antibiotics to prevent Strep A infections and recurrent (or second and subsequent) ARF. The term secondary prevention is a broader concept which includes activities to limit Strep A infections as well as antibiotic use to treat infection early if it does arise, among individuals at risk of recurrent ARF. Secondary prevention broadly includes a range of organisational-level factors and environmental and socio-political actions that help improve resourcing and awareness of the problems associated with disease prevention.

In broad terms, secondary prevention should include:

- Therapeutic strategies aimed at improving the delivery of secondary prophylaxis.
- The provision of culturally appropriate and accessible patient, family and community education about ARF and RHD.
- Support for patients and families to engage in self-management or community group-management of treatment regimens.
- Coordination of, and collaboration between, available health services and schools.
- Culturally competent, structured, and sustained routine care and follow-up.
- The establishment of local, regional and national RHD control programs.
- Advocacy for necessary and appropriate resources for all people at risk of, or living with, ARF and RHD.

The term secondary prophylaxis specifically refers to consistent and regular antibiotic therapy delivered to people with a history of ARF and RHD to prevent recurrences of ARF. This approach is a cost-effective RHD control strategy at both community and population level.[1-3]

Secondary prophylaxis antibiotic therapy goes beyond giving needles. It should include cultural and workforce considerations which place the patient at the centre of care. Locally tailored interventions provided within a framework of cultural, environmental and social factors related to the treatment, the patient, and the health service have been shown to significantly improve secondary prophylaxis delivery.[4]

Pharmacological therapy

1,200,000 units of BPG is administered to all persons weighing 20 kg or more, and 600,000 units is administered to children weighing less than 20 kg.

BPG is a Schedule 4 class medicine available in Australia in a prefilled syringe (Bicillin-LA™). It is supplied in boxes of 10 syringes.[5]

Local name variations in use across Australia include 'LA Bicillin', 'L-AB', 'B-LA' and 'Bicillin'.

Recommended secondary prophylaxis dosage

The internationally accepted standard dose of BPG for the secondary prevention of ARF in adults is 1,200,000 units.[6,7] The dose for children is less clear, with variations across international guidelines regarding the precise weight limit for a lower dose of 600,000 units.[6,8] For example, in 2001 the World Health Organization (WHO) recommended 600,000 units for children weighing ≤27 kg[6] and in New Zealand the weight cutoff is 600,000 units for children weighing <30 kg.[9]

Pharmacokinetics

Serum penicillin levels may be low or undetectable at 28 days following a dose of 1,200,000 units.[10] Analysis of data from the Northern Territory RHD register has shown some recurrences despite timely delivery of all injections on the 28-day regimen and in rare instances, on the 21-day regimen, revealing the complexities of interpreting the pharmacokinetics and the Strep A environment.[11] A study of BPG pharmacokinetics in children and adolescents in 2019 showed that few patients will achieve the widely accepted penicillin serum concentration of ≥0.02 mg/L for the majority of time between injections if the recommended dosage is used. One proposed explanation for the lower-than-expected concentration was inadvertent injection into subcutaneous or adipose tissue rather than into muscle, since Body Mass Index (BMI) was identified as a significant determinant of penicillin concentration after injection.[12] Previous studies of BPG pharmacokinetics in children suggested that higher per kg doses are required to achieve sustained penicillin concentrations in serum and urine, and that 600,000 units is insufficient for most children weighing less than 27 kg.[13,14] More recently, a trial delivering targeted, high dose subcutaneous penicillin found that serum penicillin levels are maintained for up to 16 weeks (See Chapter 14, New Technologies, Penicillin Delivery).While this suggests a promising alternative to current delivery methods, intramuscular penicillin remains the currently recommended pharmacological strategy for ARF prevention.[15]

Frequency of injections

Injection frequency is sometimes referred to as 'monthly', 'four-weekly' or 'moon-cycle'; however, these terms can be interpreted inconsistently, therefore the terms '28-day regimen' and every 28 days' is preferred.

BPG given at least every 28 days aims to maintain prolonged, low-level benzylpenicillin concentrations.[12] A 21-day antibiotic regimen may be recommended by a medical specialist if a patient has breakthrough ARF despite receiving the 28-day regimen or is at high risk of adverse consequences if ARF occurs.[6,16,17]

Indications for 21-day BPG regimen:

- People diagnosed with definite, recurrent ARF, despite complete adherence to a 28-day regimen (Table 10.2).
- Consider in people at high epidemiological risk of Strep A infection who have moderate or severe RHD, or a history of heart valve surgery.

Duration of secondary prophylaxis after ARF

There may be clinician discretion regarding duration of prophylaxis following surgery for people aged >40 years based on ongoing risk of ARF recurrence, and type of valve surgery (repaired native valves are higher risk of further damage; replaced mechanical valves are lower risk). Although the risk of ARF recurrence is low in older people, secondary prophylaxis to age 45 or 50 may be recommended for some Priority 1 individuals e.g. recent ARF within 5 years, native aortic or mitral valve tissue present, ongoing high risk of Strep A exposure. (See Special considerations, Following heart valve surgery).

Recommendations on the duration of secondary prophylaxis are made by balancing the risk of ARF recurrence and its consequences to the patient, against the complexities associated with delivering and receiving regular BPG.

- **Risk of ARF recurrence:** ARF recurrences are most likely to occur between within 1 and up to 5 year after initial ARF diagnosis, with the risk continuing to decrease over the subsequent 5-10 years (Figure 3.13).[18] A study analysing ARF cases between 1997 and 2003 found that the recurrence rate in the first year after ARF diagnosis was 4%, the cumulative five-year recurrence rate was 10%, and the ongoing risk after 10 years was low. The other determinant of ARF risk is patient age, with recurrences becoming less common from the age of 21.[19-21]
- **Potential consequences to the patient of ARF recurrence:** Many ARF recurrences are 'mimetic' (mimicking the first episode).[22,23] Therefore, if rheumatic carditis occurs with the first ARF, carditis is likely to be present in ARF recurrences in that individual. The fact that some cases are not mimetic (e.g. the risk of future carditis and RHD is still high after an ARF presentation with arthritis or chorea only) is the reason that secondary prophylaxis is provided for anyone who has had ARF. Nevertheless, ARF recurrence carries a more serious risk for patients who already have significant valve damage.[23]

The duration of secondary prophylaxis following ARF is determined by the presence and/or severity of RHD (Table 10.3). The presence of severe RHD may also prompt the medical specialist to prescribe a more frequent BPG regimen.

- **Personal and health system costs of BPG:** The benefit to risk ratio falls with each passing year after the most recent ARF episode, and as the patient ages.[24] BPG has side effects and costs, and is burdensome to patients, families and health systems, and should not be continued when the likelihood of ARF recurrence, and therefore risk to the individual, is low.

Before ceasing secondary prophylaxis, it must be confirmed that there is no symptomatic deterioration, and that any existing valve lesions are stable. This must include echocardiographic assessment and comprehensive clinical assessment by a physician, paediatrician, cardiologist, infectious diseases physician or senior primary care doctor with experience and expertise in ARF and RHD.

Ceasing secondary prophylaxis (Table 10.3) is a decision between a patient and their medical specialist which must include:

1. Detailed diagnostic history including dates and clinical features.
2. Review of recent echocardiogram results to confirm no disease progression.
3. Assessment of ongoing social, economic and environmental circumstances and the likelihood of ongoing exposure to Strep A and subsequent infections.

The patient's local healthcare team should also be involved in these discussions because they are likely to be aware of any social circumstances and ongoing risk exposure which may influence the decision.

Rationale for revision of secondary prophylaxis duration

The recommended duration of secondary prophylaxis has shifted from 10 years[25] to five years in selected patients (Table 10.3). However, the existing recommendation to continue until age 21, if that comes later than the 5 to 10-year period, still applies. The implication of this change is that patients aged 16 years and over at the time of their ARF diagnosis, who did not have cardiac involvement and have normal follow-up echocardiography, can cease treatment earlier under the current recommendations. This reflects the knowledge that the likelihood of an older individual developing RHD, when the last ARF episode was five or more years ago and did not affect the heart, is low.

Ascertaining whether cardiac involvement is present

Rheumatic carditis can have acute clinical, ECG and echocardiographic findings. A normal echocardiogram especially if done early in the illness, does not exclude carditis. Changes in electrical conduction due to cardiac inflammation may be evident in the absence of visible valve changes. The most common electrical conduction abnormality is first-degree heart block (seen on ECG as prolongation of the P-R interval); but other conduction abnormalities such as higher grade atrioventricular block and accelerated junctional rhythm are also well recognised.[26] While not included as a minor Jones criterion, these cardiac arrhythmias should be considered during diagnostic decisions. Examples of electrical conduction abnormalities associated with ARF are shown in Chapter 6. Diagnosis of ARF chapter Figures 6.8 to 6.11.

ECG findings during an ARF episode should therefore be used to help inform decision-making on secondary prophylaxis duration (Table 10.3).

Duration of secondary prophylaxis after RHD diagnosis

In instances where the date of an ARF illness is unavailable – that is, RHD is diagnosed in the absence of any recognised ARF episode – the recommended duration of secondary prophylaxis is for 5-10 years after RHD diagnosis depending on RHD severity, or until age 21, whichever is longer. If the person is aged over 35 years at the time of RHD diagnosis and there is no history of ARF, then no secondary prophylaxis is recommended (Table 10.3).

Diagnosis of RHD in the absence of recognised ARF is common. Of First Nations people diagnosed with RHD in 2022, 78% did not have prior documented ARF,[27] reflecting the challenges in diagnosing ARF.

Secondary prophylaxis is not routinely recommended if the person is aged over 35 years at the time of RHD diagnosis, and where there is no documented history of ARF, as the likelihood of recurrent ARF is considered low (Table 10.3).

Long-acting penicillin supply interruptions

Interruptions to the supply of premix BPG in Australia do occur. The supply shortage which started in November 2023[28] resulted in the importation of limited quantities of alternative powdered products. This required alternative guidance for preparation and dosing, including interpreting the product information for the Australian environment. Such changes can significantly impact on the already fragile process for BPG delivery. Alternative powdered BPG products:

- Contain the same medication and have the same therapeutic effect as the premix syringe product.
- Should be used for all conditions that require BPG.
- Are given with the same frequency and duration for ARF and RHD (Table 10.3).
- Require different volumes for the same dose (as compared to the premix syringe volumes).
- Are safe for people of all ages.
- Are safe to use during pregnancy and breastfeeding.[29]
- Do not need to be refrigerated.

Oral versus intramuscular secondary prophylaxis

While oral penicillin is prescribed for the same duration as BPG (Table 10.3), it is not as effective as BPG at preventing Strep A infections and subsequent recurrences of ARF[6,30,31] because oral administration achieves less predictable serum penicillin concentrations.[32] Twice-daily oral regimens are also more difficult to adhere to over many years of prescribed therapy.[33] Treatment with non-penicillin regimens or patients with a documented penicillin allergy is discussed below (See Penicillin allergy and reaction). If a patient is provided with oral penicillin, the consequences of missed doses must be clearly emphasised, and the patient carefully monitored for Strep A infections and recurring symptoms of ARF.

Oral penicillin should be reserved for patients who experience bleeding problems following injection, and for those who consistently decline intramuscular BPG despite attempts to identify and address the barriers to injections.

Monitoring oral prophylaxis

Monitoring oral prophylaxis over many years is difficult. An oral regimen should be supported by effective communication with the patient, and with people who are strongly connected with the patient. Everyone needs to be aware of the short- and long-term risks of missing oral prophylaxis doses, including recurrent ARF and the development or worsening of RHD, and the impact that this can have on quality of life, and on future pregnancies for women (Table 12.1).

Box 10.1 Strategies that may support oral prophylaxis

Access

Support priority housing if lack of housing or unstable housing is contributing to inability to safely store and access medication.

Cultural Respect and Understanding

Build trust in healthcare and medications through culturally safe approaches.

Use Plain English.

Use interpreters when needed.

Respect client decision making and work collaboratively on healthcare solutions.

Community and Family Involvement

Identify a medication support person(s) in the family and involving them in healthcare discussions.

Consider using group health education sessions that include family and peers to reinforce the importance of treatment.

Involve First Nations Health Workers.

Reminders

For people who use smartphones or written reminders, consider setting a reminder alarm for evening dose or calendar reminder for when a new medication pack needs to be collected from the clinic or pharmacy.

Health Literacy and Education

Use culturally appropriate education materials, such as illustrated pamphlets or videos, to explain the purpose, benefits, and side effects of medications.

Positive Reinforcement

Highlight how the medication might have helped them since their last review (e.g. no new ARF recurrences).

Injection sites and techniques

Health staff administering BPG injections need to be able to accurately identify each injection site using bony landmarks, and be familiar with potential complications inherent to each site.[32]

As with all medications, clinicians should check and confirm that the medicine, patient, dose, frequency, indication, and duration of therapy are consistent with the patient's prescription and local protocol for administration.

Injection sites for BPG

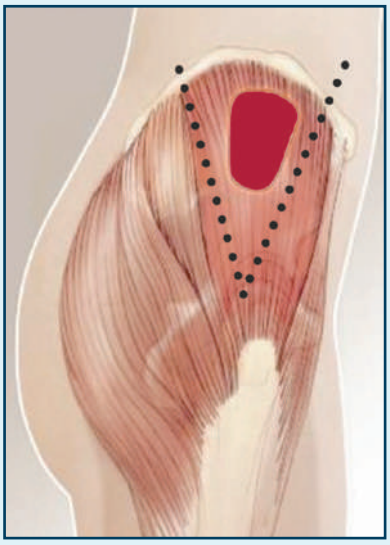
- The ventrogluteal site (lateral hip).[35,36]
- The dorsogluteal site (upper outer quadrant of the buttock).
- The vastus lateralis (lateral thigh).

The deltoid muscle of the arm is not used for BPG administration.

While the ventrogluteal site has been associated with less pain during injection and is further from neurovascular structures than other sites,[37-39] experience and competence with this site among clinicians in Australia is low. Nurses who are not trained to use the ventrogluteal site are more familiar with the dorsogluteal and vastus lateralis sites which were commonly used sites for surgical premedication and other routine treatments.

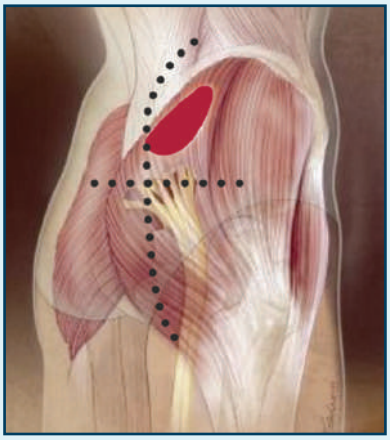
The dorsogluteal site has been associated with neurovascular damage due to its proximity to the sciatic nerve and should be used with caution.[40]

VENTROGLUTEAL SITE



1. Place the patient in a side-lying position.
2. Using your right hand on the patient's left hip; or left hand on the patient's right hip:
   a. With the palm of your hand, locate the greater trochanter of the femur.
   b. Place your index finger towards the front or anterior superior iliac spine and fan the middle finger as far along the iliac crest as you can reach. (The thumb should always be pointed toward the front of the leg.)
3. The injection site is in the middle of the triangle between the middle and index fingers.
4. Remove your fingers prior to inserting the needle.

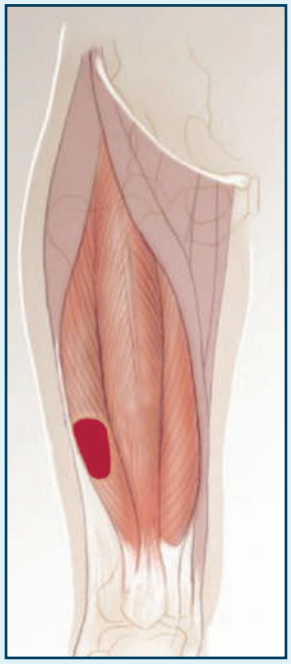
DORSOGLUTEAL SITE



CAUTION: Injections into the dorsogluteal muscle have been associated with sciatic nerve injury.

1. Place the patient in a prone (face down) position or lying on the side. Some patients may prefer standing up. Patients with valve disease at risk of cardiac decompensation must lie down (See Vasovagal syncope (fainting)).
2. The site for injection can be identified by either:
   a. dividing the buttock into four quadrants, selecting the upper outer quadrant;
   b. drawing an imaginary diagonal line from the posterior superior iliac spine to the greater trochanter. From the middle of the line move up and out.

VASTUS LATERALIS SITE



CAUTION: Some local protocols include volume restrictions for this site.

3. Place the patient in a supine (on back) or sitting position. Patients with valve disease at risk of cardiac decompensation must lie down (See Vasovagal syncope (fainting)).
4. Place one hand on patient's thigh against greater trochanter, the other hand against the lateral femoral condyle near the knee.
5. Visualise a rectangle between the hands across the thigh.
6. The correct injection site is the middle third of the anterolateral thigh.

Technique for administering BPG injections

1. Swab the skin with alcohol if it is visibly unclean.[41,42]
2. Allow the skin to dry completely.
3. Apply firm pressure to the site with gloved thumb for at least 10 seconds immediately before injecting.
4. Insert using a 21 g needle into deep muscle, at an angle of 90 degrees to the skin.
5. Once inserted, apply gentle back pressure on the plunger to make sure that the needle tip is not in a blood vessel. (If blood returns into the syringe, withdraw, discard, and prepare a new syringe)
6. Inject slowly over 2–3 minutes.
7. Withdraw syringe and discard immediately into a sharps container.

Managing injection pain and distress

Patients of all ages should have control over how and where they receive their injection, to enhance their sense of control and well-being. Injections should be delivered by culturally competent health staff in a culturally safe environment, with the aim of making each injection procedure as positive for the patient and family as possible.
Receiving injections in schools, homes, and places of employment are acceptable alternatives to primary care settings.

"Children need extra time to get them on track with injections; if that time is not taken, then that breaks down trust for the child. They get really scared; they build up in their head that they're going to get forced to get this painful needle.... One bad injection is enough to throw children off track. The thing that children say to me over and over again is what makes the most difference and what they remember, is that people are nice to them."

Erin Ferguson, Happy Heart Clinic, Cairns

Intramuscular BPG injections are painful. Most people do not get used to repeated painful procedures without psychological or pharmaceutical intervention.[43,44] Targeted strategies are required for managing pain; particularly for children, given the young age of many patients on secondary prophylaxis and the long-term nature of the regimen. Pain, fear and distress associated with the first injection can affect patients' expectations of future injections. Also, the patient's prior experiences of pain should be discussed before the first injection. While supportive holding may comfort some children, excessive physical restraint should not be used because it is not consistent with patient-led care, and adverse psychological effects from restraint can occur for children, their families, and clinicians, resulting in a harmful injection experience.[45]

Non-pharmacological techniques and analgesia for procedure-related pain in children are described in Australian Therapeutic Guidelines. Pain management policies for BPG injections (Figure 10.1) include:

- Non-pharmacological strategies for everyone;[46]
- Timely or preventative procedural interventions and analgesia if pain or distress is an issue;
- Protocols for procedural sedation for people with phobias or uncontrolled pain.[47]

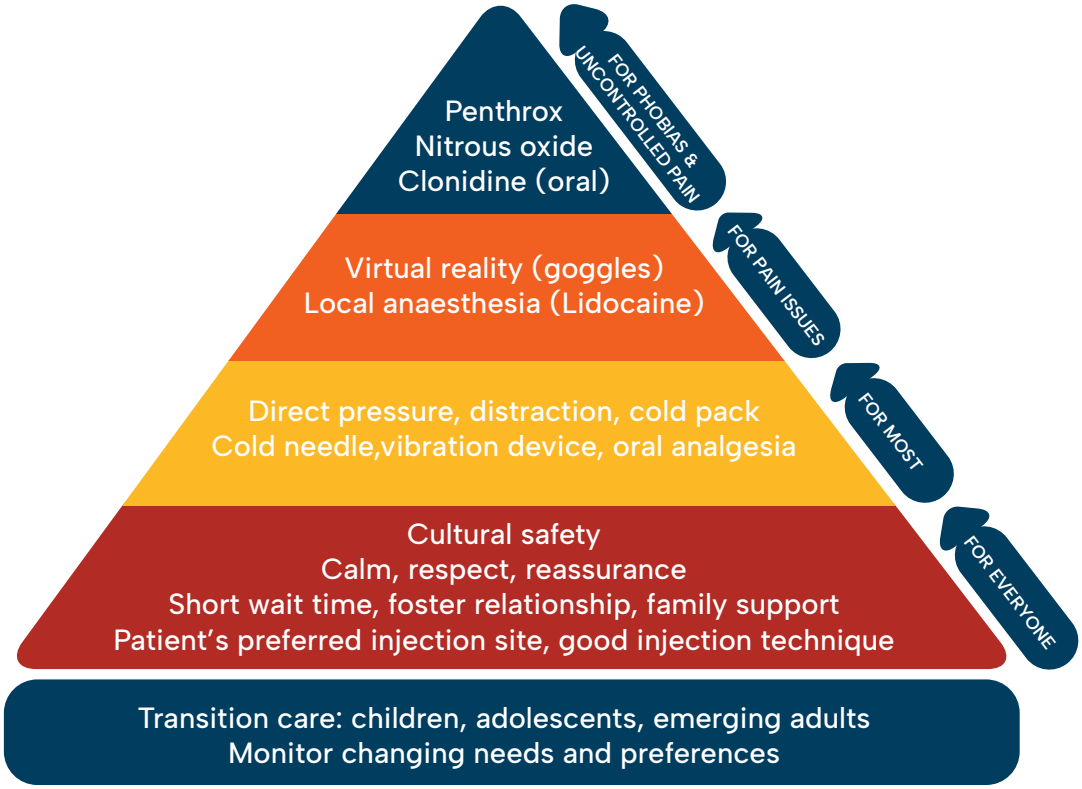


Figure 10.1. Strategies for injection managing pain, fear and distress

Non-pharmacological strategies

The following patient-centred strategies are part of the standard approach for all patients receiving BPG injections:

- A patient-focused, culturally safe environment.
- Respect for the patient's preference for pharmacological pain management strategies and site for injection (within the guidelines for appropriate delivery site).
- Relationship-based and relationship-strengthening activities which may include use of incentives and rewards.
- Family or support person involvement during injection procedures.
- Minimal waiting time for injection (children report increased anxiety when waiting times are too long.
- Best practice injection technique.
- Prefilled syringe warmed to room temperature (e.g. between the hands) prior to administration.
- Allowing skin swabbed with alcohol to dry before injecting.
- Distraction during injection with electronic games, videos etc.[48]
- Age appropriate distraction during injection such as electronic devices (such as virtual reality goggles), jokes, bubbles, deep breathing techniques.
- Injecting slowly.

The *gate theory of pain* proposes that a patient's interpretation of pain can be interrupted by applying direct stimulus at or near the injection site.[49] There are several non-pharmaceutical pain-blocking techniques and devices available in this category, including:

- Firm pressure to the site for at least 10 seconds immediately before injecting;.
- Ice pack applied to the site before injecting.
- Use of ice and vibration (e.g. Buzzy®, a vibrating ice pack) directly adjacent to the injection site during injection.[50,51]
- Use of other medical devices to provide distracting stimuli to the skin (e.g. Shot Blocker, a piece of plastic shaped to fit around and above the injection site. The underside has multiple, small, blunt bumps which are pressed against the skin to 'saturate sensory nerves').[52]
- Warming a cold needle prior to injection delivery.[53]

The use of virtual reality neuromodulation devices is an emerging distraction technique which has shown some success managing procedural pain, particularly in children. Devices such as the Smileyscope™ provide a virtual reality environment for the patient, which may have a role in reducing pain during BPG injections in some children.[54,55]

Pharmacological strategies: analgesia

Pain is subjective, and the level of pain varies between and for individuals. Pharmacological options for managing injection pain and distress should be discussed with patients and their families, and reviewed regularly to monitor changing needs and preferences (Figure 10.1).

Pharmacological options are topical, inhaled, ingested and injected medications, and include:

- Oral paracetamol before injection and at appropriate time intervals afterwards as required.
- Topical anaesthetic cream or spray applied before injection.
- Lidocaine (lignocaine) injected with BPG.
- Premixed nitrous oxide (Entonox) self-administered during the injection procedure.
- Methoxyflurane inhaler (Penthrox, the green whistle) self-administered during the injection procedure.
- Oral clonidine given prior to injection (in a medically supported environment.

Topical anaesthetic sprays and creams do not penetrate into deep muscle and therefore are not effective in managing deeper injection pain,[56] and having to wait until they take effect can prolong anxiety in some children.

Pharmacological interventions should be accessible to all patients depending on their level of pain and distress and should be only used as part of an individual care plan. Prescriptions, clinical scope of practice, local protocols and supply of medications and medical gases should be expended as needed.

Administering BPG injection with lidocaine (lignocaine)

Lidocaine (lignocaine) is a sodium-channel-blocking drug. It is quick-acting and lasts 60 to 90 minutes. When injected with BPG injections, it is reported to significantly reduce pain during injection and in the first 24 hours after injection.[50,57] Lidocaine is recommended in New Zealand (up to 0.25 mL of 2% lidocaine)[9] and Fiji (up to 1.0 mL of 1% lidocaine)[58] as a pain management option for people who experience moderate to severe pain during and after BPG injection.[59] A trial of interventions in New Zealand among children aged 13 years and younger included either lidocaine alone, or lidocaine with Buzzy®. Results showed a greater reduction in pain when lidocaine and Buzzy® were used together, and the fear of injection among these children was also reduced.[50] Anecdotal reports suggest that unexpected vibration such as provided by Buzzy® can cause alarm, therefore it needs to be introduced with care (e.g. demonstrate on one's own hand first before allowing the child to hold it, then using it at the injection site).

Lidocaine can also be administered as a spray or cream to anaesthetise the skin, but this is not effective in anaesthetising lower dermal or fat layers.[56]

Lidocaine is contraindicated in people with

- Known hypersensitivity to local anaesthetics of the amide type.
- Second- or third-degree heart block.
  Lidocaine is relatively contraindicated in people with bradycardia and hypovolaemia.

Due to the infrequent administration and low dose administered, intramuscular Lidocaine is tolerated well in most people with ARF and RHD.

Previously, the manufacturer of the prefilled BPG syringe noted that there was inadequate data on the rate of absorption, efficacy, and safety of an admixture of Bicillin L-A® with lidocaine, and therefore could not recommend the addition of lidocaine. Some health services continue to caution against using lidocaine due to the potential for biohazard injury in handling sharps. These concerns are outweighed by the proven benefit to the patient in pain reduction and recommendations for patient-centred care.[50,57]

A strategy to deliver lidocaine with the prefilled BPG syringe product is to transfer the contents of the prefilled syringe to a new, larger volume syringe, draw lidocaine into the larger syringe tip, and administer using the new syringe so that the lidocaine is injected first in a single injection.

A strategy to deliver lidocaine with a powdered BPG product is to prepare the contents according to the preparation and dosing guidance, using 1% lidocaine as the diluent instead of water for injection.[29]

Equipment

- Prefilled BPG syringe
- 3 mL syringe
- 2 drawing-up needles
- 21 g needle for administration

Preparation

1. Attach a drawing-up needle to a 3 mL syringe.
2. Draw the required contents of BPG from the prefilled syringe into the 3 mL syringe (2.3 mL for 1,200,000-unit dose and 1.17 mL for 600,000 unit dose).
3. Using a new needle, draw up 0.5 mL of 1% lidocaine or 0.25 mL of 2% lidocaine into the tip of the 3 mL syringe.
4. Avoid mixing to keep the lidocaine in the tip of the syringe.
5. Push plunger up carefully to remove any air in the syringe.
6. Remove the drawing-up needle.
7. Attach the 21 gauge needle to the 3 mL syringe for administration.

(Adapted from Heart Foundation New Zealand, 2014)[9]

Table 10.4. Considerations for using lidocaine (lignocaine)

CLINICAL FACTORS	PATIENT FACTORS
Lidocaine can be offered as part of a multi-faceted approach to managing injection pain.† Lidocaine should only be used following discussion between the doctor and the patient, and with input from family and other health staff. Lidocaine needs to be ordered on a medication chart according to local protocol. Lidocaine is compatible with penicillin and does not affect its chemical composition.[57] Low-dose lidocaine is safe during pregnancy.[60-62] • Lidocaine crosses the placenta; however, the dose is low and there is no evidence that it causes fetal malformations or other significant side effects. Low-dose lidocaine can be administered to women who are breastfeeding.[57,60,63] • Lidocaine is excreted into breastmilk in small amounts. Given the small amount of lidocaine used with BPG injection, the amount excreted into breastmilk to which the baby is exposed is minimal. Lidocaine is unlikely to cause adverse effects in breastfeeding babies.	Consider the impact of introducing lidocaine for a patient who is already receiving BPG injections without lidocaine. • Addition of lidocaine results in an increased volume to be administered.‡ Consider the impact of not providing lidocaine to a patient regularly receives lidocaine. • The pain of an injection without lidocaine may influence the patient's approach to future injections. Confirm use of lidocaine with the patient prior to each injection. • Ongoing use of lidocaine should be determined by the patient.

† Recommendations for the use of lidocaine (lignocaine) with BPG vary across Australia's jurisdictions; some recommend against adding lidocaine, and some recommend against decanting, mixing, or diluting during intramuscular injection preparation.

‡ The formulations of BPG vary globally, with powder formulations for reconstitution and/or larger volume injections required in some countries.

Methoxyflurane (Penthrox®, an inhaler also called the green whistle) is available as a self-administered, inhaled anaesthetic which helps reduce severe pain without causing sedation.[64] It must be used on prescription only and with sound knowledge of contraindications, and potential adverse effects, which include dizziness, nausea, and confusion. Penthrox has a rapid onset, producing analgesic effects after 6-10 breaths. Each canister contains 3 mL of active methoxyflurane 99.9% which is inhaled through a mouthpiece and provides up to 20-25 minutes of pain relief when inhaled continuously.

Penthrox is commonly used in emergency departments for procedural pain management.[65,66] It is easy to self-administer, well-tolerated, effective at managing moderate pain, and has low risk of complications.[65,66]

Pharmacological strategies: sedation

Sedation may be necessary when distress remains significant despite using other measures to manage pain, fear and distress. When sedation is needed, use the least intrusive route and lightest sedation necessary.

Pre-mixed nitrous oxide (Entonox®) is an S4 (restricted) medicine, is a gas mixture of 50% nitrous oxide and 50% oxygen which is self-administered using a mouthpiece or mask. It must be used on prescription only and with sound knowledge of potential adverse effects, which include loss of consciousness if used incorrectly.[67] Prolonged exposure can lead to bone marrow suppression, and it should not be used in children aged less than 4 years, or in older children who are unable to self-administer. The room in which nitrous oxide gas is used must be well-ventilated. Entonox is an effective, short-duration option to help manage procedural pain and anxiety reduction related to BPG injection, where use of other non-pharmacological and pharmacological strategies has failed.[67,68] While this agent has favourable qualities, it is not available in many community settings. A procurement process would be required for health services wishing to offer this option.

Oral clonidine is an alpha-2 adrenergic receptor agonist with broad cardiovascular and central nervous system effects in children and adults, including analgesia and sedation. Clonidine produces sedation by decreasing sympathetic nervous system activity and the level of arousal due to inhibition of central nervous system alpha-2 receptors. The result is 'a calm patient who can be easily aroused to full consciousness'.[69] Immediate-release clonidine has rapid oral absorption, reaching a peak concentration within 60-90 minutes. These features make clonidine an attractive option for use for BPG injection in a monitored primary- or tertiary-care setting. However, drug effects also include dry mouth, bradycardia and hypotension. Individuals with RHD may not tolerate hypotension or bradycardia; clonidine may be contraindicated in such cases, so discussion with the child's specialist would be required, and in all instances, close monitoring is required. The recommended starting dose is 3 micrograms/kg.[69,70]

Clonidine may be indicated for children and adolescents who are highly distressed with the injections despite use of other strategies), however, it is not widely used in rural and remote settings due to the specific resources required for administration and monitoring (Table 10.5). One published case study from northern Australia reports successful use of clonidine in a seven year old boy, who was eventually weaned due to his increased coping capacity.[71]

Table 10.5. Clonidine use for BPG injection[72]

Staffing requirements: two clinicians at least one of whom is trained in Paediatric Basic Life support. Equipment: pulse oximeter, sphygmomanometer, oxygen, bag and mask. Preparation: fasting for 6 hours for food and milk; fasting for 1 hour for clear fluids (water, cordial, clear apple juice). Monitoring: continuous pulse oximetry, and frequent monitoring of vital signs and level of consciousness. • Baseline observations: • Heart rate. • Oxygen saturation. • Blood pressure. • Respiratory rate. • Level of consciousness using the 'alert, verbal, pain, unresponsive' (AVPU) score.	
1. Procedural coaching – provide a clear explanation in a calm environment to the patient and their carer about the role of clonidine, the expected effect to improve the experience of the BPG injection, potential side effects, the monitoring that will occur, and the post-procedure requirements.	
2. Give clonidine 3 micrograms/kg orally, 60 minutes prior to BPG injection.	• Paracetamol or a nonsteroidal anti-inflammatory agent can be administered simultaneously. • Seat the patient with the carer and keep carer with patient until observation period is over. • Give BPG with lidocaine when patient is sufficiently calm or drowsy, usually maximally noted around 60 – 90 minutes post clonidine administration (See Administering BPG injection with lidocaine (lignocaine)) • Provide continuous pulse oximetry and 10 minutely HR, BP, pulse rate and RR from time clonidine given until drowsiness mostly resolves, patient is easily rousable to voice and vital signs normalise. Discharge from clinic. • If no drowsiness has occurred by 90 minutes and vital signs are normal, it is reasonable to cease continuous monitoring and do a final set of observations at two hours.
3. Re-dosing of clonidine for subsequent BPG doses	• Adjust next clonidine dose according to the response to 3 micrograms/kg. For example, reduce to 2 micrograms/kg if excessive drowsiness (e.g. needing respiratory support or oxygen) or unacceptable haemodynamic effects occurred with the 3 micrograms/kg; increase to 4 micrograms/kg if lower dose was inadequately effective.

Penicillin allergy and reactions

In Australia, adverse events associated with the administration of medicines should be reported to the Therapeutic Goods Administration and to the manufacturer, and details recorded in the clinical notes and provided to the patient or carer.

There is no increased risk of developing allergies to penicillin with prolonged BPG use.

The global rates of allergic and anaphylactic reactions to BPG are 3.2% and 0.2% respectively, and fatal reactions in clinical practice are exceptionally rare.[6,73-75] Most patients labelled as allergic to penicillins are not truly allergic when appropriately stratified for risk and re-challenged.[43,76]

Patients commencing secondary prophylaxis who have a documented reaction or allergy to penicillin should be referred to an allergist or immunologist to verify the type and severity of the response, and to determine if there is an absolute contraindication to penicillin. Options include skin testing for patients with immunoglobulin E-mediated reactions[77] and/or a supervised drug challenge for patients with non-severe delayed reactions. Most patients who report a penicillin allergy can safely tolerate a penicillin challenge. Penicillin desensitisation is not practical, because it would have to be repeated before each dose of BPG.[77,78]

When patients report an allergy to penicillin, it is important to cross-reference the clinical history of past reactions and review the medical record for associations between administration and symptoms, preferably using an antibiotic allergy assessment tool. For example, the tool described by Devchand et al[79] can help assign someone to a category of being likely or unlikely to have true penicillin intolerance or true immediate penicillin hypersensitivity. If a confirmed immediate and severe allergic reaction to penicillin is revealed,[80] (e.g. anaphylaxis, Stevens-Johnson syndrome/ toxic epidermal necrolysis, drug reaction with eosinophilia and systemic symptoms) a non-beta lactam antimicrobial such as erythromycin should be used instead (Table 10.2).[6,17]

Reactions resulting from BPG injections are most likely to occur within 15 minutes of administration, so the patient should be observed for 15 minutes after administration of each dose and longer if there is concern about a potential reaction. Anaphylaxis can include respiratory symptoms such as wheeze or stridor, cardiovascular symptoms such as tachycardia and sustained hypotension, skin symptoms such as itching and weals, gastrointestinal symptoms such as abdominal cramps, nausea and vomiting, and neurological symptoms such as severe anxiety and distress.

Rapid intramuscular administration of adrenaline is the first line for anaphylaxis treatment. Observe local protocols for managing anaphylaxis, including first aid.

Other adverse reactions to BPG include:

- Injection site complications including pain, myositis or abscess.[81]
- Vasovagal syncope secondary to intramuscular injection.[82]
- Non-immune mediated reaction e.g. nausea, vomiting, itch, renal impairment.[83]
- Immune-mediated including anaphylactic and non-anaphylactic reactions.[83]

Non-allergic reactions

Mild to moderate adverse reactions to BPG not comprising allergy, such as fever and malaise, are described. In qualitative work from the Northern Territory, the majority of individuals receiving regular BPG did not experience side effects, although a small number described feeling generally unwell afterwards, requiring bed rest.[43]

Concerns internationally about risks of severe or fatal reactions to BPG have in some settings has caused reluctance to prescribe BPG.[84] However, an investigation of case reports of severe and fatal adverse events associated with BPG administration for RHD prophylaxis from African and Asian settings indicated that anaphylaxis is unlikely to be a major cause of adverse reactions to BPG.[85] The authors reviewed the likely diagnosis in each case, considering potential alternative explanations: anaphylaxis, impurities or contamination of BPG products, inadvertent intravascular administration of BPG, or underlying structural cardiac disease itself predisposing to adverse outcomes. Pain or fear of BPG administration could drive a physiological response, including vasovagal syncope, which may be enough to cause haemodynamic compromise or arrhythmias in vulnerable individuals.[85]

In 2022, the American Heart Association issued an international caution against administering BPG to patients with severe RHD, following reports of deaths from diverse countries over time.[82] The mechanism of action was again not entirely clear; however, experts have hypothesised that the deaths were due to acute on chronic cardiac decompensation as a result of a fulminant vasovagal reaction secondary to the delivery of the BPG injection. Individuals with severe mitral valve disease complicated by pulmonary hypertension and right heart failure are particularly at risk of acute decompensation.

After consideration of these reports together with local data, the Australian RHD Guidelines expert group recommends that intramuscular BPG remains the first-line treatment option for ARF secondary prophylaxis in Australia. Caution is advised in the small subset of people outlined below.

Vasovagal syncope (fainting)

Vasovagal syncope is a reflex reaction comprising bradycardia and/or hypotension, also known as a faint. It can occur in response to triggers such as stress, anxiety, pain, or standing for long periods. In a person with severe RHD, fainting or vasovagal syncope can lead to cardiovascular compromise because the heart cannot adequately compensate for the loss of perfusion. In extremely rare instances, this has resulted in death occurring immediately after receipt of a BPG injection.[82] This risk is much lower than the risk of death due to RHD if regular, long-term BPG is not provided. BPG remains the best strategy to reduce progression from ARF to RHD or from mild / moderate RHD to severe RHD, however:

- The risk of fainting on administration of BPG needs to be minimised (Box 10.2).
- Some people should have BPG ceased or substituted with oral penicillin (Box 10.3).

Who is more likely to faint?

The risk of fainting is difficult to predict and not clearly associated with prior fainting, sex or other factors. However, there are a few trends observed:

1. Younger Age Groups: Fainting related to needles tends to occur more often in adolescents and young adults.
2. Anxiety or Fear: People with a history of anxiety or fear related to medical settings may be more prone to fainting.
3. Posture: Prolonged standing or rapid change in position (standing up after lying) can increase the risk of fainting.
4. Dehydration: Lack of adequate fluid intake and associated dehydration can increase the risk of fainting.

Is BPG more likely to trigger a faint than other intramuscular injections?

There are no robust data comparing fainting risk after different types of injections. The risk of fainting with BPG is considered to be higher than the risk of other intramuscular injections due to the greater duration of administration, higher chance of procedural pain and potential for priming of anxiety due to past negative experiences.[83] Medications that are less viscous,

Box 10.2. Minimising the risk of fainting when BPG is administered

1. Prior to injection

- Check if there is any dizziness, chest pain or increasing shortness of breath. If yes:
  - Check manual pulse and blood pressure (if equipment available).
  - Withhold the BPG dose.
  - Follow usual clinical practice as per CARPA[86] or other local guideline appropriate for the setting.
  - Arrange for transfer to the clinic if providing an outreach service.
  - Obtain medical (general practitioner) review, including phone consultation with a medical specialist where indicated.
  - If recommended by the doctor, substitute BPG with oral penicillin until the medical situation is stabilised and the doctor is confident in BPG safety (see Box 10.3).
- Provide a glass of water.
- Provide a snack if the patient is hungry.
- Provide reassurance and strategies to manage anxiety if there is anxiety about the injection.

2. During injection

- Recommend the patient lie down to receive the injection and stay resting for 5 minutes afterwards. If they don't want to lie down, respect patient autonomy but ensure they are making an informed decision. Explain that some people faint if they're standing up, but it's their choice how they get their injection.
- Use correct technique for injection delivery, and the hierarchy of strategies for managing injection pain, fear and distress (Figure 10.1).
- Use the 'Boss of my Body' checklist[87] specifying the patient's choice on who gives the injection, where they have it, pre-medication approaches, during needle methods, post-injection approaches.

administered in smaller volumes, or cause less pain during injection (e.g. vaccines, or antibiotics like ceftriaxone) tend to have a lower risk of fainting.

Review by a medical specialist regarding ongoing safety of BPG is needed in the situations listed in Box 10.3. The physiology of unrecoverable cardiovascular collapse after vasovagal syncope in individual cases is not able to be determined precisely but is likely to comprise factors such as high pulmonary pressures, impaired ventricular function and low cardiac output secondary to severe valvular disease, in particular severe mitral stenosis. Concomitant coronary artery disease may also contribute to limited cardiac reserve and poor response to resuscttion efforts.

Box 10.3: Checklist to review ongoing appropriateness of BPG in severe RHD

1. Can BPG be CEASED?

Ensure people who are no longer recommended for BPG have the opportunity to discuss discontinuation. Patients with Stage C or Stage D RHD may be able to cease secondary antibiotic prophylaxis at the age of 35 or 40 respectively, (Table 10.3) and according to the outcome of patient and clinician shared decision making discussions.[24] All changes to treatment must be made by an RHD medical specialist.

2. Should the patient PERMANENTLY switch from injectable to oral penicillin?

Circumstances in which cardiovascular collapse may complicate a vasovagal episode include the following:

- RHD complicated by severe pulmonary hypertension (mean pulmonary arterial pressure >50 mmHg) with or without right ventricular failure.
- RHD complicated by advanced (Class III, IV) and severe left ventricular systolic dysfunction function for which valvular intervention is not an option.

3. Should the patient TEMPORARILY switch from injectable to oral penicillin?

A temporary switch to oral penicillin may be needed in the days to weeks while a patient with increasing RHD severity is being stabilised (e.g. pending surgical and improved medical management). Additional circumstances in which there may be the very rare chance of cardiovascular compromise complicating a vasovagal episode include the following:

- Severe aortic insufficiency.
- Severe mitral stenosis.
- Severe aortic stenosis.
- Moderate or severe ventricular dysfunction.
- Significant or unstable symptoms (NYHA class III or IV).

4. What measures are being used to support oral penicillin prophylaxis?

People on oral penicillin may be taking other medications (e.g. anticoagulation, heart failure medications), so may be accustomed to taking medications every day. However, penicillin is taken twice per day and extra support may be needed (See Box 10.1).

Correct administration of BPG is important. BPG injections should be administered by people trained in intramuscular injections and identification of anatomical landmarks, which minimise the risk of intravascular administration and adverse events.[82] (See Injection sites and techniques).

Special considerations

Pregnancy and breastfeeding

Penicillin and erythromycin are safe for mother and child during pregnancy and breastfeeding and should continue if indicated (Table 12.2).

Penicillins cross the placenta in low concentrations, and can be detected in amniotic fluid, however there is no evidence that penicillins have any teratogenic effects on the fetus.[88] The importance of continuing secondary prophylaxis during pregnancy, which is a time of higher cardiac risk, should be discussed with the woman and her family prior to a planned pregnancy, and as soon as possible during an unplanned pregnancy (Table 12.1).

Following heart valve surgery

Surgery does not remove the risk of Strep A infections or recurrent ARF.

The duration of secondary prophylaxis is guided by the individual's priority status, which for most undergoing valve surgery will be Priority 1, with secondary prophylaxis recommended until age 40 years or beyond. There may however be clinician discretion depending on the perceived ongoing risk of ARF recurrence and the type of valve surgery performed (e.g. higher risk with angioplasty, native valve repair, and lower risk with bioprosthetic or mechanical valve replacement, including transcatheter aortic valve implantation–TAVI). As such, some individuals may cease secondary prophylaxis sooner than 40 years of age following clinician guidance. A previous audit of the Northern Territory RHD register data found that there were 32 instances of ARF diagnosed in people over the age of 40 years, out of 343 people reviewed who were currently receiving secondary prophylaxis. This shows that ARF is rare in that age group but does still occur. Patients who require heart valve surgery for non–rheumatic heart valve disease and who are not at high risk of ARF, are not indicated for secondary prophylaxis.

Bleeding disorders

Bleeding complications from BPG injections in patients receiving anticoagulation therapy in Australia are rare.[89] Therefore, BPG injections should be continued in patients receiving anticoagulation unless there is evidence of uncontrolled bleeding, or the international normalised ratio (INR) is greater than 4.5.[90] If the INR is greater than 4.5 and secondary prophylaxis is due, oral penicillin can be prescribed until the INR has reduced, and BPG can then be resumed.

Multidisciplinary patient-centred care

Patient education

Patients and their families should be provided with clear information about how secondary prophylaxis works, and the risk of recurrent ARF and its consequences if they do not receive treatment as prescribed. This may require an interpreter, language-appropriate written material, and culturally appropriate conversation.

Patient-related factors to consider and appropriately respond to include level of health literacy, experiences of pain (including previous experience with BPG injections), knowledge and beliefs about secondary prophylaxis, expectations of health services, and recognition of ARF recurrence.

Multidisciplinary teams should provide clear and consistent health messaging to patients about the importance of secondary prophylaxis, and its role in preventing recurrent ARF and avoiding or delaying the development of RHD. Providing culturally appropriate education is emphasised at the time of diagnosis (See Chapter 7. Management of ARF, Education), however, effective, engaging and age-appropriate educational opportunities need to be repeated. Each time the patient and family encounter the health system for secondary prophylaxis is an opportunity to provide relevant education. This should include:

- Respecting and acknowledging the family's beliefs about what causes disease.
- Opportunities for two-way knowledge exchange.
- Use of trained interpreters to aid communication between clinicians and their patients where English is not the primary language.
- Information about primordial prevention of Strep A infections.
- Information about ARF and RHD, the reason for BPG injections, and the importance of receiving each injection on time.
- Discussions about the patient's injection experience, duration of the prescribed regimen and proposed cease date (date to cease may change based on recurrent ARF and RHD status) (Table 10.3).
- Discussions about recognising and responding to Strep A infections, and symptoms of ARF.

A range of resources are available to guide health education, supporting people of different ages, gender and language. (See HealthInfoNet, and Menzies resources)

Adolescent care

Most people receiving secondary prophylaxis injections will be pre-teens, adolescents and young adults. Several studies have shown delivery of secondary prophylaxis decreases when children reach adolescence.[91-93] To help provide support at this critical time, members of the health workforce need to have a good understanding of adolescent health needs around ARF, RHD and secondary prophylaxis. Patient support navigators also provide an effective bridge between Indigenous peoples and western biomedical healthcare.[94]

Adolescents should be involved in the planning, monitoring and evaluation of health series and decisions regarding their own care. Where possible, they should have shared decision-making about where and how to receive BPG injections.

Chronic illness in children and adults can have lifelong physical and psychological impacts. ARF even without RHD is a 'chronic disease' due to the long-term nature of secondary prophylaxis, and the complicated care plan and engagement with the health system.[93] Health services that acknowledge adolescent health needs and embrace the concept of 'transition care' are likely to achieve better delivery of secondary prophylaxis.[95] Child and adolescent-friendly spaces within health services are a tangible way of supporting this. Tracking the development of children and adolescents within a clinic's RHD program, including how they are coping with their injections and what they understand about their condition, helps to provide responsive health care (Table 11.4). Nurse care navigators are beneficial for both patients and clinicians,[94] however, supporting people with complex needs requires resilience.[96]

A systematic review[97] of regular injections in children and adolescents for various conditions, found several common themes including ease of injection use (preparation and delivery), tolerability of injection (levels of pain and impact at the injection site), relationship between home and health services, and impact on daily life (including frequency of injections). These factors drove patient and staff preference for devices and regimens. Adolescents showed a greater desire to switch to a lower frequency injection schedule. These results provide an insight into how young people, their carers, and health workers feel about regular injection delivery.

Measuring BPG injection adherence

Delivery of BPG for individual patients can be measured as a percentage, and calculated as follows:

$$\text{Percent (\%) delivered} = \frac{\text{number of doses administered}}{\text{number of doses recommended}} \times 100$$

This can be expressed as an annual measure, or shorter if the patient has not yet been receiving BPG for 12 months.

While percent is the simplest way to calculate injections delivered and is easy to comprehend, the measure does not take account of dose timing. For example, 100% delivery can be achieved by someone on a 28-day regimen who receives 13 doses in 12 months given on time, every time. If some doses are delivered at short intervals while having longer breaks between other doses, the person is vulnerable to Strep A infection and ARF recurrence during the late days. Therefore, to estimate an individual's adherence more precisely, a calculation of *days at risk* provides a better estimate.

Days at risk for a 28-day regimen are the number of days after day 28 and before the next dose is administered. If the next dose is given on day 32, there are 4 *days at risk*.

Days at risk for a 21 day regimen are the number of days after day 21 and before the next dose is administered. If the next dose is given on day 27, there are 6 *days at risk*.

In a comparison of the association between different measures of injection delivery and ARF recurrence risk, total *days at risk* was the strongest predictor of ARF recurrence.[98] It is recommended that calculation of days at risk be included in program reporting as well as percent delivered. The reason to calculate and report both is that while *days at risk* is more precise and more predictive of ARF recurrence risk, it can be difficult to calculate and interpret.

Recall for injection

Depending on social circumstances and methods used for reminders, patients may benefit from receiving recall reminders in the week leading up to their next due date for BPG. This recall starts from day 21 for people receiving a 28-day regimen and from day 14 for people receiving a 21-day regimen. This minimises the risk of injections being delivered late. Over-dosage due to early administration is not of concern since the serum concentrations achieved are low. Calculation of *days at risk* for ARF recurrence allows healthcare services to be alerted to late doses to ensure patient recall.

To minimise days at risk, patients prescribed a 28-day regimen should be recalled between day 21 and 28 to allow adequate time for patients to attend for their injection.

Local knowledge should be sought to document in advance the locations where patients are likely to live and visit for social, economic, cultural and other reasons. Health service networking between these sites should be intentional and collaborative around delivery of secondary prophylaxis.

Patient and family support strategies

Secondary prophylaxis support strategies should be informed by local knowledge of barriers to treatment. Some factors vary widely from one health service to another (wait times, triage processes, accessibility of the clinic); other factors are universal (the time commitment required to attend clinic, needle-related factors). Support can be broadly categorised into health centre-related approaches, community-level approaches, patient-level approaches and treatment-specific approaches.

Table 10.6. Strategies to improve the delivery of secondary prophylaxis

SUPPORT CATEGORY	EXAMPLES OF STRATEGIES
Health centre-related approaches	Health services imbed secondary prophylaxis strategies into existing programs including: • Prioritising secondary prophylaxis delivery • Ensuring that staff are skilled in injection delivery techniques • Providing care that is culturally safe • Using proactive, register-based recall systems to ensure patients are recalled for their next dose and given adequate notice • Having strategies in place to respond to overdue or missed injections • Providing options for outreach (home-based / school-based) injection delivery when feasible Liaising with other health services to help support continuation of care for patients who travel between regional areas.
Community-level approaches	Community awareness-raising events are supported Local peer support groups are established
Patient-level approaches	Self-management support with family and community engagement is provided ARF and RHD educational materials are suitable for the target audience e.g. in the patient's local language; provided in audio or video format BPG dose reminder systems are used, such as: • Smartphone application • Electronic or paper calendar Incentives are considered
Condition and therapy-specific approaches	Validated methods such as 'transition care' are used to support chronic care management from childhood through to adolescence and adulthood Non-pharmacological techniques are employed to improve the experience of BPG injection Pharmacological techniques are used when needed, and in addition to non-pharmacological approaches

RHD program oversight

Attending a health service for injections every few weeks may be inconvenient for people who work or attend school. Wherever possible, patients should be offered the opportunity to receive their injections at a location of their choice (e.g. at the health service, home, workplace, school).

Culturally competent, experienced staff should be appointed to deliver local secondary prophylaxis programs, and staff who are competent to administer BPG injections to children and adolescents within a culturally safe framework should be identified. Clinician expertise and confidence in administering BPG injections can be improved and maintained by continuing professional development, observing local protocols for injection delivery, and by working directly with patients and their preferences.

In a health system environment of frequent clinician turnover and high deployment of agency staff, health service managers have a responsibility to ensure governance and oversight of local RHD portfolios and to promote a whole-of-team approach to delivery of secondary prophylaxis.

Administration of each injection needs to be recorded at primary care level and reported to the jurisdictional RHD register (where it exists, see Table 13.1). Information on BPG delivery should be recorded in a centralised database, so that health staff can monitor injection delivery and make informed clinical decisions. This is especially important in settings where multiple patient information systems are used in parallel.

Patients require clear information about where they can receive secondary prophylaxis, details about the date and location of future appointments, and contact details for their local health centre or hospital. Patients and families should be encouraged to phone or visit their local health service or hospital if they have any questions concerning their follow-up or secondary prophylaxis.

Unsuccessful secondary prophylaxis delivery

In 2022, 43% of all people prescribed BPG on Australian registered received less than 50% of their injections, including 10% who received no injections.[27] Lower rates of secondary prophylaxis delivery are seen in urban centres, and males are slightly less likely than females to receive all prescribed injections.[27] Unsuccessful secondary prophylaxis delivery can be defined as:

- **Short term**, where the patient misses or declines 1–2 scheduled injections;
- **Medium term**, during which the patient misses or declines scheduled injections for a period of months;
- **Enduring**, when the patient rejects secondary prophylaxis as a treatment method.

Where patients miss or decline injections in the short or medium term, health staff and First Nations Community Workers should work with the patient and family to identify and address any manageable factors that may be contributing to unsuccessful secondary prophylaxis delivery (Table 10.6).

Where patients reject secondary prophylaxis as a treatment method to prevent ARF, a high level of support is required. A multidisciplinary supportive network should be engaged to ensure that the patient is aware of the risks of non-treatment, and regular patient monitoring should be scheduled to determine ongoing risk of Strep A infections, recurrent ARF, and the development or progression of RHD. Patients should continue to be offered secondary prophylaxis treatment as indicated.

Patients miss and decline secondary prophylaxis for many reasons which may be within or outside their control.[92] Where secondary prophylaxis is refused; health staff should support patients and their families within a culturally supportive framework.[99,100]

CASE STUDY

Children receiving BPG injections need a supportive and culturally safe environment in which they have some control over how they receive injections.

Background

The Happy Heart Clinic was established at Cairns Regional Hospital, Queensland in 2019 to support children requiring BPG injections. The clinic caters specifically for children who have difficulty receiving injections or experienced psychological trauma from previous injections. The aim of the clinic is to provide a positive experience with injections in a patient-focused, culturally safe, and supported environment to improve the child's confidence and involvement in care.

Model of care

This clinic was developed in collaboration with children and their families and primary care services throughout the Cairns and Hinterland and Torres and Cape Health Service districts. The clinic was designed and is run by First Nations Health Workers and a nurse, with support from a Paediatric Cardiologist. Children design their own "game plan" which guides their injection experience.

1. Children are referred to the clinic by other health services.
2. For each injection, the child works with the RHD nurse to decide on the method of pain management (such as numbing cream, ice pack, Buzzy®, Entonox), distraction techniques (such as an electronic device, distraction box, talking and deep breathing) support people involved, position during injection, and preferred site of injection.
3. The whole process is not time-pressured; the process moves at the child's pace.
4. Staffing at the clinic is consistent. This means that children are cared for by people they know and with whom they have developed a relationship.
5. Children and their families help make decisions about how the clinic provides care.

Results

As of October 2024, the clinic has supported 30 children aged between 4 and 17 years.

Children previously receiving no injections have increased to 100% their injections, and almost all continue to receive 100% of injections. Assistance with transport is provided to some families, and children have options for ice packs, cold spray, topical anaesthetic cream, Buzzy®, virtual reality goggles and Entonox.

Resources developed by the clinic are being rolled out Australia-wide to support children and clinicians with therapeutic Bicillin injections.

REFERENCES

1 Carapetis JR, Steer AC, Mulholland K, Weber M. The global burden of group A streptococcal diseases. The Lancet Infectious Diseases 2005;5(11):685-694.

2 Steer A, Carapetis JR. Prevention and treatment of rheumatic heart disease in the developing world. Nature Review Cardiology. 2009;B(11):689-698.

3 Woods JA, Katzenellenbogen JM. Adherence to Secondary Prophylaxis Among Patients with Acute Rheumatic Fever and Rheumatic Heart Disease. Current Cardiology reviews. 2019;15(3):239-241.

4 World Health Organization. Adherence to long-term therapies: evidence for action. Geneva Switzerland, 2003.

5 Pfizer Consumer Information Bicillin® L-A. 11 September 2018.

6 World Health Organization. Rheumatic fever and rheumatic heart disease: report of a WHO expert consultation, Geneva, 29 October–1 November 2001. WHO Technical Report Series 923 2004 .

7 Mataika R, Carapetis JR, Kado J, Steer AC. Acute rheumatic fever: an important differential diagnosis of septic arthritis. Journal of Tropical Pediatrics. 2008;54(3):205-207.

8 Gerber M, Baltimore RS, Eaton CB, et al. Prevention of rheumatic fever and diagnosis and treatment of acute streptococcal pharyngitis: a scientific statement from the American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee of the Council on Cardiovascular Disease in the Young, the Interdisciplinary Council on Functional Genomics and Translational Biology, and the Interdisciplinary Council on Quality of Care and Outcomes Research: Endorsed by the American Academy of Pediatrics. Circulation. 2009;119(11):1541-1551.

9 Anderson A, Mills C, Rentta N, et al. 2025. Aotearoa New Zealand Guidelines for the Prevention, Diagnosis, and Management of Acute Rheumatic Fever and Rheumatic Heart Disease: 2024 Update. Wellington: Health New Zealand | Te Whatu Ora.

10 Kaplan E, Berrios X, Speth J, et al. Pharmacokinetics of benzathine penicillin G: serum levels during the 28 days after intramuscular injection of 1,200,000 units. Journal of Pediatrics. 1989;115(1):146-150.

11 de Dassel JL, Malik H, Ralph AP, et al. Four-weekly benzathine penicillin G provides inadequate protection against acute rheumatic fever for some children (in Australia's Northern Territory). American Journal of Tropical Medicine and Hygiene. 2019;100(5):1118-1120.

12 Hand RM, Salman S, Newall N, et al. A population pharmacokinetic study of benzathine benzylpenicillin G administration in children and adolescents with rheumatic heart disease: new insights for improved secondary prophylaxis strategies. Journal of Antimicrobial Chemotherapy. 2019;74(7):1984-1991.

13 Ginsburg C, McCracken G Jr, Zweighaft TC. Serum penicillin concentrations after intramuscular administration of benzathine penicillin G in children. Journal of Pediatrics. 1982;69(4):452-454.

14 Meira Z, Mota Cde C, Tonelli E, et al. Evaluation of secondary prophylactic schemes, based on benzathine penicillin G, for rheumatic fever in children. Journal of Pediatrics. 1993;123(1):156-158.

15 Manyemba J, Mayosi BM. Penicillin for secondary prevention of rheumatic fever (Review). Cochrane Database of Systematic Reviews. 2002;(3): CD002227

16 Division of Drug Management and Policies (World Health Organization). WHO model prescribing information. Drugs used in the treatment of streptococcal pharyngitis and prevention of rheumatic fever. 1999, World Health Organization: Geneva.

17 Bonow R, Carabello BA, Chatterjee K, et al. ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (writing committee to revise the 1998 guidelines for the management of patients with valvular heart disease) developed in collaboration with the Society of Cardiovascular Anesthesiologists endorsed by the Society for Cardiovascular Angiography and Interventions and the Society of Thoracic Surgeons. Journal of the American College of Cardiology. 2006;48(3):e1-e148.

18 Stacey I, Ralph A, de Dassel J et al. The evidence that rheumatic heart disease control programs in Australia are making an impact. Australian and New Zealand Journal of Public Health. 2023;47:100071.

19 Lawrence JG, Carapetis JR, Griffiths K, et al. Acute Rheumatic Fever and Rheumatic Heart Disease: Incidence and Progression in the Northern Territory of Australia, 1997 to 2010. Circulation. 2013;128(5):492-501.

20 He VY, Condon JR, Ralph AR, et al. Long-Term Outcomes from Acute Rheumatic Fever and Rheumatic Heart Disease. A Data-Linkage and Survival Analysis Approach. Circulation 2016;134(3):222-232.

21 Katzenellenbogen JM, Bond-Smith D, Seth RJ, et al. Contemporary Incidence and Prevalence of Rheumatic Fever and Rheumatic Heart Disease in Australia Using Linked Data: The Case for Policy Change. J Am Heart Assoc. 2020;9(19):e016851.

22 Alvan R. Feinstein AR, Spagnuolo M. Mimetic features of rheumatic fever recurrences. N Engl J Med 1960;262:533-540.

23 Sheikh AM, Sadiq M, Rehman AU. Changing clinical profile of acute rheumatic fever and rheumatic recurrence. J Ayub Med Coll Abbottabad. 2016;28(1):141-145.

24 Holland JV, Hardie K, de Dassel J, Ralph AP. Rheumatic Heart Disease Prophylaxis in Older Patients: A Register-Based Audit of Adherence to Guidelines. Open Forum Infectious Diseases. 2018;5(6):ofy125.

25 RHDAustralia (ARF/RHD writing group), National Heart Foundation of Australia and the Cardiac Society of Australia and New Zealand. Australian guideline for prevention, diagnosis and management of acute rheumatic fever and rheumatic heart disease (2nd edition). 2012

26 Agnew J, Wilson N, Skinner J, Nicholson R. Beyond first-degree heart block in the diagnosis of acute rheumatic fever. Cardiology in the Young. 2019;29(6):744-748.

27 Australian Institute of Health and Welfare. Acute rheumatic fever and rheumatic heart disease in Australia. Cat. no: CVD 100. Australian Institute of Health and Welfare, Canberra, 2024.

28 Australian Government. Benzathine benzylpenicillin tetrahydrate - medicine shortage information. (Accessed 8 May 2024)

29 Menzies School of Health Research. Preparation and dosing of long-acting s19A benzathine benzylpenicillin BRANCASTER product. 2023. (Accessed 8 May 2024)

30 Kassem A, et al. Guidelines for management of children with rheumatic fever (RF) and rheumatic heart disease (RHD) in Egypt, The Egyptian Society of Cardiology and the Egyptian Society of Pediatric Cardiologists: Alexandria.

31 Feinstein A, Wood HF, Epstein JA, et al. A controlled study of three methods of prophylaxis against streptococcal infection in a population of rheumatic children. Results of the first three years of the study, including methods for evaluating the maintenance of oral prophylaxis. New England Journal of Medicine. 1959;260(14):697-702.

32 Wood H, Feinstein AR, Taranta A, et al. Rheumatic fever in children and adolescents. A long term epidemiological study of subsequent prophylaxis, streptococcal infections and clinical sequelae. III. Comparative effectiveness of three prophylaxis regimes in preventing streptococcal infections and rheumatic recurrences. Annals of Internal Medicine. 1964;60(S5):31-46.

33 Dajani A. Adherence to physicians' instructions as a factor in managing streptococcal pharyngitis. Pediatrics. 1996;97(6):976-980.

34 Nicoll JH, Hesby A. Intramuscular injection: an integrative research review and guideline for evidence-based practice. Applied Nursing Research. 2002;16(2):149-162.

35 Brown J, Gillespie M, Chard S. The dorso-ventro debate: in search of empirical evidence. British Journal of Nursing. 2015;24(22):1136-1139.

36 Stephenson M. Evidence Summary. Intramuscular Injection: Site Selection. The Joanna Briggs Institute EBP Database, JBI@Ovid. 2019; JBI20991.

37 Balci S, Sivri BB. Comparison of pain levels developed during intramuscular injections to laterofemoral and ventrogluteal regions in children: a randomized controlled study. Rev Assoc Med Bras (1992). 2023;69(1):85-89.

38 Coskun H, Kilic C, Senture C. The evaluation of dorsogluteal and ventrogluteal injection sites: a cadaver study. J Clin Nurs. 2016;25(7-8):1112-1119.

39 Roldán-Chicano MT, Rodríguez-Tello J, Cebrián-López R, et al. Adverse effects of dorsogluteal intramuscular injection versus ventrogluteal intramuscular injection: A systematic review and meta-analysis. Nurs Open. 2023;10(9):5975-5988.

40 Ogston-Tuck S. Intramuscular injection technique: an evidence-based approach. Nursing Standard. 2014;29(4):52-59.

41 Dulong C, Brett K, Argáez C. Skin Preparation for Injections: A Review of Clinical Effectiveness, Cost-Effectiveness and Guidelines [Internet]. Ottawa (ON): Canadian Agency for Drugs and Technologies in Health; 2020.

42 World Health Organization. Best Practices Injections and Related Procedures Toolkit. WHO. 2010.

43 Mitchell AG, Belton S, Johnston V, et al. Aboriginal children and penicillin injections for rheumatic fever: how much of a problem is injection pain? Australian and New Zealand Journal of Public Health. 2018;42:46-51.

44 Royal Australasian College of Physicians. Management of Procedure-related Pain in Children and Adolescents. Journal of Paediatrics and Child Health. 2006;42:S1-S2.

45 Coyne I, Scott P. Alternatives to restraining children for clinical procedures. Nursing Children and Young People. 2014;26(2):22-27.

46 Leroy P, Costa L, Emmanouil D, et al. Beyond the drugs: nonpharmacologic strategies to optimize procedural care in children. Current Opinion in Anaesthesiology. 2016;29(1):S1-S13.

47 Hartling L, Milne A, Foisy M, et al. What Works and What's Safe in Pediatric Emergency Procedural Sedation: An Overview of Reviews. Academic Emergency Medicine. 2016;23:519-530.

48 Uman LS, Chambers CT, McGrath PJ, et al. Psychological interventions for needle-related procedural pain and distress in children and adolescents. Cochrane Database of Systematic Reviews. 2006;18:(4):CD005179.

49 Melzack R, Wall P. Pain mechanisms: A new theory. Science. 1965; 150(3699):971-979.

50 Russell K, Nicholson R, Naidu R. Reducing the pain of intramuscular benzathine penicillin injections in the rheumatic fever population of Counties Manukau District Health Board. Journal of Paediatrics and Child Health. 2014;50:112-117.

51 Kearl Y, Yanger S, Montero S, et al. Does Combined Use of the J-tip® and Buzzy® Device Decrease the Pain of Venipuncture in a Pediatric Population? Journal of Pediatric Nursing. 2015;30(6):829-833.

52 Canbulat-Sahiner N, Turkmen AS, Acikgoz A, et al. Effectiveness of Two Different Methods for Pain Reduction During Insulin Injection in Children with Type 1 Diabetes: Buzzy and ShotBlocker. Worldviews on Evidence Based Nursing. 2018;15:464-470.

53 Thomas N, Andrews R, Kaur S, et al. Needle temperature and pain perception in the treatment of rheumatic heart disease. British Journal of Cardiac Nursing. 2019;14(3):134-138.

54 Chan E, Foster S, Sambell R, Leong P (2018) Clinical efficacy of virtual reality for acute procedural pain management: A systematic review and meta-analysis. PLOS ONE 13(7):e0200987.

55 Chan E, Hovenden M, Ramage E, et al. Virtual Reality for Pediatric Needle Procedural Pain: Two Randomized Clinical Trials. The Journal of Pediatrics. 2019;209:160-167.

56 Pelone F, Kwok B, Ahmed S, et al. Local anaesthetic to reduce injection pain in patients who are prescribed intramuscular benzathine penicillin G: a systematic review and meta-analysis. 2024;76:102817.

57 Amir J, Ginat S, Choen YH, et al. Lidocaine as a diluent for administration of benzathine penicillin G. Pediatric Infectious Disease Journal. 1998;17(10):890-893.

58 Fiji Guidelines for Acute Rheumatic Fever and Rheumatic Heart Disease Diagnosis Management and Prevention. Fiji Ministry of Health; 2017.

59 Zeydi AE, Khezri HD. Can lidocaine be safely used to reduce pain caused by intramuscular penicillin injections? A short literature review. Oman Medical Journal. 2012;27:337.

60 Briggs GG, Freeman RK, Yaffe SJ. Drugs in Pregnancy and Lactation: A Reference Guide to Fetal and Neonatal Risk, 9th Edition. Philadelphia: Lippincott Williams & Wilkins; 2011.

61 Schaefer C, Paul W J, Peters PWJ, Miller RK, (Editors). Drugs during pregnancy and lactation (Second Edition) Analgesics, Antiphlogistics and Anesthetics. Academic Press; 2007

62 The Royal Women's Hospital. Pregnancy and breastfeeding medicines guide. Melbourne. Australia. 2010.

63 Hale TW, Rowe HE. Medications and Mothers' Milk 2014, 16th Edition. USA: Loke YC Hale Publishing; 2014.

64 Douglas Pharmaceuticals Ltd. Australian Product Information – Penthrox®(Methoxyflurane) Inhalation. 2023 (Accessed 4 October 2024)

65 Dias AV, Zeidan Z, Copp M, et al. Penthrox Is an Effective Analgesic but Is It Patient Approved? Cureus. 2024;16(2):e53537.

66 Gray Stephens C, Dias A, Skinner E, Brennan C, et al. Penthrox enables quicker management of fractures, dislocations and more: learning lessons from expedited care of trauma patients during the COVID-19 pandemic. Ann R Coll Surg Engl. 2023;105(S2):S22-S27.

67 Short duration Entonox® for administration of Benzathine Penicillin (Bicillin). Torres and Cape Hospital and Health Service, Queensland Government, Australia. 28 March 2017

68 Pedersen RS, Bayat A, Steen NP, Jacobsson ML. Nitrous oxide provides safe and effective analgesia for minor paediatric procedures--a systematic review. Dan Med J. 2013;60(6):A4627.

69 Basker S, Singh G, Jacob R. Clonidine in paediatrics - a review. Indian Journal of Anaesthesia. 2009; 53(3):270-80.

70 Lexicomp. Clonidine: Pediatric drug information. UpToDate® 2019

71 Mitchell A, Kelly J, Cook J, et al. Clonidine for pain-related distress in Aboriginal children on a penicillin regimen to prevent recurrence of rheumatic fever. Rural Remote Health. 2020;20(4):5930.

72 Personal communication, December 2019. Dr John Kelly and Natalie Atkinson, Laynhapuy Homelands Aboriginal Corporation Health Service, Northern Territory, Australia. Dr Brian Spain, Royal Darwin Hospital, Northern Territory, Australia. Dr Alice Mitchell, Menzies School of Health Research, Northern Territory, Australia.

73 Lagacé-Wiens P, Rubinstein E. Adverse reactions to β-lactam antimicrobials. Expert Opinion on Drug Safety. 2012;11:381-399.

74 International Rheumatic Fever Study Group. Allergic reactions to long-term benzathine penicillin prophylaxis for rheumatic fever. Lancet. 1991;337(8753):1308-1310.

75 Markowitz M, Hung-Chi L. Allergic reactions in rheumatic fever patients on long-term benzathine penicillin G: the role of skin testing for penicillin allergy. Pediatrics. 1996;97(6):981-983.

76 Blumenthal KG, Peter JG, Trubiano JA, Phillips EJ. Antibiotic allergy. The Lancet. 2019;393(10167):183-q98.

77 Weiss M, Adkinson NF. Immediate hypersensitivity reactions to penicillin and related antibiotics. Clin Exp Allergy. 1988;18(6):515-540.

78 Antibiotic Expert Group, Therapeutic guidelines: antibiotic. Vol. 15. 2014. Melbourne: Therapeutic Guidelines Limited.

79 Devchand M, Urbancic KF, Khumra S, et al. Pathways to improved antibiotic allergy and antimicrobial stewardship practice: The validation of a beta-lactam antibiotic allergy assessment tool. The Journal of Allergy and Clinical Immunology: In Practice. 2019;7(3):1063-1065.

80 Kaya A, Erkoçoğlu M, Senkon OG, et al. Confirmed penicillin allergy among patients receiving benzathine penicillin prophylaxis for acute rheumatic fever. Allergologia et Immunopathologia. 2014;42(4):289-292.

81 Francis JR, Wyber R, Remenyi B, et al. Myositis complicating benzathine penicillin-G injection in a case of rheumatic heart disease. IDCases. 2016;4: 6-7.

82 Sanyahumbi A, Ali S, Benjamin IJ, et al; American Heart Association. Penicillin Reactions in Patients With Severe Rheumatic Heart Disease: A Presidential Advisory From the American Heart Association. J Am Heart Assoc. 2022;11(5):e024517.

83 Devchand M, Trubiano JA. Penicillin allergy: a practical approach to assessment and prescribing. Aust Prescr. 2019;42(6):192-199.

84 Wyber R, Taubert K, Marko S, Kaplan EL. Benzathine Penicillin G for the Management of RHD: Concerns About Quality and Access, and Opportunities for Intervention and Improvement. Global Heart. 2013;8(3):227-234.

85 Marantelli S, Hand R, Carapetis J, et al. Severe adverse events following benzathine penicillin G injection for rheumatic heart disease prophylaxis: cardiac compromise more likely than anaphylaxis. Heart Asia. 2019;11(2):e011191.

86 Central Australian Rural Practitioners' Association (CARPA) Editorial Committee. CARPA Standard Treatment Manual, 7th ed. Alice Springs: Centre for Remote Health, Flinders University and Charles Darwin University; 2023.

87 RHDAustralia. Boss of My Body Checklist. 2021.

88 Department of Health Therapeutic Goods Administration. Medicines and TGA classifications. 2019.

89 Fox E, Misko J, Rawlins M, Manning L. The risk of intramuscular haematoma is low following injection of benzathine penicillin G in patients receiving concomitant anticoagulant therapy. Journal of Thrombosis and Thrombolysis 2020;50:237-238.

90 Tran HA, Chunilal SD, Harper PL, et al. An update of consensus guidelines for warfarin reversal. Medical Journal of Australia. 2013;198:198-199.

91 de Dassel JL, de Klerk N, Carapetis JR, Ralph A P. How Many Doses Make a Difference? An Analysis of Secondary Prevention of Rheumatic Fever and Rheumatic Heart Disease. Journal of the American Heart Association. 2018;7(24):e010223.

92 Kevat PM, Reeves BM, Ruben AR, Gunnarsson R. Adherence to Secondary Prophylaxis for Acute Rheumatic Fever and Rheumatic Heart Disease: A Systematic Review. Current Cardiology Reviews. 2017;13(2):155-166.

93 Ralph AP, de Dassel JL, Kirby A, et al. Improving Delivery of Secondary Prophylaxis for Rheumatic Heart Disease in a High-Burden Setting: Outcome of a Stepped-Wedge, Community, Randomized Trial. Journal of the American Heart Association. 2018;7(14):e009308.

94 Rankin A, Baumann A, Downey B, Valaitis R, Montour A, Mandy P. The Role of the Indigenous Patient Navigator: A Scoping Review. Can J Nurs Res. 2022;54(2):199-210.

95 Mitchell AG, Belton S, Johnston V, Ralph AP. Transition to adult care for Aboriginal children with rheumatic fever: a review informed by a focussed ethnography in northern Australia. Australian Journal of Primary Health. 2018;24(1):9-13.

96 Brown JA, Harvey CL, Byrne AL, Hegney DG. Nurse and midwife navigator resilience, well-being, burnout, and turnover intent: A multi-methods study. Public Health Nurs. 2024;41(1):77-89.

97 Ilievski J, Mirams O, Trowman R, et al. Patient preferences for prophylactic regimens requiring regular injections in children and adolescents: a systematic review and thematic analysis. BMJ Paediatr Open. 2024;8(1):e002450.

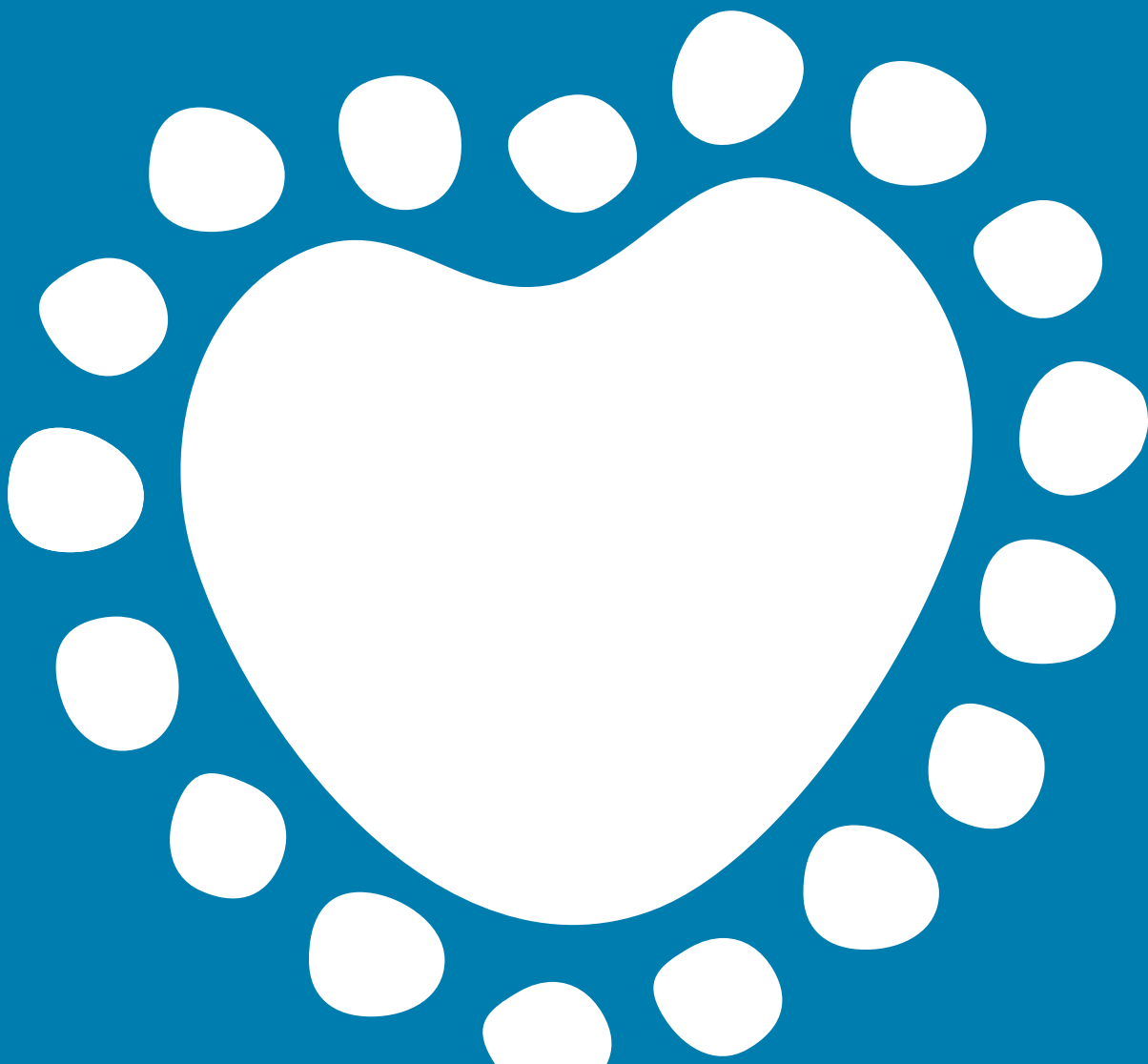
98 de Dassel J. Adherence to prophylactic penicillin and clinical outcomes for people with acute rheumatic fever and/or rheumatic heart disease in the Northern Territory of Australia. Darwin: Menzies School of Health Research Charles Darwin University; 2018.

99 Yadav M, Shah NA, Bhandari K, Iyer AG, et al. Socio-economic determinants influencing adherence to secondary prophylaxis in patients with rheumatic heart disease: a systematic review. Ann Med Surg (Lond). 2024;86(7):4092-4097.

100 Govender K, Müller A. Secondary Prophylaxis Among First Nations People With Acute Rheumatic Fever in Australia: An Integrative Review. J Transcult Nurs. 2023;34(6):443-452.

CHAPTER 11

Management of rheumatic heart disease



Management of rheumatic heart disease

IMPORTANT CHANGES IN THIS CHAPTER

Addition of Summary of recommendations with GRADE Level of Evidence (Table 11.1)

Integration of management recommendations for all stages of RHD based on 2023 WHF guidelines, Table 11.2. Priority classification and recommended follow-up (updated 2025)

Integrated evidence from INVICTUS trial regarding anticoagulation in AF and advanced MS (no change to recommendations)

(No change to the management of each individual valve lesion or indications for referral to surgery/heart team. These appear in line with ESC and AHA/ACC valvular heart disease guidelines)

Correction of Priority 1 and Priority 2 RHD Stage definitions in Table 11.2 (updated August 2025)

Addition of reference to Therapeutic Guidelines advice on dental procedures for dentists, available September 2025 (updated August 2025)

KEY INFORMATION

- Secondary prophylaxis is an integral aspect of the management of RHD.
- RHD is a notifiable disease in Western Australia, South Australia, Northern Territory, Queensland, New South Wales (for those aged <35 years) and Victoria.
- Anticoagulation in RHD:
  - Non-vitamin K antagonist oral anticoagulants (NOACs) are reasonable for patients with RHD and atrial fibrillation (AF) with an elevated CHA_2DS_2VA score, except in those with moderate or greater mitral stenosis (Table 11.5).
  - For patients with moderate or greater mitral stenosis and atrial fibrillation, warfarin is currently the only indicated oral anticoagulant.
  - Patients with a mechanical valve prosthesis require anticoagulation with warfarin, low molecular weight heparin or unfractionated heparin.
- All patients with RHD should have access to specialist paediatric and adult cardiology services.
- Coordinated transition from paediatric to adult services is imperative for young patients with ARF and/or RHD.
- Shared decision making with patients and their families can be fostered through approaches that address power differentials between healthcare providers and patients, including culturally safe communication styles and respect for Indigenous knowledges.
- First Nations Health Workers and Health Practitioners and remote area nurses should be consulted prior to surgery when applicable to provide an understanding of the patient's personal, social, economic and cultural situation that will likely determine which surgical option is best suited to that individual.
- Early engagement of a multidisciplinary heart team is essential in determining the appropriate choice and timing of intervention for patients with RHD.
- The decision between balloon valvuloplasty, repair, bioprosthetic and/or mechanical valve replacement needs to take into consideration the age at first operation, risks of anticoagulation, adherence, future pregnancy, and durability of valve repair and prosthesis.
- Choice of valve replacement for RHD:
  - Mechanical valve: proven durability, requires lifelong anticoagulation.
  - Bioprosthetic valve: does not require lifelong anticoagulation, limited durability, may enable future valve-in-valve procedure.
- Complications of RHD include atrial fibrillation, heart failure, infective endocarditis, thromboembolic events, pulmonary hypertension, prosthetic valve thrombosis and death.
- Mixed and multi-valvular disease is common in RHD and requires more frequent surveillance and follow-up.
- Regular oral healthcare and education may reduce the long-term risk of infective endocarditis (IE) for patients with RHD.
- All people with RHD require IE antibiotic prophylaxis prior to high-risk procedures.

Table 11.1. Summary of recommendations with GRADE Level of Evidence

RECOMMENDATION	GRADE
MITRAL VALVE DISEASE	
ACE inhibitors and beta-blockers are recommended in adults with mitral regurgitation and left ventricular systolic impairment.	1A
For adults with mitral regurgitation and hypertension, anti-hypertensive agents should be used, including early use of ACE inhibitors.	1A
Patients with severe mitral regurgitation and preserved LV systolic function who are symptomatic should be automatically referred for surgical management.	1B
Patients with asymptomatic significant mitral regurgitation and any of the following; LVEF <60%, LVESD >40mm, new onset AF, new PASP >50mmHg or child with enlarged indexed heart size should be referred for consideration of valve intervention.	1B
Patients with significant MR, favourable anatomy, and good adherence with secondary prophylaxis, who do not meet the above criteria for intervention may be considered for early surgery in centres with low perioperative mortality and high rates of successful mitral valve repair.	2C
The operation of choice for dominant or pure rheumatic MR is mitral valve repair.	1B
A reduction in heart rate may reduce symptoms of MS, even in patients in sinus rhythm.	1C
Diuretics may be used for symptomatic relief in patients with pulmonary congestion or right heart dysfunction secondary to significant mitral stenosis.	1C
The indication for mitral stenosis intervention is progressive symptoms associated with documented evidence of severe MS (Adults: mitral orifice area ≤1.5 cm^2, trans-mitral pressure half-time ≥150 ms, mean trans-mitral gradient ≥10 mmHg. Children: mitral orifice area ≤1.5 cm^2, PASP ≥50 mmHg).	1A
Asymptomatic patients with mitral stenosis may be considered for intervention if is a history of thromboembolism, paroxysmal AF or significant pulmonary hypertension (PASP >50 mmHg).	2B
Exercise stress echocardiography can help evaluate asymptomatic mitral stenosis or discordant echocardiography parameters. Limited exercise tolerance for age as well as significant elevation in trans-mitral mean gradient (>15 mmHg) or pulmonary artery systolic pressure (>60 mmHg) may indicate the need for intervention.	2B
The treatment of choice for dominant or pure mitral stenosis is percutaneous balloon mitral valvuloplasty.	1A
In the relatively few patients who are not suitable for percutaneous balloon mitral valvuloplasty, every effort should be made to repair the mitral valve, rather than replace it, especially if patients are in sinus rhythm.	1C
Mitral valve replacement may be necessary in heavily calcified valves, especially with sub-valvular involvement, or in those with significant mixed mitral valve disease.	1B
AORTIC VALVE DISEASE	
Antihypertensive therapy is recommended in adult patients with significant aortic regurgitation and systemic hypertension.	1B
Vasodilator therapy may aid in symptoms in patients with significant symptomatic aortic regurgitation with or without impaired LV systolic function.	2B
Patients with symptomatic severe aortic regurgitation should be referred for surgery, regardless of left ventricular systolic function.	1B
Asymptomatic patients with severe aortic regurgitation and reduced systolic function (LVEF < 50%) should be referred as soon as possible for valve surgery.	1B
Surgery should be considered in asymptomatic patients with severe aortic regurgitation and preserved left ventricular systolic function with severely dilated left ventricle (Adults: LVEDD >70 mm, LVESD >50 mm. Children: LVESD Z score >+4.0).	2B
Patients with asymptomatic aortic stenosis and hypertension should be treated as per standard guidelines, with frequent monitoring for side effects.	1B
Antihypertensives or diuretics should be used cautiously and with appropriate haemodynamic monitoring in patients with severe aortic stenosis who are normotensive, have clinical heart failure or have small LV cavity size.	1C

Table 11.1. Summary of recommendations with GRADE Level of Evidence (continued)

RECOMMENDATION	GRADE
Aortic valve replacement is recommended for severe symptomatic aortic stenosis (mean pressure gradient ≥40 mmHg, aortic valve area ≤1 cm^2, Vmax ≥4 m/sec).	1B
Patients with aortic stenosis with a moderate gradient with severely reduced aortic valve area should have further imaging including transoesophageal echocardiogram (TOE), CT or invasive haemodynamics to determine whether there is low flow, low gradient severe aortic stenosis.	2B
In patients with significantly impaired LV systolic function, dobutamine stress echo may help determine true severe aortic stenosis from pseudo-severe aortic stenosis.	2B
Patients with asymptomatic critical / very severe aortic stenosis, defined by a mean pressure gradient >50 mmHg or Vmax >5.5 m/sec, can be considered for surgery.	1C
TRICUSPID VALVE DISEASE	
Symptomatic relief of volume overload in severe tricuspid regurgitation is provided through use of diuretic therapy (frusemide, spironolactone).	1C
Severe symptomatic primary tricuspid regurgitation should be treated with surgical intervention.	1C
Severe tricuspid stenosis should be treated with surgery if symptomatic or in the setting of left-sided valve surgery.	1C
Intervention for minimally symptomatic severe primary or secondary tricuspid regurgitation may be warranted in the setting of progressive right ventricular dysfunction to prevent irreversible impairment.	2B
Functional progressive tricuspid regurgitation of moderate severity may be considered for surgery to coincide with a planned left-sided valve procedure.	2C
MIXED VALVE DISEASE	
In the setting of mixed or multi-valve disease, clinical symptoms and the nature of the predominant lesion should dictate the medical management and timing of cardiac intervention.	1C
Earlier surgery is preferred to avoid post-operative left ventricular dysfunction in patients with mixed valve disease.	2C
ATRIAL FIBRILLATION	
A CHA_2DS_2VA score of ≥2 points is associated with significantly elevated risk of thromboembolic event that can be reduced with the use of therapeutic anticoagulation.	1A
Anticoagulation should be considered in individuals with a score of 1.	1B
Anticoagulation is not recommended in individuals with a score of 0.	2B
Patients with atrial fibrillation and moderate or severe mitral stenosis (regardless of CHA_2DS_2VA score) or mechanical valve prostheses should be treated with warfarin.	1B
ANTICOAGULATION MANAGEMENT	
For patients with severe mitral stenosis in sinus rhythm and no history of atrial fibrillation, anticoagulation is indicated if there is a history of thromboembolic event or thrombus is visualised within the left atrium or left atrial appendage.	1B
Anticoagulation should be considered in those with severe mitral stenosis in sinus rhythm with significant spontaneous echo-contrast seen within the left atrium on echocardiography or significantly dilated left atrium.	2C
NOAC use in patients with significant mitral stenosis may be considered for specific cases where warfarin is contraindicated, and adherence has been demonstrated.	2D
Lifelong warfarin remains the only option for anticoagulation following implantation of a mechanical valve replacement.	1A
Patients receiving a bioprosthetic valve replacement may be treated with anticoagulation (warfarin) for the first one to three months post-surgery, as this has been demonstrated to be the highest risk period for thromboembolic events.	1C
For patients with thrombosis affecting a bioprosthetic valve, anticoagulation should be trialled before considering repeat surgery.	1C
Urgent surgery is recommended in critically ill patients with acute mechanical valve thrombosis.	1C

Table 11.1. Summary of recommendations with GRADE Level of Evidence (continued)

RECOMMENDATION	GRADE
For patients with acute mechanical valve thrombosis in locations where surgery is not immediately available or considered too high risk, thrombolysis should be considered.	2C
INFECTIVE ENDOCARDITIS PREVENTION	
Antibiotic prophylaxis is recommended for people with RHD undergoing specific dental, dermatological, musculoskeletal, respiratory, ENT, gastrointestinal and genitourinary procedures at high risk of bacteraemia that is associated with endocarditis.	1C
Amoxicillin is still appropriate for endocarditis prophylaxis in patients receiving long-term BPG injections for secondary prevention of ARF.	2D
All people with ARF and RHD need regular dental review to reduce the risk of infective endocarditis.	1C
Patients requiring cardiac intervention for RHD need a comprehensive dental consultation prior to surgery.	1C

Table 11.2. Priority classification and recommended follow-up (updated 2025)

DIAGNOSIS	RECOMMENDED FOLLOW -UP PLAN†
Priority 1 **Severe Stage C and all Stage D RHD**†‡ High risk post-valve surgery patients§ ≥3 episodes of ARF within the last 5 years Pregnant women with RHD (of any severity) may be considered Priority 1 for the duration of the pregnancy Children ≤5 years of age with ARF or RHD	Specialist review: at least 6 monthly Echocardiogram: at least 6 monthly Medical review: at least 6 monthly Pregnant: see Figure 12.1 for care pathway Dental review: within 3 months of diagnosis, then 6 monthly
Priority 2 **Moderate Stage C RHD**†‡ Moderate risk post-valve surgical patients§	Specialist review: 6 monthly – yearly Echocardiogram: 6 monthly – yearly Medical review: 6 monthly Dental review: within 3 months of diagnosis, then 6 monthly
Priority 3 **Any Stage A or Stage B RHD**†‡ ARF without carditis or RHD, currently prescribed secondary prophylaxis¶ Low risk post-valve surgical patients§	Specialist review: 1 – 3 yearly Echocardiogram: children ≤21 years: 1–2 yearly, >21 years: 2–3 yearly Medical review: yearly Dental review: yearly
Priority 4 **History of ARF**† (possible, probable or definite) and completed secondary prophylaxis **Resolved RHD** (including Stage A) and completed secondary prophylaxis††	Specialist referral: 1 year, 3 years and 5 years post cessation of secondary prophylaxis Echocardiogram: 1 year, 3 years and 5 years post cessation of secondary prophylaxis Medical review: yearly until discharge from specialist care and then as required Dental review: yearly or as required

† Frequencies in follow-up plans are based on RHD Severity Stage Category and can be varied and tailored to the individual in consultation between primary care and specialist teams. All patients should be given influenza vaccine annually and have completed pneumococcal vaccinations as per Australian Immunisation Handbook. Intervals for medical and specialist review and echocardiography are a guide and may vary for specific individuals. Medical and dental reviews may be combined with general health check-up. People with RHD require endocarditis prevention as indicated. (See Prevention of infective endocarditis).

‡ See Table 10.3 for definitions of RHD severity.

§ While post-surgical RHD is by definition severe RHD, post-surgical risk varies for individuals due to age, type of surgery, recurrence of ARF, adherence with secondary prophylaxis and other factors. Priority category for post-surgical RHD varies as listed in this Priority classification table and should be determined by specialist cardiologist/paediatrician/physician. (See Monitoring following valve surgery).

¶ See Table 7.1 regarding initial treatment of possible, probable and definite ARF with and without carditis. Table 10.3 provides guidance on longer term established RHD based on Stage of disease once the acute illness has resolved.

†† A proportion of early RHD changes can resolve with no residual valve dysfunction. These cases are referred to as 'resolved RHD' and as such may not need the longer-term follow-up required by Stage B/C/D disease.

NOTE: For Staging of RHD see Table 8.7. Staging of RHD as detected by echocardiography based on WHF 2023 guidelines.

Table 11.3. Summary of medical and surgical management options for specific advanced valve disease

VALVE DISEASE	MEDICAL THERAPY	INDICATIONS FOR CONSIDERATION OF INTERVENTION & REFERRAL TO HEART TEAM	VALVE INTERVENTION
Mitral Regurgitation (MR)	ACE inhibitor, beta-blocker and diuretic therapy in setting of heart failure. Antihypertensive medication in setting of hypertension.	Symptomatic severe MR Asymptomatic severe MR and: • LVEF ≤60% or • LVESD ≥40 mm or • New-onset AF or • New PASP ≥50 mmHg or • Child with enlarged indexed heart size	Valve repair (preferred intervention). If unable to be repaired, surgical valve replacement: • Bioprosthetic valve or • Mechanical valve
Mitral Stenosis (MS)	Beta-blockers (AF or sinus rhythm) or ivabradine (sinus rhythm) for symptom relief. Diuretics if evidence of pulmonary oedema/ congestion. Anticoagulation with warfarin if AF or high-risk features for thromboembolism present (See Monitoring anticoagulation).	Symptomatic severe MS Asymptomatic severe MS and: • Significantly elevated trans-mitral gradient or elevated PASP on EST or • New PASP ≥50 mmHg or • New-onset AF or • Cardio-embolic stroke	Percutaneous balloon mitral valvuloplasty (PBMV) if anatomically suitable. Closed or open surgical mitral valvotomy. Surgical valve replacement if not suitable for PBMV: • Bioprosthetic valve or • Mechanical valve
Aortic Regurgitation (AR)	Vasodilator therapy with ACE inhibitor, angiotensin receptor blocker or dihydropyridine calcium channel antagonist for symptom relief. Antihypertensive medication in setting of hypertension.	Symptomatic severe AR Asymptomatic severe AR and: • LVEF ≤50% or • LVESD >50 mm or • LVEDD >70 mm or • Child with enlarged indexed heart size	Aortic valve repair, if technically feasible. Surgical valve replacement: • Mechanical valve or • Bioprosthetic valve or • Homograft valve or • Ross procedure
Aortic Stenosis (AS)	Antihypertensive medication in setting of hypertension Cautious use of diuretic and afterload reduction in those with heart failure	Symptomatic severe AS Asymptomatic severe AS and: • LVEF <50% or • Abnormal EST or • Mean PG ≥60 mmHg or • Vmax ≥5 m/s or • PASP ≥60 mmHg	Surgical valve replacement or transcatheter valve replacement Decision based on surgical risk, age, anatomical assessment and heart team opinion
Tricuspid Regurgitation (TR)	Diuretic therapy for symptom relief from right heart failure and congestion	Severe primary TR Symptomatic severe secondary TR and absence of severe RV or LV dysfunction or severe pulmonary hypertension Asymptomatic or mildly symptomatic severe secondary TR with evidence of progressive RV dilatation or dysfunction Secondary moderate TR with annular dilatation in patients presenting for left-sided valve procedure	Valve repair / annuloplasty (preferred intervention) Surgical valve replacement: • Bioprosthetic valve or • Mechanical valve
Tricuspid Stenosis (TS)	Diuretic therapy for symptom relief from right heart failure and congestion	Symptomatic severe TS	Surgical valve replacement: • Bioprosthetic valve or • Mechanical valve

PASP: Pulmonary artery systolic pressure, AF: Atrial fibrillation, EST: Exercise stress test, LVEF: Left ventricular ejection fraction, LVEDD: Left ventricular end-diastolic diameter, LVESD: Left ventricular end-systolic diameter, PG: Pressure gradient, RV: Right ventricle.

DISCUSSION

"I was walking by his room and the door was open. He was standing there, looking in the mirror with his shirt off, staring at the scar running up the middle of his chest. He was just standing there crying. I said to him, 'What's wrong? What's wrong? I can't do anything to help if you won't tell me what's wrong with you.' He said, 'I hate the way I look, I hate this scar'."

RHD Champion, 2019.

Access to care

Access to specialist physician, paediatrician or cardiologist

The highest burden of RHD in Australia is within First Nations populations, many of whom live in rural and remote locations. It can be difficult and expensive for people living in remote areas to access specialist cardiac services, which are predominantly located in major towns and cities. Although there has been an expansion in specialist outreach services in Australia through programs such as Medical Specialist Outreach Assistance and Indigenous Outreach Assistance, access to adult and paediatric specialist care remains inadequate in many rural and remote areas.[1,2] Consistency of visiting specialists to remote communities is crucial, because it allows for therapeutic relationships to be developed in often culturally diverse and geographically challenging environments.

Holistic best-practice care prioritises effective clinical interactions and communication, two-way learning to upskill clinicians in patient needs and support patient health literacy and empowerment, local care navigation and patient support, shared decision making, and cultural safety.

Successful models of care have been developed in various remote locations across Australia. Cardiology outreach teams may consist of a specialist cardiologist, doctors-in-training, First Nations health staff and clinical nurse educators. The various models have been shown to be successful and impactful regarding the cardiac care of people living in rural and remote Australia.[2,3] Furthermore, telehealth consultation may improve access to specialist care[4,5] and is likely to be most effective when combined with face-to-face consultations. Ensuring adequate access to specialist services is vital to the management of RHD.[3]

Access to comprehensive cardiac services

The interventional cardiology and cardiothoracic surgical management of RHD in Australia is challenging. The number of patients undergoing procedures for RHD is relatively low compared with other forms of heart valve disease. Furthermore, there are social, cultural and geographical complexities that impact on the delivery of patient care. This means that few cardiothoracic and cardiology services have the opportunity to obtain the necessary experience, and skill sets to maintain a high level of expertise. The rapid progression of transcatheter and percutaneous valve intervention technology has led to the need for a multidisciplinary team approach to determine the best treatment for individual patients. This has led to the development of heart teams which have been shown to improve patient outcomes.[6,7] A heart team for RHD should include people with expertise in rheumatic and valvular heart disease such as cardiologists, cardiac surgeons, anaesthetists, allied health staff and, when indicated, intensive care physicians, infectious disease physicians and obstetricians.[7] Given the described challenges, it is recommended that the surgical management of RHD for First Nations peoples be concentrated in select locations in order to develop centres of excellence.

Of vital importance in Australia is the inclusion of First Nations Health Workers and Health Practitioners, nurses, Liaison Officers, and educators who are familiar with patients' social and cultural backgrounds. Early engagement of the heart team at dedicated centres of excellence is essential in determining the appropriate choice and timing of intervention for patients with RHD.

Accessible care for First Nations adolescents

The peak burden of ARF and RHD occurs in adolescents and young adults. It is therefore essential that primary care services are developmentally appropriate and accessible to young people. The World Health Organization (WHO) has defined eight standards for ensuring accessible and quality healthcare for adolescents (Table 11.5).

Primary healthcare services need to be culturally competent. Key features of a quality consultation with a young person include appropriate engagement, including language and the use of interpreters as needed; assuring confidentiality, trust and respect; and moving beyond the presenting complaint to explore broader aspects of health and well-being.

Engaging adolescents involves building rapport, trust and involving them in decisions about their health. This includes making a point of speaking with them rather than to their accompanying parent or guardian, and if possible, offering to see the young person alone as part of the consultation. Confidentiality is a particular barrier to young people accessing healthcare. Many adolescents will forgo healthcare around sensitive issues without a guarantee of confidentiality.[8] Additionally, with increasing maturity, young people have the right to make independent decisions and receive confidential healthcare.[9] Assuring confidentiality, and explaining when it may need to be breached, is critical. A quality consultation for a young person may involve exploring beyond the primary health issue. Other concerns may impact adversely on, or be more important to, the young person than RHD. Finally, it is important to use plain language to explain the diagnosis, and if possible, involve the young person in developing a management plan because this will likely enable better adherence and long-term engagement.

Transition from paediatric to adult cardiology services and care providers

The lack of well-coordinated transition of care can put patients at risk of being lost to follow-up and suffering preventable and significant morbidity. Cardiac services providing care for young people with RHD need to develop structured transition programs to prevent these avoidable negative outcomes.

Good transition care is well-planned and has a strong focus on building health literacy. Young people should be involved in the transition planning with adult specialists. They should be able to describe their condition, medications and treatments, follow-up schedule, and access help if required. Given these tasks, transition planning should begin early, perhaps years before the actual transfer of care occurs.

Primary healthcare providers, particularly First Nations Health Workers, and Health Practitioners and general practitioners, play an important role in providing continuity of care during the period of transition and transfer. A further consideration is that adult specialist services may provide a different scope of services than those provided by paediatric services. This may be particularly relevant in considering the transition needs of young people living with complex comorbidities and transition may involve several other care providers in addition to cardiologists.

Cultural considerations that relate to men's and women's business should be observed, especially when contraception and family planning is introduced.

Table 11.4. Standards for quality healthcare for adolescents[10]

Adolescents' health literacy	**Standard 1**. The health facility implements systems to ensure that adolescents are knowledgeable about their own health, and they know where and when to obtain health services. *Communication needs to be in the young person's first language.*
Community support	**Standard 2**. The health facility implements systems to ensure that parents, guardians and other community members and community organisations recognise the value of providing health services to adolescents and support provision and use of services by adolescents. *Some communities have strong and active youth programs.*
Appropriate package of services	**Standard 3.** The health facility provides a package of information, counselling, diagnostic, treatment and care services that fulfills the needs of all adolescents. Services are provided in the facility and through referral linkages and outreach. *Where possible, regular BPG injections should be provided through outreach with consideration of school, work, and family commitments.*
Providers' competencies	**Standard 4**. Healthcare providers demonstrate the cultural and technical competence required to provide effective health services to adolescents. Both healthcare providers and support staff respect, protect and fulfill adolescents' rights to information, privacy, confidentiality, non-discrimination, non-judgmental attitude and respect.
Facility characteristics	**Standard 5**. The health facility has convenient operating hours, a welcoming, safe, friendly and clean environment, and maintains privacy and confidentiality. It has the equipment, medicines, supplies and technology needed to ensure effective service provision to adolescents.
Equity and non-discrimination	**Standard 6.** The health facility provides quality services to all adolescents irrespective of their ability to pay, age, sex, marital status, education level, ethnic origin, sexual orientation or other characteristics. *There needs to be reference to men's and women's business and services that reflect this.*
Data and quality improvement	**Standard 7.** The health facility collects, analyses and uses data on service utilisation and quality of care, disaggregated by age and sex, to support quality improvement. Health facility staff are supported to participate in continuous quality improvement.
Adolescents' participation	**Standard 8.** Adolescents are involved in the planning, monitoring and evaluation of health services and in decisions regarding their own care, as well as in certain appropriate aspects of service provision.

This table has been adapted to include First Nations cultural considerations.

Secondary prevention with penicillin prophylaxis

A fundamental goal in long-term management of RHD is to prevent ARF recurrences and progression of disease with secondary antibiotic prophylaxis (Table 10.2). In cases of mild RHD, continuous antibiotic prophylaxis may also result in the resolution of heart disease.[11] Rheumatic valve disease following the first episode of ARF is often mild,[12,13] and with secondary prophylaxis, the majority of people with mild disease at diagnosis have no detectable disease within 5–10 years.[13-16] There are randomised control trial data demonstrating reduced risk of disease progression for Stage A and B RHD with the use of secondary prophylaxis which has informed the recommendations in these guidelines.

It is recommended that individuals with Stage A RHD be considered for secondary prophylaxis in combination with education regarding ARF/RHD and repeat echocardiography within 1-2 years of diagnosis. Subsequent cessation of secondary prophylaxis could be considered if there is resolution of the Stage A findings on follow-up echocardiography.[17]

Patients with moderate or severe disease at first presentation and those who suffer from recurrent ARF have poorer long-term outcomes, with a greater need for cardiac surgical intervention.[13,14,18] Patients with severe RHD at initial presentation may avoid cardiac surgery providing there is a high level of adherence to secondary prophylaxis.[19] Jurisdictional RHD registers and control programs can provide administrative data to support health services in ensuring adequate delivery and adherence to secondary prophylaxis.

MANAGEMENT OF VALVULAR HEART DISEASE

Medical management of valve disease

Many patients with RHD will have less than severe valvular disease which is asymptomatic or minimally symptomatic. These patients require routine follow-up to monitor for recurrence of ARF, progression of valve pathology and symptoms, and administration of secondary prophylaxis. Regular interaction with health services provides opportunity for preventative health care and continued education. Recommended follow-up periods are outlined in Table 11.2.

Shared decision making with patients and their families can be fostered through approaches that address power differentials between healthcare providers and patients, including culturally safe communication styles and respect for Indigenous knowledge.

Medical therapy plays a role in both preventing and treating complications of more advanced disease. Complications of RHD include atrial fibrillation, heart failure, endocarditis and thromboembolic events.[20] There is limited evidence regarding medical management of RHD, with a large focus on procedural intervention.[21,22] However, medical therapy can play a crucial role in preventing complications and ensuring that patients undergo procedural intervention at the most appropriate time.

Surgical management of valve disease

Surgical and percutaneous management of RHD is consistent with international valvular heart disease guidelines regarding indication, timing and choice of intervention.[7,8] The recommendations in this chapter are not an exhaustive list of indications for valve intervention but rather a summary relevant to patients with RHD. The final decision regarding surgical or percutaneous valve procedures should be made by the heart team who can appropriately apply international guidelines to the context of patients with RHD in Australia.

Surgical repair of rheumatic valvular disease is technically more difficult than non-rheumatic pathologies.[23,24] However, where possible, the mitral and aortic valves should be repaired, rather than replaced with prosthetic valves, especially for children and young adults.[7,25] There is increasing interest in conservation of native valve tissue in surgery for aortic valve disease but this is less well established compared to mitral valve repair techniques.[26,27] In certain cases of rheumatic disease, earlier intervention as compared to international guidelines may be recommended when valve repair is likely to be achieved and provide a durable long-term outcome. Additionally, selective repair of the mitral valve with conservative management of other valves with moderate disease may be suggested on the understanding that the patient is likely to require redo surgery in the future and thus enabling a less complicated subsequent operation.

There are significant challenges regarding valve replacement in younger patients, including rapid prosthesis degeneration, management of anticoagulation – particularly in women of child-bearing age, due to concerns of warfarin use during pregnancy (Table 12.2) – and young patients outgrowing a prosthesis.

If a valve is not able to be repaired, a decision between bioprosthetic and mechanical valve prosthesis needs to be made before the patient undergoes surgery, with consideration of adherence, geography, access to specialist follow-up, and cultural factors.

A bioprosthetic valve prosthesis has the benefit of not requiring long-term anticoagulation. However, it will have a limited durability, particularly in younger patients, resulting in an increased likelihood of repeat surgery.[28]

In the era of transcatheter valve implantation, valve-in-valve procedures may offer suitable options for the replacement of a degenerated bioprosthetic valve, to avoid repeat sternotomy.[29,30] A valve-in-valve procedure refers to percutaneous implantation of a transcatheter heart valve within an existing degenerated surgical (bioprosthetic) heart valve.

Since the 1990s, there has been a steep rise in the use of bioprosthetic valves.[31] Mechanical valve prostheses have the benefit of durability, however lifelong anticoagulation is required. The main complications of mechanical valves are bleeding, thromboembolic events, and valve thrombosis, usually due to problems with anticoagulation adherence.[31-33] Where possible, mechanical valves should be reserved for adult patients who are likely to be able to manage daily warfarin and routine follow-up. Long-term propensity-matched data comparing bioprosthetic versus mechanical prostheses have shown either equivalent survival or superiority of mechanical valves.[31,32,34] All valve prostheses are at risk of other complications such as endocarditis, thrombosis, dehiscence and haemolysis.

Australian experience in valvular intervention for RHD

A woman of child-bearing years who is in sinus rhythm but not suitable for valve repair, may need to be considered for bioprosthetic valve replacement to avoid the hazards of anticoagulation during pregnancy.

There are limited data available regarding the long-term outcomes of rheumatic valve surgery in Australia.[24,28,35-37] Patients with RHD tend to be younger and are more likely to be female compared to people undergoing surgery for non-RHD-related valve disease.[38] Surgical registry data suggest there has been an increasing trend in the use of bioprosthetic valves for RHD surgery.[38] This shows five and ten-year mortality following RHD valve surgery is 15% and 25% respectively. A small cohort study of valve surgery performed between 1992 and 2004 in First Nations patients reported freedom from reoperation at five years of 88%.[37] More recently, published data for mitral valve repair in children demonstrated 100% success of repair with quality survival rates to 15 years.[21] However, 72% had valve repair deterioration over the same time frame, highlighting the lifelong burden of RHD in a young population, including the need for repeat interventions. Data on redo cardiac surgery suggest that median time to requiring repeat valve surgery is six years amongst First Nations patients with prior valve repair or replacement.[28]

The morbidity associated with redo surgery in this cohort was lower for those with prior valve repair as compared to replacement. Recently published single-centre experience of transcatheter valve implantation within failing bioprosthetic mitral prostheses revealed encouraging results.[30] Long-term follow-up studies in Australia have shown a significantly poorer outcome for First Nations patients who have undergone valve surgery compared to non-Indigenous patients.[36,37,39] There are likely many factors contributing to this, including recurrence of ARF, problems with medication delivery, difficulties in providing follow-up specialist care to patients who may live in rural or remote communities, inadequate health literacy, and cultural and language barriers.[36,37,39,40]

Remote area nurses and First Nations Health Workers and Health Practitioners should be consulted prior to surgery to provide an understanding of the patient's personal, social, economic and cultural situation that will likely determine which surgical option is best suited to that individual.

Patient resources and education

The over representation of First Nations peoples requiring rheumatic valve surgery[24,35] emphasises the need to provide a surgical and interventional cardiology service that incorporates appropriate resources to inform patients, their families, and the First Nations health workforce that supports them. Such resources should include relevant disease information, discussion and informed consent regarding the risks and implications of valve intervention procedures. Interpreters should be available when required and written and visual resources should be provided in a patient's primary language. This helps ensure that the patient, their family and the surgical service understand the effect of the agreed treatment on future childbearing and physical and work activities, and the capacity for anticoagulation and long-term follow-up. A close partnership between the multidisciplinary primary healthcare team and specialist services is a prerequisite for the optimal care of patients with RHD.

First Nations Hospital Liaison Officers should be involved in care as early as possible, to help arrange accommodation and transport, and provide support with social and economic circumstances that could impede care.

Box 11.1. Factors to consider in selecting the nature and timing of valve interventions

Age at first operation, continued growth in children.

For women – future pregnancy and associated risk (Table 12.1).

Patient preference.

Adherence to regular secondary prophylaxis.

Access to anticoagulation monitoring and medications.

Adherence with medical therapy and anticoagulation.

Access to specialist follow-up – especially if previous valve repair.

Presence and severity of mixed and multi-valve disease.

Acceptability of redo surgery.

Comorbidities that would preclude patients from redo surgery.

Appropriateness for redo surgery using percutaneous valve-in-valve options.

Secondary indication for anticoagulation (e.g. atrial fibrillation).

Contraindications to anticoagulation
(e.g. prior significant bleeding complications or bleeding conditions).

Access to primary healthcare services.

When discussing valve choice with First Nations peoples, the following factors remain important:

- Family support.
- Patient preference and lifestyle.
- Culturally appropriate communication.
- Interpreters being used where English is not the preferred language.
- Involvement of the patient's local health care providers with knowledge of the patient and available health care services.

Mitral regurgitation

Medical management

Limited evidence from small studies of medical management of non-rheumatic primary mitral regurgitation shows conflicting results.[6,22] Traditionally, vasodilator drug therapy is considered potentially beneficial in primary significant MR. However, there is no evidence to support this in patients who are normotensive with preserved left ventricular systolic function.[6]

For adults with mitral regurgitation and left ventricular systolic impairment, recommended management is described in the Guideline for Prevention, Detection and Management of Heart Failure in Australia, including ACE inhibitors and beta-blockers.[1,41] Diuretic therapy is recommended in patients with clinical volume overload.[41] For adults with MR and hypertension, antihypertensive agents should be used in accordance with the Australian Guideline for the diagnosis and management of hypertension in adults, including early use of ACE inhibitors.[6]

Indications for surgery

Patients with severe MR and preserved LV systolic function who are symptomatic should be automatically referred for surgical management[6,7] (Figure 11.1). Patients who develop left ventricular dilatation (adults LVESD ≥40 mm) or impaired systolic function (ejection fraction [EF] ≥30% – <60%) have an increased surgical risk, less likelihood of restoring normal systolic function, and increased risk of late heart failure and death.[42-44] This also applies to people with significant pulmonary hypertension (pulmonary artery systolic pressure >50 mmHg)[43] and preoperative AF.[45-47] A critical LV end-systolic dimension has not been identified in children, however data suggest that surgery could be considered if LVESD or LVES volume Z score >+2.0 and is highly recommended if Z score >+3.0.[48] Therefore, it is recommended that in severe chronic MR, patients should be recommended for surgery once the above parameters are approached, rather than reached, regardless of symptomatic status.[6,7] This is especially important in children and young people in whom a high rate of successful repair, rather than replacement, is the aim. Patients with severe MR and severely impaired left ventricular systolic function (EF <30%) have poorer outcomes post-surgery. Whilst the threshold for intervention for children and adolescence is lower, valve intervention for adults with severe MR and an EF <30% is only indicated in those with symptoms refractory to medical therapy.[6,7]

The recommended guidelines in Figure 11.1 should be applied with a degree of flexibility. For example, patients with significant MR, favourable anatomy and good adherence with secondary prophylaxis, who do not meet the above criteria, may be considered for early surgery in centres with low perioperative mortality and high rates of successful mitral valve repair.[7]

As indications for surgery in asymptomatic patients are not always clear, it is important that patients with asymptomatic moderate or severe MR are referred to specialist heart teams early, so appropriate care plans can be arranged. This should take into consideration the clinical and echocardiographic findings, the patient's individual circumstances and findings of exercise testing.[6,7,21]

Mitral valve repair

The operation of choice for dominant or pure rheumatic MR is mitral valve repair.[25,49-51] Mitral valve repair has a lower operative risk and provides better preservation of LV systolic function.[52,53] Although there have been no randomised, comparative trials, more recent surgical experience has shown that the long-term results of mitral valve repair are at least equivalent or superior to those of mitral valve replacement in RHD.[24,25,35,51,54,55] This is attributable to avoidance of complications of anticoagulation and infection, with several series demonstrating similar durability to bioprosthetic valves.[56]

Valve repair for rheumatic MR is more technically demanding than repair of a degenerative mitral valve, and the long-term results are not as good.[57,58] Nevertheless, very acceptable results have been obtained in surgical centres that perform these operations regularly.[24,59,60] Centres specialising in repair of rheumatic MR in the paediatric population should aim to provide 100% success rates.[24]

In adults, the late reoperation rate is higher with mitral valve repair than bioprosthetic valve replacement, although in experienced centres reoperation can be carried out at low risk.[58] It is also higher in the First Nations populations than in other populations.[28,36,37] Long-term results will be affected by valve morphology, surgeon experience, age at first operation, and ARF recurrences.[61-63] Active carditis at the time of surgery is a major predictor of late valve failure and therefore, if clinically reasonable, surgery should be delayed until the ARF episode subsides.[59] Reoperation may require mitral valve replacement, but initial valve repair can delay the need for long-term anticoagulation for many years.

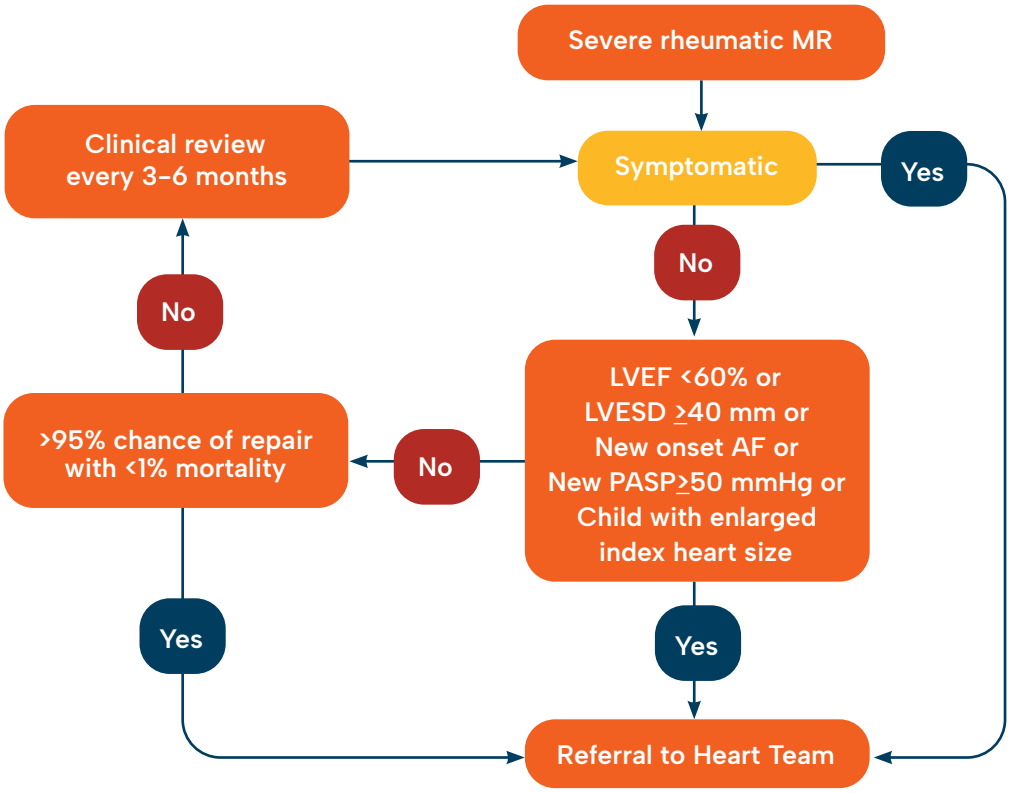


Figure 11.1. Rheumatic mitral regurgitation: indications for intervention

LVEF: left ventricular ejection fraction, LVESD: left ventricular end systolic dimension, PASP: pulmonary artery systolic pressure

Bioprosthetic mitral valve replacement

Some patients with rheumatic MR will not be suitable for valve repair due to particular valve morphology, including significant leaflet retraction, fibrosis or calcification. In these cases, valve replacement may be needed. Considerations for mechanical versus bioprosthetic valves are discussed earlier. After bioprosthetic valve replacement, most patients in sinus rhythm can be managed with only three months of anticoagulation.[64] The major disadvantage of bioprosthetic valves is their limited durability, especially in younger patients. It has previously been documented that structural valve degeneration occurs earlier, and is more common with mitral bioprosthetic valves than aortic bioprosthetic valves in younger patients.[65] More recent work looking at bioprosthetic valve replacement in young people with RHD from India has shown promising long-term event-free survival of 93% to 16 years.[66] Australian experience has shown that First Nations peoples required reoperation at a median of 6.5 years following initial bioprosthetic valve replacement and at a median age of 29.5 years.[28]

Mechanical mitral valve replacement

The advantage of mechanical valve prostheses is their long-term durability with low rates of failure.[31,67] However, lifelong anticoagulation with warfarin is necessary. Older patients who demonstrate good adherence with medical therapy may benefit from a mechanical prosthesis, avoiding the need for repeat surgery. Patients with tilting disc or bileaflet valves in the mitral position require a slightly higher target international normalised ratio (INR) of 3 (range: 2.5–3.5), compared to those in the aortic position (INR range 2–3).[6]

Mitral stenosis

Medical management

Significant mitral stenosis (MS) is associated with atrial arrhythmias, thromboembolic complications and congestive heart failure.[20,68]

MS results in impaired left ventricular filling and elevated left atrial pressure, both of which are exacerbated by a rapid heart rate due to anaemia, pregnancy, exercise or tachyarrhythmia. This exacerbation can occur even in patients below the threshold for intervention on the valve.[69] A reduction in heart rate may reduce symptoms, even in patients in sinus rhythm.[70] This can be achieved using beta-blockers, which significantly improve symptoms.[71] Ivabradine, an agent used in heart failure that lowers the resting heart rate through its inhibiting effect on the cardiac pacemaker, if current,[72] has similar efficacy to metoprolol in MS with an improvement in haemodynamics, exercise performance and dyspnoea.[70] As such, ivabradine may be used for symptom management in MS when beta-blockers are contraindicated or not tolerated or where an adequate reduction in heart rate cannot be achieved with beta-blockers alone. There is limited evidence for its use in the paediatric population and therefore caution and discussion with a paediatric cardiologist are recommended.[73] Due to its mechanism of action, ivabradine is not useful in atrial fibrillation. For patients with pulmonary congestion or right heart dysfunction secondary to significant mitral stenosis, diuretics may be used for symptomatic relief.[41] Anticoagulation in the setting of mitral stenosis is discussed in the Management of Anticoagulation section later in this chapter.

Indications for intervention

The indication for intervention is progressive symptoms associated with documented evidence of severe MS (Adults: mitral orifice area ≤1.5 cm^2, trans-mitral pressure half-time ≥150 ms, mean trans-mitral gradient ≥10 mmHg. Children: mitral orifice area ≤1.5 cm^2, PASP ≥50 mmHg).[6,7] Asymptomatic patients usually do not need intervention, unless there is a history of thromboembolism, paroxysmal AF or significant pulmonary hypertension (PASP >50 mmHg).[6,7] If the presence of symptoms is difficult to elicit then exercise testing with or without echocardiography can be useful. Limited exercise tolerance for age as well as significant elevation in trans-mitral mean gradient (>15 mmHg) or pulmonary artery systolic pressure (>60 mmHg) measured by echocardiography may indicate the need for intervention.[6] Patients with severe MS in combination with significant mitral regurgitation or in heavily calcified valves not amenable to percutaneous treatment should be referred for consideration of surgical management.

Percutaneous balloon mitral valvuloplasty

The treatment of choice for dominant or pure mitral stenosis is PBMV (Figure 11.2).[6,7,74-76] PBMV involves a balloon catheter being inserted via the femoral vein and placed in the left atrium, via a transseptal puncture technique. The balloon is positioned across the stenotic mitral valve and inflated, thereby spitting the fused commissures. Invasive pressure measurements are performed before, during and after balloon deployment to determine success of the procedure.

The short- and medium-term results are comparable to surgical valvuloplasty.[77,78] However, PBMV is much less invasive, usually requiring only one night in hospital, considerably cheaper and has less associated morbidity than mitral valve surgery.[68] Mitral valve gradient usually reduces significantly with improvement in orifice area following balloon valvuloplasty, reduction in left atrial pressure and increase in cardiac output. Symptoms of pulmonary congestion are relieved. Long-term results have been good, with 65% of patients being free of restenosis 10 years after the procedure.[75,76,79,80] Repeat valvuloplasty can be performed if restenosis leads to symptom recurrence, especially if the predominant mechanism of restenosis is commissural fusion.

Patients with pure or dominant MS requiring intervention should be referred for PBMV to a high-volume centre.[74] Early referral is recommended for younger patients, since they have the most favourable valve morphology and the best long-term results. Echocardiographic criteria contribute to case selection.[81] This includes consideration of valve mobility, thickening, calcification and subvalvular involvement. Patients with pliable, mobile, relatively thin valves, with no or minimal calcification, and without significant thickening and fusion of the subvalvular apparatus, are the best candidates for PBMV.[81] Significant calcification and subvalvular thickening are associated with worse outcomes following PBMV. A large left atrial thrombus or greater than moderate mitral regurgitation are contraindications to PBMV. However, PBMV can often be performed safely in the presence of a small, stable thrombus in the left atrial appendage.[82]

> PBMV is ideally suited to managing MS in pregnancy, where the risk of surgery and associated fetal loss is high.

The most serious complication of the procedure is tearing of the mitral valve leaflets and/or subvalvular apparatus, causing severe mitral regurgitation.[83,84] Other rare complications are cardiac tamponade and systemic embolism.

Surgical management

PBMV has largely replaced surgical mitral commissuroplasty and commissurotomy.[68,79] In the relatively few patients who are not suitable for PBMV, every effort should be made to repair the mitral valve, rather than replace it, especially if patients are in sinus rhythm. The goal of surgical repair is to restore the pliability of the mitral valve leaflets by excising fibrous tissue, secondary chordae and areas of calcification, and to increase the orifice area by performing two commissurotomies extended deep into the respective fused papillary muscles.

Mitral valve replacement may be necessary in heavily calcified valves, especially with subvalvular involvement, or in those with significant mixed mitral valve disease.[6,7] Refer to Mitral regurgitation section for choice of valve prosthesis.

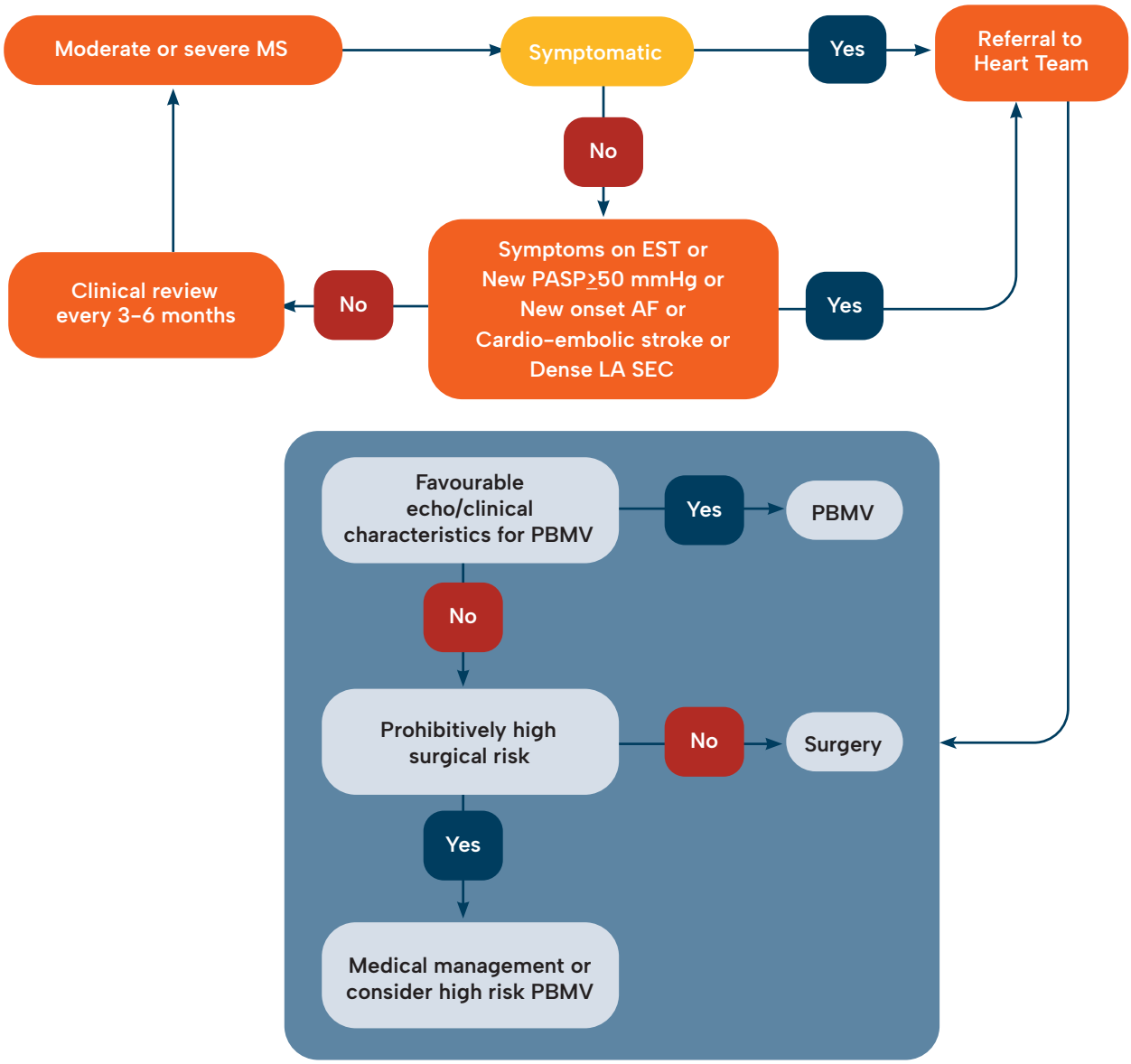


Figure 11.2. Rheumatic mitral stenosis: indications for intervention

EST: exercise stress test, PASP: pulmonary artery systolic pressure, AF: atrial fibrillation, LA SEC: left atrial spontaneous echo contrast, PBMV: percutaneous balloon mitral valvuloplasty

Aortic regurgitation

Medical management

In patients with significant, asymptomatic aortic regurgitation, vasodilator therapy has been demonstrated to reduce LV dilatation and regurgitant fraction.[52,85] This has the potential to slow the progression of LV dilatation, delaying the need for surgery.[86] However, randomised studies have been limited and findings are inconsistent.[86-88] Most evidence involves the use of dihydropyridine calcium channel antagonists with smaller studies including ACE inhibitors or aldosterone receptor antagonists.[85-87] In adult patients with significant aortic regurgitation and systemic hypertension, vasodilator therapy is recommended.[6] In patients with significant symptomatic AR with or without impaired LV systolic function, vasodilator therapy may aid in symptoms.[87,88] Medical therapy is not a substitute for surgical intervention for severe AR. However, medical therapy is appropriate in patients considered to be at very high surgical risk or in those who decline surgery).[6]

Indications for surgery

Patients with symptomatic severe aortic regurgitation (AR) should be referred for surgery, regardless of left ventricular systolic function (Figure 11.3). [7,89,90] Asymptomatic patients with reduced systolic function (LVEF <50%) should be referred as soon as possible for valve surgery, as long-term studies suggest that progression of heart failure and death occur in up to 25% of these patients per year.[91,92]

Patients with equivocal symptoms should undergo exercise testing to assess functional capacity and symptomatic response.[89]

For patients with normal LV systolic function without symptoms, surgery should be delayed for as long as possible.[52] Surgery should be considered in asymptomatic patients with severe AR and preserved left ventricular systolic function with severely dilated left ventricle (Adults: LVEDD >70 mm, LVESD >50 mm. Children: LVESD Z score >+4.0).[7,48,93]

Choice of operation

The options for aortic valve surgery include repair or replacement. Aortic valve replacement options include mechanical prosthesis, a stented or stentless bioprosthesis, or an aortic homograft.[65,94] Another less common surgical option is the Ross procedure.

Mechanical valve replacement

Mechanical tilting disc/bileaflet prostheses have excellent long-term durability, with favourable long-term outcomes, if INR can be maintained.[31,67] If patients already have chronic AF requiring anticoagulation, the valve of choice is a mechanical valve prosthesis. However, in young patients, it is often not possible to fit an adult sized prosthesis, and further surgery may be required following a growth spurt. Patients with tilting disc/bileaflet mechanical aortic valve can usually be anticoagulated to a lower INR (2-3) than was needed with the earlier-generation caged ball/disc valves, because of a lower risk of thromboembolism, especially in the aortic position.[64] The newest generation tilting disc valves in the aortic position demonstrate acceptable safety profile with an INR 1.5-2.[95]

Bioprosthetic valve replacement

Replacement with a bioprosthesis has the advantage of avoiding long-term anticoagulation. The main disadvantage is their limited durability in younger patients with long-term data suggesting approximately 50% deterioration at 10-15 years in those aged <65 years.[65,96,97]

With the advent of transcatheter aortic valve replacements, a bioprosthetic valve replacement has the added advantage of permitting future transcatheter aortic valve implantation (TAVI) to occur as a valve-in-valve procedure. These procedures are associated with a lower risk of mortality and morbidity compared to redo operations, especially when able to be performed by a trans-femoral artery approach.[28,98]

Aortic valve repair

Experience with repairing the rheumatic aortic valve is limited.[99–102] The Carpentier group in Paris has pioneered this approach, reporting a 92% freedom from reoperation at five years with cusp augmentation techniques.[101] Repair is best in the early stages of rheumatic valvular disease when the cusps are thin and pliable, and often associated with more durable outcomes in children. There is limited experience with aortic valve repair in Australia.[26] Despite concern about the durability of repair, it may be the procedure of choice in some children at high-volume centres, because there are limited alternatives in this age group. The valve morphology, including leaflet retraction and volume loss, seen in First Nations adults makes repair more challenging.

Homograft valve replacement

Homograft valve replacements are subject to structural deterioration, often with associated calcification.[103–105] They do have the advantage of haemodynamics identical to that of a native aortic valve and the avoidance of anticoagulant therapy. One large follow-up study of aortic homografts found a 10- and 20-year freedom from tissue failure (development of significant valve degeneration) of 62% and 18%, respectively.[105] A more contemporary single- centre experience demonstrated that 30% of patients were alive without reoperation out to 20 years follow-up.[103] Difficulties in obtaining donor homografts and the significantly increased complexity of reoperation in many of these patients has led to this procedure becoming less favoured in recent years, especially in younger patients.

Ross procedure

Another alternative for aortic valve surgery is the Ross procedure,[106,107] which uses a pulmonary autograft for valve replacement and a homograft for pulmonary valve replacement. The surgery is more complex, so has slightly higher risk. It is best suited for the aortic valve in later stages of rheumatic disease, when leaflets are thickened and retracted. It has the theoretical advantages of the valve 'growing' in younger patients and anticoagulation not being required.

However, ARF recurrence can involve the neo-aortic valve (pulmonary autograft), causing regurgitation. Late follow-up has also shown that some patients may develop significant AR, especially after five years, and require reoperation.[108] In younger patients, structural degeneration of the pulmonary homograft, usually manifesting as pulmonary stenosis, remains a problem.[109] The need for late reoperation, which is often quite complex, is the principal limitation of the Ross procedure.[110]

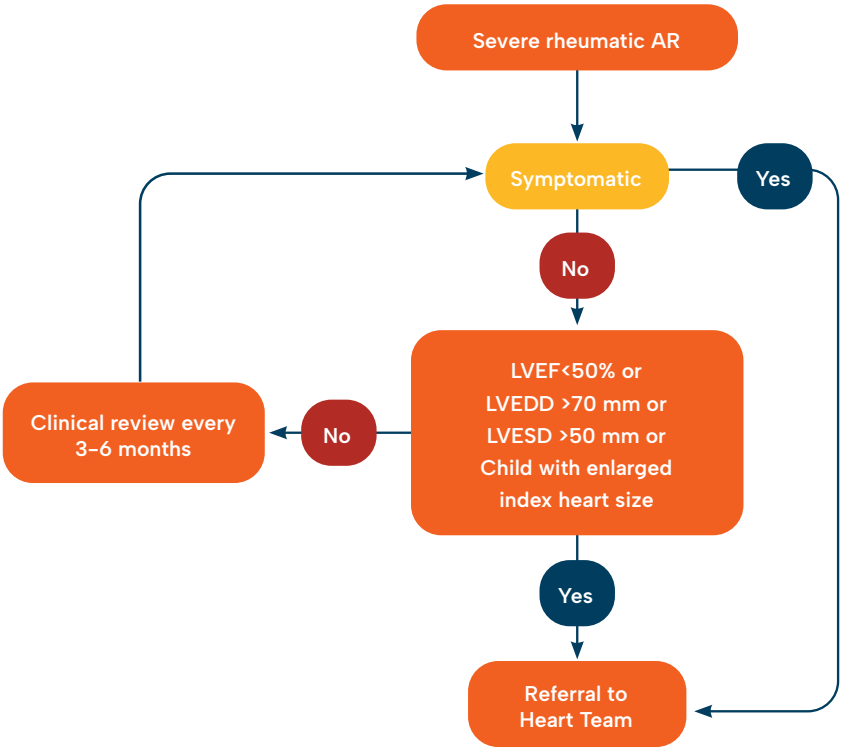


Figure 11.3. Rheumatic aortic regurgitation: indications for intervention

AR: aortic regurgitation, LVEF: left ventricular ejection fraction, LVEDD: left ventricular end-diastolic diameter, LVESD: left ventricular end systolic dimension

Aortic stenosis

Medical management

Patients with aortic stenosis (AS) do not usually become symptomatic until a severe systolic gradient (≥40 mmHg) develops. Initially, symptoms include exertional dyspnoea and fatigue, but syncope and angina can also occur. Many patients may remain asymptomatic despite haemodynamically significant AS. Once symptoms develop, prognosis is poor without intervention.[111,112] Patients with asymptomatic AS and hypertension should be treated as per standard guidelines, with frequent monitoring for side effects.[6] Antihypertensive or diuretic use in patients who are normotensive, have clinical heart failure or have small LV cavity size should be used cautiously and with appropriate haemodynamic monitoring due to the risk of significant hypotension and subsequent reduced coronary perfusion.[6,113,114]

Indications for intervention

Aortic valve replacement (AVR) is recommended for severe symptomatic AS (mean pressure gradient ≥40 mmHg, aortic valve area ≤1 cm^2, Vmax ≥4 m/sec).[6,7] This can be performed using either a transcatheter or surgical approach. It should be undertaken in all patients with severe stenosis once they have developed symptoms.[6,7] Patients with moderate gradients with severely reduced aortic valve area should have further imaging including dobutamine stress echocardiography, transoesophageal echocardiogram (TOE), CT or invasive haemodynamic assessment to determine whether there is low-flow, low-gradient severe AS.[6] In those with significantly impaired LV systolic function, dobutamine stress echocardiography may help determine true severe AS from pseudo-severe AS.[6,7] Exercise stress testing may help determine effort tolerance and symptomatic status and therefore guide timing of intervention.[76] Asymptomatic patients with severe aortic stenosis and impaired left ventricular systolic function (LVEF <50%) should be referred for surgery. Patients with asymptomatic critical/very severe aortic stenosis, defined by a mean pressure gradient >50 mmHg or Vmax >5.5 m/sec, can be considered for surgery.[115,116]

Choice of intervention

Surgery for AS includes replacement with a mechanical or bioprosthetic prosthesis, or a homograft valve.[65,94] Transcatheter aortic valve implantation (TAVI) is an additional therapeutic option for patients with isolated AS who are at significant surgical risk. Surgical risk is defined by specific scoring systems that consider anatomical and clinical parameters.[117,118] TAVI is a minimally invasive technique to replace an aortic valve with a bioprosthetic valve. It involves a valve being placed within the native valve via the femoral or subclavian artery or direct aortic approach. Outcomes using this technique are similar to outcomes for surgical bioprostheses for patients with severe AS at intermediate or high surgical risk.[119,120] There is emerging evidence that at least short-term outcomes also support TAVI in low-risk populations.[120,121] The durability of TAVI compared to bioprosthetic AVR appears similar at 5-10 years follow-up, however longer-term data are needed.[122,123] At this stage, TAVI has limited role in patients with RHD because predominant AS is rare in RHD and patients with RHD are typically younger than the traditional TAVI cohort with different valve morphology, therefore making extrapolation of results difficult.

Aortic valvuloplasty

Percutaneous balloon aortic valvuloplasty (BAV)[124,125] may reduce severe AS to moderate stenosis but usually leaves a significant residual gradient. The procedure may entail substantial morbidity and mortality, particularly in older patients.[126] Follow-up studies have shown that initial improvement is usually not maintained after a few months.[127] Medium-term mortality remains high if definitive valve intervention is not performed.[127-129] There is a high restenosis rate in calcific valvular disease, however no evidence basis exists for rheumatic aortic stenosis.[124] BAV may be considered in symptomatic and haemodynamically unstable patients as a bridge to definitive surgical or transcatheter intervention, or as a means of diagnosis when there is lack of clarity regarding cardiac symptoms (for example, dyspnoea in a person with significant lung disease).[7]

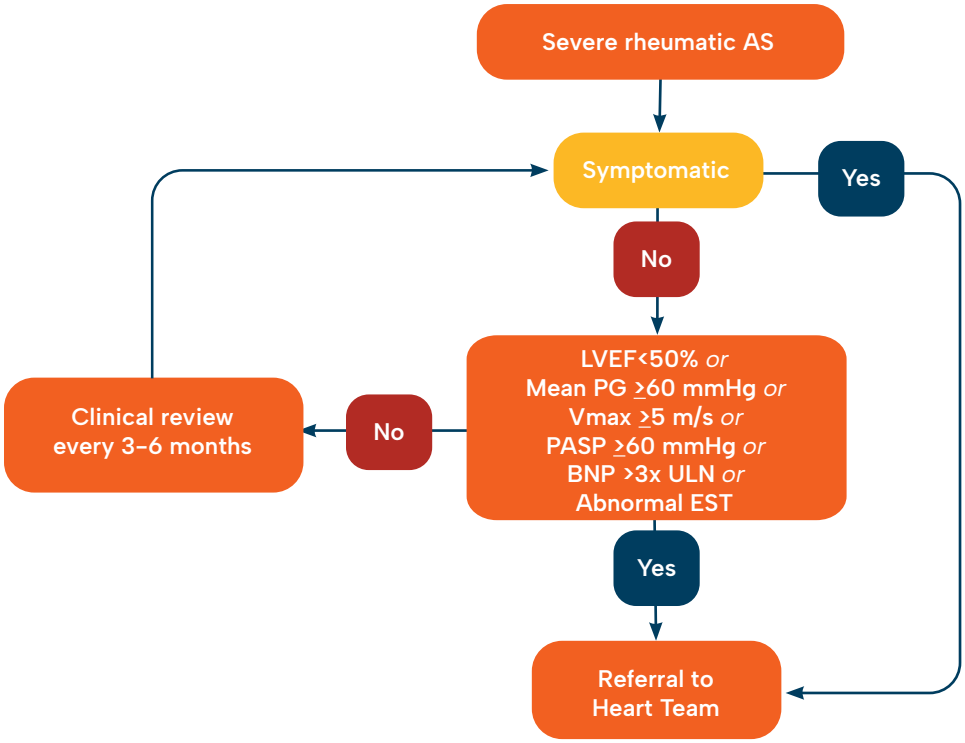


Figure 11.4. Rheumatic aortic stenosis: indications for intervention

LVEF: left ventricular ejection fraction, PG: pressure gradient, Vmax:, maximum flow velocity, PASP: pulmonary artery systolic pressure, BNP:B-type natriuretic protein, ULN: upper limit of normal, EST; exercise stress test

Tricuspid valve disease

Medical management

Significant tricuspid regurgitation (TR) is associated with right heart failure symptoms including peripheral oedema, congestive hepatomegaly and, in more severe cases, intestinal oedema and anorexia. Symptomatic relief is provided through use of diuretic therapy (frusemide, spironolactone) in those with volume overload.[6]

Surgical management

Tricuspid valve disease in RHD is most commonly secondary (functional) regurgitation due to progressive right ventricular dilatation and dysfunction as a result of left-sided valvular disease. Less commonly, primary rheumatic tricuspid valve disease may occur, presenting as regurgitation or stenosis.[7,21] Severe TR is associated with poor long-term prognosis.[130] In most cases, a repair is preferred over replacement as the latter is associated with greater surgical risk and long-term morbidity and mortality.[7,131] In the setting of secondary severe TR, tricuspid valve repair during left-sided valve surgery does not add to peri-operative mortality and may prevent right heart deterioration.[132,133] Delayed or repeat surgery for secondary TR is associated with significant mortality, due to irreversible right heart dysfunction.[130]

Severe symptomatic primary TR should be treated with surgical intervention.[6,7] Severe tricuspid stenosis should be treated with surgery if either symptomatic or in the setting of left-sided valve surgery.[6,7] Intervention for minimally symptomatic severe primary or secondary TR may be warranted in the setting of progressive right ventricular dysfunction to prevent irreversible impairment.[6,7] Functional progressive TR of moderate severity may be considered for surgery at the time of a left-sided valve procedure[6] whereas mild functional TR and moderate TR with stable annular dimensions may be managed conservatively. There are limited long term data regarding percutaneous balloon valvuloplasty for tricuspid stenosis.[6] However, this option may be considered by the heart team in select cases, such as patients deemed high surgical risk. Tricuspid valve replacement may be necessary in the setting of fibrotic or calcified rheumatic tricuspid valve disease. In this case, a discussion of mechanical or bioprosthetic valve replacement is necessary. A mechanical prosthesis in the tricuspid position is at higher risk of thrombotic complications due to the relatively lower pressures of the right heart.

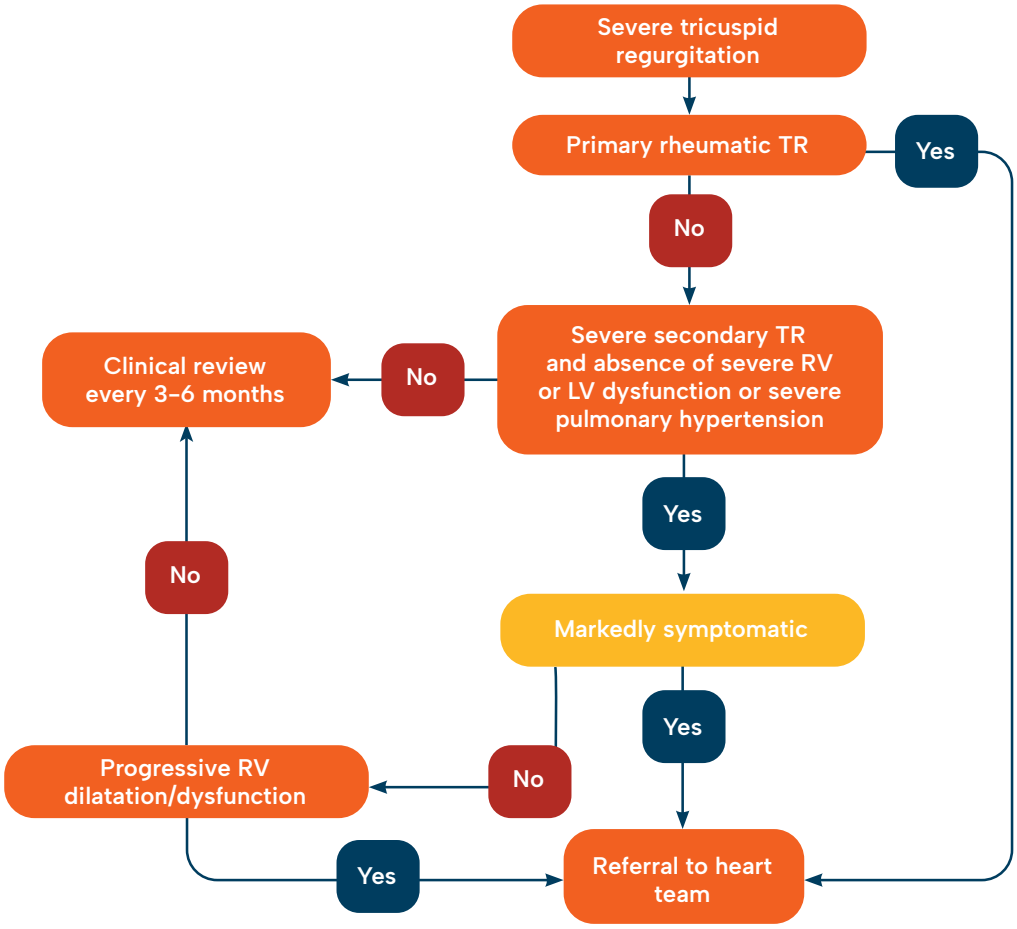


Figure 11.5. Tricuspid regurgitation in the setting of RHD: indication for intervention

TR: tricuspid regurgitation, RV: right ventricular, LV: left ventricular

Mixed and multi-valvular disease

The mitral valve is affected in more than 90% of RHD cases and commonly presents with mixed mitral valve disease. In more than half of cases, both mitral and aortic valves are involved.[20] Stages of multi-valvular disease will vary, with the mitral valve disease often more advanced than aortic valve disease.

Despite the predominance of multi-valvular and mixed valvular disease in RHD, there is no clear evidence on the timing of surgery in these cases. Clinical symptoms and the nature of the predominant lesion should therefore dictate the medical management and timing of cardiac intervention.

Earlier surgery is preferred to avoid post-operative left ventricular dysfunction.[48] The presence of mixed valvular disease may place limitations on non-invasive and invasive measures of valvular disease severity due to the haemodynamic effects each lesion may have on the other.[134] For example, mixed rheumatic mitral valve disease with predominant MR may result in left ventricular remodelling and a significantly elevated gradient across the valve despite the valve area remaining large. Conversely, in mixed MR and AS, the MR may result in under-estimation of the AS severity due to relatively reduced flow, and therefore gradient, across the aortic valve. Multimodality imaging evaluation is encouraged to determine anatomical and physiological severity. This should include TOE, exercise stress testing, stress echocardiography and cardiac MRI. These should be used particularly in cases with multiple valvular lesions, atypical symptoms or discordant clinical and echocardiographic information.

There are limited data regarding the outcomes of mixed or multi-valvular disease, particularly when lesions are less than severe.[135] Some research suggests that mixed moderate valvular disease may have a similar prognosis to severe single pathology disease.[136] Intervention in these cases needs to be based on thorough assessment of anatomy, haemodynamics and patient symptoms and comorbidities. Timing and choice of intervention should be determined by a heart team with expertise in RHD. For example, it is reasonable to consider isolated mitral valve repair and conservative management of moderate aortic disease (especially AR), knowing further surgery will be required in the future. More frequent surveillance of mixed or multi-valvular disease may be necessary.

Monitoring following valve surgery

There are several key points regarding patient follow-up after valvular intervention. Adherence to secondary penicillin prophylaxis is vital in preventing recurrence of ARF. In patients with mechanical prostheses, lifelong anticoagulation requires routine and regular monitoring of INR and management of anticoagulation surrounding other future invasive procedures. Due to their relatively limited long-term durability, bioprosthetic valves will require regular review and echocardiography. Similarly, valve repairs will require regular follow-up to identify early and late failure. It is important to note that patients vary in their short and long-term outcomes following valvular intervention.

Children and young adults remain at the highest risk of recurrence of ARF and recurrent valve injury, so require closer follow-up.

Older patients with mechanical prosthesis who demonstrate adequate management on anticoagulation and remain clinically stable may benefit from less frequent review (Figure 11.2).

Strict adherence to secondary prophylaxis following cardiac surgery is vital to prevent valve failure due to the recurrence of ARF. Regular echocardiographic studies are also required to monitor valve repairs and prostheses to detect any deterioration, thus enabling appropriate and timely management.

Management of thromboembolic risk and anticoagulation

Patients living with RHD may have several indications for anticoagulation. These indications include atrial fibrillation and atrial flutter with an elevated thromboembolic risk; significant mitral stenosis with other risk factors for thromboembolism; and post valve surgery, including mechanical valve replacement. Each of these scenarios will be addressed here.

Atrial fibrillation and atrial flutter

Since the publication of the second edition of the Australian rheumatic heart disease guidelines in 2012, the role of non-vitamin K antagonist oral anticoagulants (NOACs) – also known as novel oral anticoagulants or direct-acting oral anticoagulants (DOACs) – has been established in the setting of atrial fibrillation or atrial flutter with elevated thromboembolic risk as assessed by the CHA_2DS_2VA score.[137] The 2018 Australian guidelines for the management of atrial fibrillation elected to remove gender from the scoring system due to the lack of evidence supporting the increased risk attributed to females. This has resulted in the adoption of the CHA_2DS_2VA score (Table 11.5) rather than the previous CHA_2DS_2VASc score. A score of ≥2 points is associated with significantly elevated risk of thromboembolic event that can be reduced with the use of therapeutic anticoagulation. Anticoagulation should be considered in individuals with a score of 1. Anticoagulation is not recommended in individuals with a score of 0.

NOACs have been shown to be equivalent or superior to warfarin for thromboembolic events and safety.[138-140] In these landmark trials, AF was described as "non-valvular". This term has caused confusion in clinical practice; however, "valvular" in this context refers specifically to moderate or greater mitral stenosis (MS) or prosthetic valve replacements. Patients with these pathologies were excluded from the NOACs trials. Patients with other forms of valvular disease, including clinically significant regurgitation and non-mitral valve stenosis, were represented in smaller numbers within these studies. Later publications interrogating these specific cohorts suggest similar benefits to the larger trial populations.[141,142]

It is reasonable to recommend non-vitamin K antagonist oral anticoagulants (e.g. rivaroxaban, apixaban, dabigatran) in patients with AF and elevated CHA_2DS_2VA score even if valvular disease is present, provided there is no mitral stenosis of moderate or greater severity, and no mechanical valve replacement.[137]

Evidence to support the use of NOACs in patients with bioprosthetic valve replacements and AF is limited, with very few of these patients represented in trials and as such warfarin is the default option in this group.[7] NOACs may be used in cases where it is preferred over warfarin for specific clinical reasons after being discussed with the relevant specialist. Patients with atrial fibrillation and moderate or severe mitral stenosis (regardless of CHA_2DS_2VA score) or mechanical valve prostheses should be treated with warfarin.[137]

Mitral stenosis

Significant mitral stenosis is a cause of atrial fibrillation and elevated thromboembolic risk, regardless of CHA_2DS_2VA score. As mentioned above, these patients were excluded from the major NOAC trials. As such, warfarin (a vitamin K antagonist) remains the only oral anticoagulant for the management of patients with atrial fibrillation and moderate or greater MS. A single registry-based study

suggests that NOACs may be safe and effective in patients with significant mitral stenosis.[143] A subsequent randomised trial performed in low- and middle-income countries comparing warfarin versus rivaroxaban for thrombo-embolic prophylaxis in people with (predominantly) moderate or greater mitral stenosis demonstrated a lower rate of composite cardiovascular events and death in the warfarin group (the INVICTUS trial).[144] As such, warfarin remains the only recommended agent in this cohort of patients.

For patients in sinus rhythm and no history of atrial fibrillation, anticoagulation is indicated if there is a history of thromboembolic event or thrombus visualised within the left atrium (LA) or left atrial appendage.[6] Furthermore, it should be considered in those with significant spontaneous echo-contrast seen within the LA on echocardiography or significantly dilated LA.[6,7] Warfarin is recommended in these latter cohorts also, due to lack of evidence supporting the use of NOACs.[7] NOAC use in patients with significant mitral stenosis may be considered for specific cases where warfarin is contraindicated, and adherence has been demonstrated. In such circumstances, discussion with a cardiologist is strongly advised. Aspirin in combination with anticoagulation may have a role in specific circumstances and again discussion with a specialist is advised.

Warfarin remains the only option for anticoagulation following implantation of a mechanical valve replacement. A study of Dabigatran (a NOAC) in mechanical valve replacement was stopped prematurely due to increased harm driven by thromboembolic events in the Dabigatran arm.[145]

Prosthetic valve replacement

Target INR may vary depending on valve prosthesis location (e.g. 2–3 for mechanical aortic valves and 2.5–3.5 for mechanical mitral valves. Patients receiving a bioprosthetic valve replacement may be treated with anticoagulation (warfarin) for the first one to three months post-surgery, as this has been demonstrated to be the highest risk period for thromboembolic events.[7] This practice may vary between institutions and therefore discussion with local cardiothoracic and cardiology services is advised. Enoxaparin or heparin may be used in cases of sub-therapeutic INR or if bridging is needed for patients with mechanical valves.

Monitoring anticoagulation

The major limitation of warfarin is the requirement for monitoring its therapeutic effect (INR) in the form of regular blood tests. Both under-anticoagulation and over-anticoagulation can lead to a life-threatening event. Dosing requirements are variable, as warfarin interacts with many commonly used medications and foods. Difficulties also may arise because of language and cultural barriers, mobility of the population, and remoteness from pathology services. For these reasons, achieving satisfactory anticoagulation is often a challenge.[146] Point-of-care INR testing is available for patients remote from regular pathology services, and this can improve anticoagulation management.[147]

Table 11.5. The CHA_2DS_2VA score is used to determine thromboembolic risk and guide use of anticoagulation in patients with non-valvular atrial fibrillation

CRITERIA	POINTS †
Age	65-74yrs = 1, ≥75yrs = 2
Congestive heart failure	1
Hypertension	1
Stroke/ transient ischaemic attack/ thromboembolic event	2
Vascular disease	1
Diabetes mellitus	1

† A score of ≥2 in the setting of non-valvular atrial fibrillation is an indication for anticoagulation. Anticoagulation should be considered in individuals with a score of 1. Anticoagulation is not recommended in individuals with a score of 0-1.[148]

Management of RHD complications

Heart failure

Heart failure (congestive cardiac failure) is a clinical presentation where the heart is either unable to pump blood at the rate required for organ function or can only do so with an elevated diastolic filling pressure. It may be associated with reduced or preserved ejection fraction on imaging, respectively termed 'heart failure with reduced ejection fraction' (HFrEF) or 'heart failure with preserved ejection fraction' (HFpEF).[41] The clinical presentation of heart failure varies widely, from mild symptoms of peripheral oedema or reduced exercise tolerance through to pronounced pulmonary congestion or fulminant cardiogenic shock.

The aetiology of heart failure may be due to the rheumatic valvular disease itself or other pathologies such as concomitant coronary heart disease, hypertension or another form of cardiomyopathy. Specific to RHD, heart failure may be due to a volume loaded and dilated left ventricle (LV) secondary to regurgitant lesions (e.g. AR, MR), or associated with development of tachycardia and atrial arrhythmias (e.g. atrial fibrillation), particularly in mitral stenosis. While management of these precipitants may be beneficial in the longer term, acute management of decompensated heart failure is often necessary.

The majority of evidence-based therapy has been developed for HFrEF, whereas a paucity of efficacious treatment options is available for HFpEF. Management of acute decompensated heart failure includes appropriate use of investigations and management of precipitating causes. In patients with RHD, this may include new-onset tachyarrhythmia, coronary ischaemia, sepsis, anaemia, non-adherence with medical therapy or pregnancy. Haemodynamic monitoring may be necessary. Diuretic therapy is recommended to reduce congestion.[41] Negatively inotropic agents, such as beta-blockers, may need to be withheld during acute congestive heart failure. Afterload reduction with vasodilator therapy (i.e. intravenous/topical nitrates) can be of benefit in those with a systolic blood pressure ≥90 mmHg.[41] Inotropic therapy may be necessary in those with progressive hypotension, congestion or cardiogenic shock refractory to earlier treatments.[41]

Management of chronic heart failure includes lifestyle, behaviour, medical and device-based treatments. The appropriate use of these therapies and details regarding acute heart failure management are outlined in the Australian Clinical Guidelines for the Management of Heart Failure (2018).[41]

A thorough clinical assessment is imperative in all patients presenting with possible heart failure, particularly in younger patients who may compensate well, therefore masking the severity of the disease.

Pulmonary hypertension

Left heart disease can result in pulmonary hypertension (PH). Common causes include left ventricular failure (both HFrEF and HFpEF) or valvular heart disease. In the setting of RHD, any valve disease of significant severity resulting in abnormal left ventricular function may lead to pulmonary hypertension. Of particular note, mitral stenosis may result in significant pulmonary hypertension due to elevated filling pressures and reduced left atrial compliance, even in the setting of preserved LV systolic function. Although the exact mechanism of pulmonary hypertension is not known, it is thought that the pulmonary venous congestion results in a cascade of metabolic responses leading to abnormal pulmonary vascular remodelling.[149] Furthermore, patients may have concomitant pulmonary hypertension due to another pathology, such as autoimmune disease. The correct classification of PH is vital as this determines treatment options.[149] Clinical assessment in combination with echocardiography is used to determine the likely cause of PH, including identification of reversible factors.[149] Right heart catheterisation plays a role in determining severity of disease and may aid in distinguishing types of PH and identifying response to treatment. Treatment of PH complicating left heart disease is focused on management and reversal of the underlying cardiac pathology. This may include medical management of heart failure or procedural intervention of valve disease.[149] Early identification of PH due to RHD is vital to enable appropriate timing of intervention in order to prevent irreversible complications of PH.[6,7] Pulmonary arterial hypertension therapies are not recommended in PH due to left heart disease.[149]

Atrial fibrillation

Atrial fibrillation is a common complication of RHD, particularly mitral stenosis.[20] Patients who develop AF with a rapid ventricular rate may develop acute heart failure, including pulmonary oedema, and require intravenous diuretic therapy. The ventricular rate in AF is best slowed with rate-controlling medications such as beta-blockers, digoxin and non-dihydropyridine calcium channel antagonists (diltiazem, verapamil). Rhythm-controlling agents such as flecainide, sotalol or amiodarone may play a role in maintaining sinus rhythm in selected patients. However, the long-term use of these agents should be avoided in younger patients due to adverse effects.[137]

If a direct current cardioversion is being considered as a treatment for new-onset AF (≤48 hours duration), TOE is recommended in those at high risk of thromboembolic complications, including significant mitral stenosis, severely dilated left atrium, evidence of thrombus or spontaneous echo-contrast on a transthoracic echocardiogram (TTE), or prior thromboembolic event. Although four weeks of therapeutic anticoagulation is usually considered adequate to reduce the risk of embolism in non-valvular AF cohorts, no evidence for safe cardioversion without TOE exists in patients with moderate or severe MS.[150,151]

Detailed discussion of other management strategies for atrial fibrillation, including ablation and surgical procedures, can be found in the Australian Clinical Guidelines for the Diagnosis and Management of Atrial Fibrillation (2018).[148]

Prosthetic valve thrombosis

Prosthetic valve thrombosis is an uncommon but serious complication following valve surgery. Australian data demonstrate the high morbidity and mortality associated with valve thrombosis.[152] It is most commonly associated with inadequate anticoagulation in the setting of a mechanical prosthesis.[152] The diagnosis should be considered in any patient with a history of valve replacement presenting with symptoms of congestive heart failure or cardiogenic shock. Early cardiologist involvement is crucial. Urgent surgery is recommended in critically ill patients with mechanical valve thrombosis.[7] In locations where surgery is not immediately available or considered too high risk, thrombolysis should be considered.[7] For patients with thrombosis affecting a bioprosthetic valve, anticoagulation should be trialled before considering repeat surgery.[7]

Prevention of infective endocarditis

Infective endocarditis (IE) – infection of the endocardial aspect of the heart, most commonly the heart valves – carries high morbidity and mortality.[153,154] It most commonly affects previously damaged or prosthetic valves, which is why RHD poses a major risk for IE. Common bacterial pathogens include Staphylococcus aureus, organisms of the viridans group of Streptococci, Enterococcus species and coagulase-negative Staphylococci.[153,154] Risk factors for development of bacteraemia with these pathogens, in turn causing IE, include dental and other invasive procedures, intravenous drug use, haemodialysis, immunosuppression and indwelling intravascular/invasive devices or catheters.[153] IE complicating RHD is an important adverse event following prosthetic valve replacement.[22,153]

In a study from northern Australia, the rate of endocarditis was found to be 6.5 per 100,000 person-years, being more common in people with RHD (relative risk 58) or people of Indigenous status (relative risk 2.0).[155]

There was significant controversy during the decade from 2008 on the need to give antibiotic prophylaxis for dental procedures. The evidence that peri-procedural antibiotic prophylaxis prevents IE was considered poor quality. Therefore, guidelines committees internationally recommended that antibiotic prophylaxis is not given except to highest risk individuals. While Australia has continued to recommend IE prophylaxis for high-risk individuals undergoing certain procedures, in 2008 the United Kingdom's National Institute for Health and Care Excellence (NICE) recommended that dentists stop its use completely.[156] In 2015, an observational study in The Lancet showed that antibiotic prophylaxis prescribing in England had reduced by 89% since the NICE guideline change, and the incidence of IE had increased significantly.[157] The European Society of Cardiology then concluded 'the weight of evidence and opinion is now in favour of the efficacy and usefulness of antibiotic prophylaxis in preventing IE in those at high-risk' and that 'the risk of not giving antibiotic prophylaxis outweighed any risk of giving it'.[158]

The Australian Therapeutic Guideline recommendations for the use of prophylactic antibiotics for the prevention of IE have evolved over recent editions to the current version which provides clarity and more comprehensive advice regarding the specifics of who is at risk and what procedures are considered risk procedures.[159]

Table 11.6. Cardiac conditions and procedures for which infective endocarditis prophylaxis is recommended

Endocarditis prophylaxis is recommended ONLY for patients with the following cardiac conditions who are undergoing a procedure listed below.† ‡	
CARDIAC CONDITIONS	**PROCEDURES¶**
Prosthetic cardiac valve, including transcatheter-implanted prosthesis or homograph Prosthetic material used for cardiac valve repair, such as annuloplasty rings and chords Previous infective endocarditis Congenital heart disease but only if it involves: • unrepaired cyanotic defects, including palliative shunts and conduits • repaired defects with residual defects at or adjacent to the site of a prosthetic patch or device (which inhibit endothelialisation) Rheumatic heart disease in all populations	**Dental procedures.** Only those involving manipulation of the gingival or periapical tissue or perforation of the oral mucosa (e.g. extraction, implant placement, biopsy, removal of soft tissue or bone, subgingival scaling and root planing, replanting avulsed teeth). **Dermatological and musculoskeletal procedures.** Only those involving infected skin, skin structures or musculoskeletal tissues. **Respiratory tract or ear, nose and throat procedures.** Only for tonsillectomy or adenoidectomy, or invasive respiratory tract or ear, nose and throat procedures to treat an established infection (e.g. drainage of abscess). **Genitourinary and gastrointestinal tract procedures.** Only if surgical antibiotic prophylaxis is required or for patients with an established infection.

Adapted from Australian Therapeutic Guidelines: Prevention of Infective Endocarditis, 2019.

† Endocarditis prophylaxis is not recommended for patients with forms of valvular or structural heart disease not listed in this table, including patients with mitral valve prolapse, septal defects or cardiac implantable electronic devices.

‡ Patients with a heart transplant who have developed cardiac valvulopathy may also be at high risk of adverse outcomes from endocarditis. Consult with patient's cardiologist for specific recommendations.

¶ Endocarditis prophylaxis is not recommended for procedures other than those listed above. However, surgical prophylaxis may be indicated if endocarditis prophylaxis is not.

Antibiotic prophylaxis is recommended only in individuals meeting BOTH of the following criteria:

- Have a cardiac condition associated with an increased risk of developing infective endocarditis, including confirmed RHD on the most recent echocardiogram.
- Are undergoing a procedure associated with a high risk of bacteraemia that is associated with endocarditis.

NOTE: From September 2025, the Therapeutic Guidelines will provide more details for dentists on specific dental procedures (See Therapeutic Guidelines Table 13.29 Classification of dental procedures by invasiveness and considerations for risk management)

The following general recommendations are made to prevent IE in those at risk:

- Regular, routine dental examination and scaling.
- Timely treatment of all bacterial infections.
- Avoidance of intravascular catheters and invasive procedures, unless necessary.
- Strict adherence to protocols for managing central and peripheral intravenous devices.
- Active discouragement of tattooing, piercing and intravenous drug use.

The presentation of infective endocarditis often includes non-specific symptoms and signs including fever, rigors, malaise, anorexia, weight loss, myalgias, arthralgias, night sweats and abdominal pain.[153] A cardiac murmur is common, noted in the majority of patients.[153] Peripheral embolic lesions including splinter haemorrhages are not uncommon but classical Janeway lesions, Osler's nodes and Roth spots are less common.[153] Patients may present with complications of the disease, including acute severe valvular dysfunction, heart failure and deep embolic complications such as stroke, deep organ septic emboli or abscess.[154] It is imperative that patients at high risk of IE with unexplained fever or non-specific symptoms are investigated for infective endocarditis.[154] Blood tests including blood cultures should be taken prior to the administration of antibiotics.

Antibiotic prophylaxis to reduce endocarditis risk

For patients taking long-term BPG injections for secondary prevention of ARF, it is the consensus view of the Antibiotic Expert Groups that amoxicillin is still appropriate for endocarditis prophylaxis (Table 11.7).[159] This is a departure from the previous guidelines[160] which recommended the use of clindamycin as the first-line approach for people receiving long-term penicillin therapy. The rationale is that, while the level of penicillin achieved with BPG prophylaxis is not adequate as peri-procedural prophylaxis to prevent bacteraemia from mouth organisms, the amoxicillin susceptibility of viridans streptococci in the oral flora is not significantly affected by the by the penicillin prophylaxis. However, for patients currently taking or who have recently taken a course of other beta-lactam therapy (not BPG), evidence suggests that the amoxicillin susceptibility of viridans streptococci may be affected. Therefore, a non–beta-lactam antibiotic, such as clindamycin, may be considered for prophylaxis in this setting.

Table 11.7. Antibiotics for infective endocarditis prophylaxis

DRUG	ROUTE	TIME BEFORE PROCEDURE
For endocarditis prophylaxis, use:		
Amoxicillin 2 g *(child: 50 mg/kg up to 2 g)*	oral	60 minutes before the procedure
If oral administration is not possible, use:		
Amoxicillin 2 g *(child: 50 mg/kg up to 2 g)*	intramuscular	30 minutes before the procedure, or
Amoxicillin 2 g *(child: 50 mg/kg up to 2 g)*	intravenous	within 60 minutes before the procedure, or
Ampicillin 2 g *(child: 50 mg/kg up to 2 g)*	intramuscular	30 minutes before the procedure, or
Ampicillin 2 g *(child: 50 mg/kg up to 2 g)*	intravenous	within 60 minutes before the procedure
For patients with delayed non-severe hypersensitivity to penicillins, cefalexin can be used in most cases.† Use:		
Cefalexin 2 g *(child: 50 mg/kg up to 2 g)*	oral	60 minutes before the procedure
If oral administration is not possible, use:		
Cefazolin 2 g *(child: 30 mg/kg up to 2 g)*	intramuscular	30 minutes before the procedure, or
Cefazolin 2 g *(child: 30 mg/kg up to 2 g)*	intravenous	within 60 minutes before the procedure
For patients with immediate (severe or non-severe) or delayed severe hypersensitivity to penicillins,† use:		
Clindamycin‡ 600 mg *(child: 20 mg/kg up to 600 mg)*	oral	60–120 minutes before the procedure
If oral administration is not possible, use:		
Clindamycin‡ 600 mg *(child: 20 mg/kg up to 600 mg)*	intravenous	within 120 minutes before the procedure

† See Therapeutic Guidelines: Antimicrobial hypersensitivity / Management of patients reporting hypersensitivity to penicillins.

‡ There is some evidence that moxifloxacin may be used as an alternative to clindamycin for patients with immediate (severe) or non-severe or delayed hypersensitivity to penicillins, but this has not been validated.

Oral health and RHD

Oral health is an important element of care for people living with RHD. Poor oral health, particularly the presence of dental caries, is associated with increased risk of infective endocarditis (IE) complicating RHD.[161]

Common dental pathologies and pre-surgical assessment

Common dental conditions seen in patients requiring cardiac surgery are untreated dental caries, high levels of plaque and gingival inflammation, retained roots and poorly controlled periodontitis.[162] There is correlation between people with severe RHD and poor oral health, which places these individuals at high risk for IE.[163] First Nations peoples, particularly those in rural and remote areas, suffer from poorer oral health than non-Indigenous Australians.[164] Poor oral health is associated with higher risk of significant bacteraemia and therefore maintaining good oral health and hygiene is likely to have a greater positive impact than antibiotic prophylaxis during dental procedures.[161]

All people with ARF and RHD need regular dental review to reduce the risk of IE. Patients requiring cardiac intervention for RHD need a comprehensive dental consultation prior to surgery.

Dental review preceding cardiac surgery comprises detailed treatment planning for caries stabilisation, management of active periodontal disease, and elimination of any odontogenic infection supported with appropriate radiography. Treatment includes extraction of any teeth with poor prognosis from dental caries, filling of restorable teeth, treatment of moderate to severe periodontitis and stabilisation of periodontal or gingival health. Patients should also receive age- and culturally appropriate education to improve oral hygiene practice in the longer term.

Access to dental care

Oral health services in rural and remote areas are usually provided by visiting oral healthcare professionals. The short duration and limited frequency of visits result in a low level of access to oral health services for people living in many rural and remote communities. Oral health services provided are usually limited to general services, and do not include specialist care or more complex procedures. The need to travel to regional centres for urgent dental care is common.

Effective communication between dental services and local healthcare centres or referring general practitioners is important to ensure that patients can access dental services in their community when available. Treatment required over multiple appointments can be difficult. Patients should be made aware of the number of appointments required for treatment. Reminders and transport should be arranged to ensure that treatment is timely, particularly ahead of scheduled cardiac surgery.

CASE STUDY

Surgery journey

Patients living in rural and remote areas who need to access cardiothoracic and interventional cardiology services are required to travel to major tertiary hospitals. These tertiary centres are often located a significant distance from the patient's home, away from family and familiar community support services. Primary care services located across rural and remote Australia have shaped effective referral relationships with tertiary centres, specialist cardiothoracic surgeons and cardiologists. Table 11.8 provides an example of the journey for surgery – from pre-surgical assessment through to follow-up after hospital discharge. The information provided here can be used to help patients and families understand what is involved during the surgical journey, from the time that a recommendation for operation is made through to the journey home after the initial recovery period.

This is a guide only; hospital management can vary between institutions.

The cultural and language differences between some First Nations patients and the personnel encountered along the surgery journey may be significant.

At every stage:

- First Nations health staff need to be included in the process and involved with the patient.
- The level of patient and escort health literacy needs to be considered.
- The patient, and relevant family and escorts, need to be involved in all discussions and decisions.
- Appropriate, trained interpreters need to be employed as required, to bridge language differences and facilitate informed consent for investigations and procedures.
- The system's capacity for cultural competence needs be considered and addressed as indicated.

Table 11.8. Patient surgery journey

STAGE	PERSONNEL	MANAGEMENT	SYSTEM FACTORS	CONSIDERATIONS	PATIENT CARE
Assessment for heart valve surgery OUTCOMES: Patient indicated or not indicated for surgery, based on severity of disease, symptoms, and ongoing risk to health Patient and family are adequately informed so that they can agree to or refuse surgery (if indicated)	Paediatrician/ Physician Cardiologist Cardiothoracic surgeon Local primary healthcare staff • GP • AHW, AHP • Nurse	Review by cardiologist & cardiothoracic surgeon • Medical history • Symptoms and impact on daily living • Treatment (including secondary prophylaxis delivery) Discussion around risks and benefits of surgery Refer to heart team†	Timely access to surgical consultation (particularly for people in rural and remote areas) Communication between local cardiology services and cardiothoracic surgeons Engagement with local primary care service to ensure appropriate follow-up, prescription of secondary prophylaxis, involvement of dental and/or indicated allied health services Advanced allocation of surgery date (+/- 3 months)	Understanding the importance of surgical intervention Community consent for surgery to proceed (where indicated) Implications of future planned pregnancies Implications of travel from remote areas Work, education, financial and family implications of taking time for surgery	Involvement by proposed escort as early as possible Stories from other people who have had surgery
Pre-operative clinical preparation OUTCOMES: Clinical preparation completed prior to surgery Clinical preparation planning sensitive to the patient's capacity to attend and accept assessments and treatments	Paediatrician/ Physician Cardiologist Local primary healthcare staff • GP • AHW, AHP • Local Cardiac Coordinator • Nurse/ Midwife	Team, patient, family discussion: • pre- and post-operative testing and care including surgical equipment, attachments, procedures • heart valve options (repair vs replacement, tissue vs mechanical) • risks and benefits of long-term anticoagulation Transthoracic echocardiogram +/- transoesophageal echocardiogram (for mitral valve disease) Coronary angiogram (if aged >30 years) Biochemistry analysis/ complete blood exam Urine culture Multidrug resistant organism screening (i.e. MRSA/ VRE/CRE) Skin assessment and treatment (fungal infections/ rash/open wounds) Oral health assessment and treatment (dental caries, gum disease) Other chronic conditions stabilised (e.g. diabetes, hypertension) Medication review (e.g. anticoagulant therapy ceased 5-7 days before surgery) Informed consent for surgery	Access to investigation and interventional services Treatments completed (e.g. skin conditions, dental work) as indicated Timing of investigations and tests as close to surgery date as possible (preferably within 1 month of surgery date) Test results communicated to surgical facility Capacity of local health staff to provide detailed and accurate information Capacity to provide education over multiple sessions Coordinated input from local health staff to aid in determining valve choice options and medication delivery Capacity to arrange appointments so that regional travel and inconvenience is minimised	Capacity to attend for multiple assessments and treatments Understanding the importance of pre-operative preparation (particularly if lengthy or complex) Patient, family, escort overwhelmed	Transport to attend appointments Clear communications about assessments and treatments Appointments arranged to reduce regional travel and inconvenience

Table 11.8. Patient surgery journey (continued)

STAGE	PERSONNEL	MANAGEMENT	SYSTEM FACTORS	CONSIDERATIONS	PATIENT CARE
Travel planning OUTCOMES: Return travel and accommodation secured for patient and appropriate escort Patient and escort have a clear understanding of travel arrangements and their responsibilities related to travel	GP ALO Local Cardiac Coordinator Nurse/ Midwife Patient Travel Officer	All flights, accommodation, and transfers from patient's home to surgical facility and return home	Capacity to include escort in travel and accommodation Timing of connecting flights and transfers Access to money (e.g. use of basics card, location of ATM)	Availability of appropriate escort at time of travel Arrangements (and issues) related to substitute family care and leave from school or work (where indicated) Remoteness of home, and additional transfers required Money and appropriate clothing and other requirements available for patient and escort	Travel details provided to local primary care facility and family at home Planned communication (sharing phone numbers, out-of-hours contacts) between patient, escort and health service/home
Travel to surgical facility‡ OUTCOME: Smooth transfer between home (or regional health facility) and cardiothoracic surgery facility	Regional aeromedical staff Commercial airline staff Airport staff Road transport drivers (bus, taxi, rail) Hotel, hostel, outreach services staff		Travel processing times and transfers Long drives and flights Overnight travel arrangements Access to hospital from hostel accommodation Availability of hospital (units, rooms) accommodation Transit staff capacity to communicate with patient and escort effectively	Unfamiliar and/or uncomfortable travel Unfamiliar and/ or uncomfortable weather conditions Cultural isolation (being away from family, friends, and traditional Lands) Personal isolation (no escort available)	Trained support staff to send and receive patient and escort Well-planned travel arrangements, including patient and escort education Planned communication (sharing phone numbers, out-of-hours contacts) between patient, escort and travel organiser

Table 11.8. Patient surgery journey (continued)

STAGE	PERSONNEL	MANAGEMENT	SYSTEM FACTORS	CONSIDERATIONS	PATIENT CARE
Preparation for surgery – surgical assessment and planning	Cardiothoracic surgical team (consultant surgeon, surgical registrars) AHW, AHP ALO Nurse Clinical pharmacist	Review of recent tests and treatments (clinical preparation) Clinical measurements: • repeat biochemistry, complete blood picture, coagulation studies • blood group & cross match • ECG • CXR (repeated and compared to previous) • other imaging as required (CT Chest (if reoperation), Carotid Duplex Ultrasound) Team, patient, escort discussion: • pre- and post-operative testing and care including equipment and personal attachments • surgery procedure and associated risks • post-operative treatment plan Signed consent form for surgery Medication review, including cessation of anticoagulant therapy (if indicated)	Established process for surgery Capacity to incorporate patient, escort care preferences Capacity for escort to accompany patient to theatre Support for escort during surgery	Unfamiliar healthcare environment and routine Concern about surgery (procedure, pain, scarring) Concern about anaesthesia (process, risks) Concern about future health and capacity for independence Patient, escort overwhelmed	Escort and Aboriginal and Torres Strait Islander health staff included in all discussions Activities available to patient and escort in between appointments and tests
Preparation for surgery – anaesthetic risk assessment and planning	Anaesthetist AHW, AHP ALO	Clinical assessment • medical history, including existing anaesthetic risk • physical examination of mouth, throat, teeth • auscultation (lung and heart sounds) • need for transfusion Anaesthetist, patient, escort discussion: • anaesthetic process and care of patient under anaesthesia • premedication, fasting prior to surgery, post-operative pain management Consent to anaesthesia	Capacity to incorporate patient, escort care preferences Introduction and orientation to theatre environment Capacity to provide clear instruction about pain relief options post-surgery		
Preparation for surgery – cardiothoracic ward OUTCOMES: Patient prepared for surgery according to hospital protocol Preparation for surgery is culturally safe and acceptable to the patient and escort	Nurse AHW, AHP Physiotherapist	Antibacterial body wash and shave Oral fasting for 8–10 hours before surgery Premedication Intravenous line insertion Nurse, physiotherapist, patient, escort discussion: • post-operative mobilisation plans • deep breathing and coughing exercises (demonstrated use of *triflo* device)	Capacity to incorporate patient, escort care preferences and to communicate this clearly between ward and theatre staff		

Table 11.8. Patient surgery journey (continued)

STAGE	PERSONNEL	MANAGEMENT	SYSTEM FACTORS	CONSIDERATIONS	PATIENT CARE
Surgery[§] OUTCOME: Surgery completed as planned	Cardiothoracic surgeon Anaesthetist Theatre Nurses Perfusionist (operates the *Heart-lung machine*)	Surgical antibiotic protocol Heart valve repair/replacement Central venous catheter insertion Urinary catheter insertion Cardio-pulmonary bypass (not indicated for transcatheter procedure	Clear communication and handover within the team	Patient, escort overwhelmed by operating theatre environment, surgical masks and equipment	Escort and/or Aboriginal Liaison Officer support through to operating theatre Welcoming and supporting surgical team *NOTE: Cardiothoracic surgeon talks to the escort or other relevant patient contacts immediately after surgery*
Intensive care[¶] **(24-48 hours after surgery)**	Cardiothoracic surgeon AHP Intensive Care Team • Intensivist • Nurse • Physiotherapist Clinical pharmacist	Daily cardiothoracic review Surgical antibiotic protocol Routine monitoring and management • respiratory support (ventilation) • haemodynamic management • heart function/status • nutrition/hydration • pain management • CXR, ECG, echocardiogram • blood tests – biochemistry, haemoglobin • passive movement and mobilisation	Clear communication and handover within the team Capacity to provide culturally safe (intimate personal) care Capacity to include escort	Unfamiliar healthcare environment and routine Pain and fear (and unfamiliar with pain relief options) Cultural isolation (being away from family, friends, and traditional Lands) Concerns about lack of privacy Patient, escort overwhelmed (potentially unsure of expectations from hospital staff) Increasing independence with mobility and self-care Cultural considerations around pain management	Escort involvement in patient care (if appropriate) Access to phone and/or video to communicate directly with family and friends at home Culturally appropriate care – appropriate staff available to conduct male and female procedures *NOTE: AHP provides regular updates to local primary healthcare team and family at home* *NOTE: AHP accompanies escort to visit patient during intensive care admission. They also advocate for the patient while under intensive care, and provide ongoing support to the escort and others associated with the patient*
Post-surgery ward-based care **(day 2-5 after surgery)**	Cardiothoracic surgeon ALO AHW, AHP Nurse Cardiac rehabilitation Physiotherapist Clinical pharmacist	Daily cardiothoracic review Routine monitoring and management: • monitoring vital signs • daily weight Blood tests as indicated: • daily INR • haemoglobin • troponin Wound management Pain management Deep breathing & coughing exercises DAY 2 Removal of urinary catheter Light diet and oral fluids as tolerated First shower and/or sit out of bed Physiotherapist review (sit out of bed/shower)	Capacity to provide culturally safe (intimate personal) care Capacity for clear communication and clinical handover Planning for discharge from ward Capacity to plan discharge with local primary healthcare team		

Table 11.8. Patient surgery journey (continued)

STAGE	PERSONNEL	MANAGEMENT	SYSTEM FACTORS	CONSIDERATIONS	PATIENT CARE
		DAY 3–5 Removal central venous catheter Removal temporary pacing wires (if used) Increased physical mobility as tolerated Commence team, patient, escort discussions: • discharge planning • care after discharge Cardiac rehabilitation review			
Post-surgery ward-based care **(day 5 after surgery to discharge)**	Cardiothoracic surgeon ALO AHW, AHP Nurse Cardiac rehabilitation Physiotherapist Clinical pharmacist Social worker (if indicated)	Daily cardiothoracic review Routine monitoring and management: • monitoring vital signs • daily weight Blood tests as indicated: • daily INR • haemoglobin • troponin Normal diet as tolerated Wound management Pain management Deep breathing & coughing exercises Continue team, patient, escort discussions: • discharge planning • care after discharge Cardiac rehabilitation review			
Hospital Discharge Planning[††] **(discharge on day 5 or 6 post-surgery)**	Nurse AHW, AHP ALO Cardiac Rehabilitation Physiotherapist Pharmacist	Comprehensive discharge report to primary healthcare service and local cardiologist Team, patient, escort discussion: • what to expect after surgery (diet, wound care, sleeping, mental health, energy levels, constipation) • guidelines for mobility, pain management, medications, driving etc. • infective endocarditis prevention (formal prophylaxis and management of small infections) Cardiac rehabilitation review prior to discharge Medication review, including discharge medications Future appointment bookings: • Hospital in the Home • INR AHP contact information provided	Established process for discharge Clear communication and handover within the team Capacity to incorporate patient, escort care preferences Capacity to involve local primary healthcare team during discharge planning Visit from *Hospital in the Home*	Uncertainty about support after hospital discharge	Written information to guide patient through the post-discharge period *NOTE: ALO assists with Centrelink, finances, travel arrangements, transport to and from hospital*

Table 11.8. Patient surgery journey (continued)

STAGE	PERSONNEL	MANAGEMENT	SYSTEM FACTORS	CONSIDERATIONS	PATIENT CARE
Residential Convalescence (for 1 week prior to travel home)	Nurse AHW, AHP ALO Cardiac rehabilitation	Indirect support with daily living Hospital in the Home nurse visit (including INR if required) Surgical review prior to travel home – AHP in attendance	Access to hospital Access to local facilities (shops, public transport) Access to ALO for guidance and support	Unfamiliar metropolitan environment Post-operative pain or complications	Support to navigate metropolitan environment Transport to hospital Clear instruction for expectations during this period 24-hour contact for clinical support Access to money for food, and entertainment
Travel home OUTCOME: Smooth transfer between cardiothoracic surgery hospital and home (or regional health facility)	See: *Travel to surgical facility (above)*	Transfer between metropolitan residential facility and home.	See: *Travel to surgical facility* (above)		

The term escort is used to describe the person or people who accompany the patient to hospital. The escort/s may be family members, friends, or community representatives.
† A heart team for RHD should include people with expertise in rheumatic and valvular heart disease such as cardiologists, cardiac surgeons, anaesthetists, allied health staff and, when indicated, intensive care physicians, infectious disease physicians and obstetricians (as indicated).
‡ Cardiothoracic surgical facilities are based in tertiary hospitals in Perth, Adelaide, Brisbane, Melbourne and Sydney.
§ Cardiothoracic (open heart) surgery usually takes between 3-5 hours; transcatheter surgery usually takes about 1-5 hours.
¶ Patients with complications and complex comorbidities may need to stay in the intensive care unit for an extended period.
†† Elements of hospital discharge planning should commence at admission to hospital.
GP, General Practitioner; AHW, Aboriginal Health Worker; AHP, Aboriginal Health Practitioner; MRSA, methicillin-resistant Staphylococcus aureus; VRE, vancomycin-resistant enterococci; CRE, carbapenem-resistant Enterobacteriaceae; ALO, Aboriginal Liaison Officer; ECG, electrocardiogram; CXR, chest x-ray; CT, computed tomography (scan); INR, International Normalised Ratio

REFERENCES

1 Australian Government Department of Health and Ageing (2008). Report on the Audit of Health Workforce in Rural and Regional Australia, April 2008. Commonwealth of Australia, Canberra.

2 Tibby D, Corpus R, Walters DL. Establishment of an innovative specialist cardiac indigenous outreach service in rural and remote Queensland. Heart Lung and Circulation. 2010;19(5-6):361-366.

3 Walsh WF, Kangaharan N. Cardiac care for Indigenous Australians: practical considerations from a clinical perspective. Medical Journal of Australia. 2017;207(1):40-45.

4 Razavi H, Copeland SP, Turner AW. Increasing the impact of teleophthalmology in Australia: Analysis of structural and economic drivers in a state service. Australian Journal of Rural Health. 2017;25(1):45-52.

5 Thaker DA, Monypenny R, Olver I, Sabesan S. Cost savings from a telemedicine model of care in northern Queensland, Australia. Medical Journal of Australia. 2013;199(6):414-417.

6 Nishimura RA, Otto CM, Bonow RO, et al. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. The Journal of Thoracic and Cardiovascular Surgery. 2014;148(1):e1-e132.

7 Baumgartner H, Falk V, Bax JJ, et al. 2017 ESC/EACTS Guidelines for the Management of Valvular Heart Disease. European Heart Journal. 2017;71(2):2739-2791.

8 Ford C, English A, Sigman G. Confidential Health Care for Adolescents: position paper for the society for adolescent medicine. Journal of Adolescent Health. 2004;35(2):160-167.

9 Lansdown G. Every Child's Right to be Heard: A resource guide on the UN committee on the rights of the child: General comment no.12. London: Save the Children UK and UNICEF. 2011.

10 World Health Organization & Joint United Nations Programme on HIV/AIDS . Global standards for quality health-care services for adolescents: a guide to implement a standards-driven approach to improve the quality of health care services for adolescents. Volume 2: Implementation guide. Geneva, 2015.

11 World Health Organization. Rheumatic fever and rheumatic heart disease: report of a WHO expert consultation, Geneva, 29 October–1 November 2001. WHO technical report series 923. 2004.

12 Vasan RS, Shrivastava S, Vijayakumar M, et al. Echocardiographic evaluation of patients with acute rheumatic fever and rheumatic carditis. Circulation. 1996;94(1):73-82.

13 Chagani H, Aziz K. Clinical profile of acute rheumatic fever in Pakistan. Cardiology in the Young. 2003;13(1):28-35.

14 Kassem A, el-Walili TM, Zaher SR, et al. Reversibility of mitral regurgitation following rheumatic fever: clinical profile and echocardiographic evaluation. Indian Journal of Pediatrics, 1995;62(6):717-23.

15 Milliken A. The short-term morbidity of acute rheumatic fever in children and youth under the age of 20 years at first diagnosis in Auckland, 1998–1999. 2003, The University of Auckland, New Zealand.

16 Tompkins D, Boxerbaum BMD, Liebman JMD. Long-term prognosis of rheumatic fever patients receiving regular intramuscular benzathine penicillin. Circulation. 1972;45(3):543-551.

17 Rwebembera J, Marangou J, Mwita JC, et al. 2023 World Heart Federation guidelines for the echocardiographic diagnosis of rheumatic heart disease. Nat Rev Cardiol. 2024;21(4):250-263.

18 Meira Z, Goulart EMA, Colosimo EA, Mota CC. Long term follow up of rheumatic fever and predictors of severe rheumatic valvar disease in Brazilian children and adolescents. Heart (British Cardiac Society). 2005;91(8):1019-1022.

19 Kamblock J, N'Guyen L, Pagis B, et al. Acute severe mitral regurgitation during first attacks of rheumatic fever: clinical spectrum, mechanisms and prognostic factors. Journal of Heart Valve Diseases. 2005;14(4):440-446.

20 Zühlke L, Karthikeyan G, Engel ME, et al. Clinical Outcomes in 3343 Children and Adults with Rheumatic Heart Disease From 14 Low- and Middle-Income Countries: Two-Year Follow-Up of the Global Rheumatic Heart Disease Registry (the REMEDY Study). Circulation. 2016;134(19):1456-1466.

21 Reményi B, El Guindy A, Smith SC, Yacoub M, Holmes DR Jr. Valvular aspects of rheumatic heart disease. The Lancet. 2016;387:1335-1346.

22 Russell EA, Walsh WF, Costello B, et al. Medical Management of Rheumatic Heart Disease: A Systematic Review of the Evidence. Cardiology in Review. 2018;26(4):187-195.

23 Bolling SF, Li S, O'Brien SM, et al. Predictors of mitral valve repair: clinical and surgeon factors. Annals of Thoracic Surgery. 2010; 90(6):1904-1911; discussion 1912.

24 McGurty D, Reményi B, Cheung M, et al. Outcomes after rheumatic mitral valve repair in children. Annals of Thoracic Surgery. 2019;108(3):792-797.

25 Reményi B, Webb R, Gentles T, et al. Improved long-term survival for rheumatic mitral valve repair compared to replacement in the young. World Journal for Pediatric and Congenital Heart Surgery. 2013;4(2):155-164.

26 d' Udekem Y, Siddiqui J, Seaman CS, et al. Long-term results of a strategy of aortic valve repair in the pediatric population. The Journal of Thoracic and Cardiovascular Surgery. 2013;145(2):461-7; discussion 467-469.

27 d' Udekem Y. Aortic valve repair in children. Annals of Cardiothoracic Surgery. 2013;2(1):100-104.

28 Keenan NM, Newland RF, Baker RA, et al. Outcomes of Redo Valve Surgery in Indigenous Australians. Heart Lung and Circulation. 2018;28(7):1102-1111.

29 Murdoch DJ, Webb JG. Transcatheter valve-in-valve implantation for degenerated surgical bioprostheses. Journal of Thoracic Disease. 2018;10(Suppl 30):S3573-S3577.

30 Keenan NM, Bennetts JS, McGavigan AD, et al. Transcatheter Transseptal Mitral Valve-in-Valve Replacement: An Early Australian Case Series and Literature Review. Heart Lung and Circulation. 2020;29(6):921-930.

31 Goldstone AB, Chiu P, Baiocchi M, et al. Mechanical or Biologic Prostheses for Aortic-Valve and Mitral-Valve Replacement. The New England Journal of Medicine. 2017;377(19):1847-1857.

32 Hammermeister K, Sethi GK, Henderson WG, et al. Outcomes 15 years after valve replacement with a mechanical versus a bioprosthetic valve: final report of the Veterans Affairs randomized trial. Journal of the American College of Cardiology. 2000;36(4):1152-1158.

33 van Gedorp, Jamieson, EWR, Kappetein AP, et al. Patient outcome after aortic valve replacement with a mechanical or biological prosthesis: weighing lifetime anticoagulant-related event risk against reoperation risk. Journal of Thoracic and Cardiovasc Surgery. 2009;137:881-886.

34 Head SJ, Çelik M, Kappetein AP. Mechanical versus bioprosthetic aortic valve replacement. European Heart Journal. 2017;38(28):2183-2191.

35 Russell EA, Walsh WF, Reid CM, et al. Outcomes after mitral valve surgery for rheumatic heart disease. Heart Asia. 2017;9(2):e010916.

36 Alizzi A, Knight J, Tully PJ. Surgical challenges in rheumatic heart disease in the Australian Indigenous population. Heart Lung Circulation. 2010.19(5-6):295-299.

37 McLean A, Waters M, Spencer E, Hadfield C. Experience with cardiac valve operations in Cape York Peninsula and the Torres Strait Islands, Australia. The Medical Journal of Australia. 2007;186(11):560-563.

38 Russell EA, Tran L, Baker RA, et al. A review of outcome following valve surgery for rheumatic heart disease in Australia. BMC Cardiovascular Disorders. 2015; 15:103.

39 McDonald M, Currie B. Outcomes of cardiac surgery in Aboriginal Australians: what are the problems and what's to be done? Heart Lung Circulation. 2004;13(2):129-131.

40 Matebele MP, Rohde S, Clarke A, Fraser JF. Cardiac surgery in indigenous Australians: early onset cardiac disease with follow-up challenges. Heart Lung and Circulation. 2014;23(6):566-571.

41 National Heart Foundation of Australia and Cardiac Society of Australia and New Zealand Heart Failure Guidelines Working Group, Atherton JJ, Sindone A, De Pasquale CG, et al. National Heart Foundation of Australia and Cardiac Society of Australia and New Zealand: Guidelines for the Prevention, Detection, and Management of Heart Failure in Australia 2018. Heart Lung Circ. 2018;27(10):1123-1208.

42 Wisenbaugh T, Skudicky D, Sareli P. Prediction of outcome after valve replacement for rheumatic mitral regurgitation in the era of chordal preservation. Circulation. 1994;89(1):191-197.

43 Crawford M, Souchek JP, Oprian CAP, et al. Determinants of survival and left ventricular performance after mitral valve replacement. Circulation. 1990;81(4):1173-1181.

44 Enriquez-Sarano M, Tajik AJ, Schaff HV, et al. Echocardiographic prediction of left ventricular function after correction of mitral regurgitation: results and clinical implications. Journal of the American College of Cardiology. 1994;24(6):1536-1543.

45 Eguchi K, Ohtaki E, Matsumura T, et al. Pre-operative atrial fibrillation as the key determinant of outcome of mitral valve repair for degenerative mitral regurgitation. European Heart Journal. 2005;26(18):1866-1872.

46 Grigioni F, Avierinos JF, Ling LH, et al. Atrial fibrillation complicating the course of degenerative mitral regurgitation: determinants and long-term outcome. Journal of the American College of Cardiology. 2000;40(1):84-92.

47 Lim E, Barlow CW, Hosseinpour AR, et al. Influence of atrial fibrillation on outcome following mitral valve repair. Circulation. 2001;104(12, S1):I59-I63.

48 Gentles TL, Finucane AK, Reményi B, et al. Ventricular Function Before and After Surgery for Isolated and Combined Regurgitation in the Young. Annals of Thoracic Surgery. 2015;100(4):1383-1389.

49 Carabello BA. The current therapy for mitral regurgitation. Journal of the American College of Cardiology. 2008;52(5):319-326.

50 Kim J, Kim HJ, Moon DH, et al. Long-term outcomes after surgery for rheumatic mitral valve disease: valve repair versus mechanical valve replacement. European Journal of Cardiothoracic Surgery. 2010;37:1039-1046.

51 Shuhaiber J, Anderson RJ. Meta-analysis of clinical outcomes following surgical mitral valve repair or replacement. European Journal of Cardiothoracic Surgery. 2007;31(2):267-75.

52 Borer J, Bonow RO. Contemporary approach to aortic and mitral regurgitation. Circulation. 2003;108(20):2432-2438.

53 Enriquez-Sarano M, Schaff HV, Orszulak TA, et al. Valve repair improves the outcome of surgery for mitral regurgitation. Circulation. 1995;91(4):1022-1028.

54 Vassileva CM, Mishkel G, McNeely C, et al. Long-term survival of patients undergoing mitral valve repair and replacement: a longitudinal analysis of Medicare fee-for-service beneficiaries. Circulation. 2013;127(18):1870-1876.

55 Yau T, El-Ghoneimi YA, Armstrong S, et al. Mitral valve repair and replacement for rheumatic heart disease. Journal of Thoracic and Cardiovascular Surgery. 2000;119(1):53-61.

56 Kim WK, Kim HJ, Kim JB, et al. Clinical outcomes in 1731 patients undergoing mitral valve surgery for rheumatic valve disease. Heart (British Cardiac Society). 2018;104(10):841-848.

57 Deloche A, Jebara VA, Relland, JY, et al. Valve repair with Carpentier techniques. The second decade. Journal of Thoracic and Cardiovasc Surgery. 1990; 99(6):990-1002.

58 DiBardino D, El Bardissi AW, McClure RS, et al. Four decades of experience with mitral valve repair: analysis of differential indications, technical evolution and long-term outcome. Journal of Thoracic and Cardiovasc Surgery. 2010;139(1):76-84.

59 Chauvaud S, Fuzellier JF, Berrebi A, Deloche A, Fabiani JN, Carpentier A. Long-term (29 years) results of reconstructive surgery in rheumatic mitral valve insufficiency. Circulation. 2001;104(12 Suppl 1):I12-I15.

60 Talwar S, Rajesh MR, Subramanian A, et al. Mitral valve repair in children with rheumatic heart disease. Journal of Thoracic and Cardiovasc Surgery. 2005;129(4):875-879.

61 Gupta A, Gharde P, Kumar AS. Anterior mitral leaflet length: predictor for mitral valve repair in a rheumatic population. Annals of Thoracic Surgery. 2010;90(6):1930-1933.

62 Skoularigis J, Sinovich V, Joubert G, et al. Evaluation of the long-term results of mitral valve repair in 254 young patients with rheumatic mitral regurgitation. Circulation. 1994;90 (5 Pt 2):II167-II174.

63 Essop M, Nkomo VT. Rheumatic and nonrheumatic valvular heart disease: epidemiology, management and prevention in Africa. Circulation. 2005;112(23):3584-3591.

64 Whitlock RP, Sun JC., Fremes SE, Rubeet al. Antithombotic and thrombolytic therapy for valvular disease: Antithrombotic therapy and prevention of thrombosis: American College of Chest Physicians Evidence- Based Clinical Practice Guidelines. (9th Edition) Chest. 2012;141(2):suppl e576S-e600S.

65 Rahimtoola SH. Choice of prosthetic valve in adults. An update. Journal of the American College of Cardiology. 2010;55:2413-2426.

66 Chowdhury UK, Rizvi A, Narang R, et al. Mitral valve replacement using Carpentier-Edwards pericardial bioprosthesis in patients with rheumatic heart disease aged below 40 years: 17-year results. Heart Lung and Circulation. 2018;27(7):864-871.

67 Ruel M, Kulik M, Lam BK, et al. Long-term outcomes of valve replacement with modern prostheses in young adults. European Journal of Cardio-Thoracic Surgery. 2005;27(3):425-433.

68 Chandrashekhar Y, Westaby S, Narula J. Mitral stenosis. The Lancet. 2009;374(9697):1271-1283.

69 Schwammenthal E, Vered Z, Agranat O, et al. Impact of atrioventricular compliance on pulmonary artery pressure in mitral stenosis: an exercise echocardiographic study. Circulation. 2000; 02(19):2378-2384.

70 Saggu DK, Narain VS, SK D, et al. Effect of ivabradine on heart rate and duration of exercise in patients with mild-to-moderate mitral stenosis: A randomized comparison with metoprolol. Journal of Cardiovascular Pharmacology. 2015;65(6):552-554.

71 Agrawal V, Kumar N, Lohiya B, et al. Metoprolol vs ivabradine in patients with mitral stenosis in sinus rhythm. International Journal of Cardiology. 2016;221(221):562-566.

72 Fox KI, Ford I, Steg PG, et al. Ivabradine for patients with stable coronary artery disease and left-ventricular systolic dysfunction (BEAUTIFUL): a randomised, double-blind, placebo-controlled trial. The Lancet. 2008;372(9641):807-816.

73 Bonnet D, Berger F, Jokinen E, et al. Ivabradine in Children with Dilated Cardiomyopathy and Symptomatic Chronic Heart Failure. Journal of the American College of Cardiology. 2017;70(10):1262-1272.

74 Nobuyoshi M, Arita T, Shirai S, et al. Percutaneous balloon mitral valvuloplasty. Circulation. 2009;99(12):1580-1586.

75 Hernandez R, Banuelos C, Alfonso F, et al. Long-term clinical and echocardiographic follow-up after percutaneous valvuloplasty with the Inoue balloon. Circulation. 1999;99(12):1580-1506.

76 Iung B, Garbarz E, Michaud P, et al. Late results of percutaneous mitral commissurotomy in a series of 1024 patients. Analysis of late clinical deterioration: frequency, anatomic findings, and predictive factors. Circulation. 1999;99(25):3272-3278.

77 Reyes V, Raju BS, Wynne J, et al. Percutaneous balloon valvuloplasty compared with open surgical commissurotomy for mitral stenosis. New England Journal of Medicine. 1994;331(15):961-967.

78 Turi Z, Reyes VP, Raju BS, et al. Percutaneous balloon versus surgical closed commissurotomy for mitral stenosis. A prospective randomized trial. Circulation. 1991;83(4):1179-1185.

79 Fawzy M, Hassan W, Stefadouros M, et al. Prevalence and fate of severe pulmonary hypertension in 559 consecutive patients with severe rheumatic mitral stenosis undergoing mitral balloon valvotomy. Journal of Heart Valve Diseases. 2004;13(6):942-948.

80 McCann A, Walters DA, Aroney CN. Percutaneous balloon mitral commissurotomy in Indigenous versus non-Indigenous Australians. Heart Lung Circulation. 2008;17(3):200-205.

81 Wilkins GT, Weyman AE, Abascal VM, et al. Percutaneous balloon dilatation of the mitral valve: an analysis of echocardiographic variables related to outcome and the mechanism of dilatation. British Heart Journal. 1988;60(4):299-308.

82 Klein A, Grimm RA, Murray RD, et al. Assessment of cardioversion using transesophageal echocardiography investigators. Use of transoesophageal echocardiography to guide cardioversion in patients with atrial fibrillation. New England Journal of Medicine. 2001;344(19):1411-1420.

83 McCredie RM, Allan RM, Hill AT, Black IW. Percutaneous transseptal mitral valvotomy-progress report. Australian and New Zealand Journal of Medicine. 1998;28(6):805-810.

84 Badheka AO, Shah N, Ghatak A, et al. Balloon mitral valvuloplasty in the United States: a 13-year perspective. American Journal of Medicine. 2014;127(11):1126. e1-e12.

85 Lin M, Chiang HT, Lin SL, et al. Vasodilator therapy in chronic asymptomatic aortic regurgitation: Enalapril versus hydralazine therapy. Journal of the American College of Cardiology. 1994;24(4):1046-1053.

86 Søndergaard L, Aldershvile J, Hilderbrandt P, et al. Vasodilation with felodipine in chronic asymptomatic aortic regurgitation. American Heart Journal. 2000;139(4):667-674.

87 Elder DH, Wei L, Szwejkowski BR, et al. The impact of renin-angiotensin-aldosterone system blockade on heart failure outcomes and mortality in patients identified to have aortic regurgitation: a large population cohort study. Journal of the American College of Cardiology. 2011;58(20):2084-2091.

88 Sampat U, Varadarajan P, Turk R, et al. Effect of beta-blocker therapy on survival in patients with severe aortic regurgitation: Results from a cohort of 756 patients. Journal of the American College of Cardiology. 2009;54(5):452-457.

89 Bonow R, Carabello BA, Chatterjee K, et al. ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines, developed in collaboration with the Society of Cardiovascular Anesthesiologists endorsed by the Society for Cardiovascular Angiography and Interventions and the Society of Thoracic Surgeons. Journal of the American College of Cardiology. 2006;48(3):e1-48.

90 Tarasoutchi F, Grinberg M, Spina GS, et al. Ten-year clinical laboratory follow-up after application of a symptom-based therapeutic strategy to patients with severe chronic aortic regurgitation of predominant rheumatic aetiology. Journal of the American College of Cardiology. 2003;41(8):1316-1324.

91 Ishii D, Hirota Y, Suwa M, et al. Natural history and left ventricular response in chronic aortic regurgitation. American Journal of Cardiology. 1996;78(3):357-361.

92 Dujardin K, Enriquez-Sarano M, Schaff HV, et al. Mortality and morbidity of aortic regurgitation in clinical practice. A long-term follow-up study. Circulation. 1999;99(14):1851-1857.

93 Tornos P, Sambola A, Permanyer-Miralda G, et al. Long-term outcome of surgically treated aortic regurgitation: influence of guideline adherence toward early surgery. Journal of the American College of Cardiology. 2006;47(5):1012-1017.

94 Pibarot P, Dumesnil JG. Prosthetic heart valve: Selection of optimal prosthesis and long-term management. Circulation. 2009;119:1034-1048.

95 Puskas J, Gerdisch M, Nichols D, et al; PROACT Investigators. Reduced anticoagulation after mechanical aortic valve replacement: interim results from the prospective randomized on-X valve anticoagulation clinical trial randomized Food and Drug Administration investigational device exemption trial. J Thorac Cardiovasc Surg. 2014;1;47(4):1202-10;discussion 1210-1211.

96 Bourguignon T, Bouquiaux-Stablo A, Loardi C, et al. Very late outcomes for mitral valve replacement with the Carpentier-Edwards pericardial bioprosthesis: 25-year follow-up of 450 implantations. The Journal of Thoracic and Cardiovascular Surgery. 2014;148(5):2004-11. e1

97 Puvimanasingehe J, Steyerberg EW, Takkenberg JJM, et al. Prognosis after aortic valve replacement with a bioprosthesis. Prediction based on meta-analysis and microsimulation. Circulation. 2000;103:1535-1541.

98 Walther T, Hamm CW, Schuler G, et al. Perioperative Results and Complications in 15,964 Transcatheter Aortic Valve Replacements: Prospective Data from the GARY Registry. Journal of the American College of Cardiology. 2015;65(20):2173-2180.

99 Talwar S, Saikrishna C, Saxena A, et al. Aortic valve repair for rheumatic aortic valve disease. Annals of Thoracic Surgery. 2005;9:1921-1925.

100 Bozbuga N, Erentug V, Kirali K, et al. Midterm results of aortic valve repair with the pericardial cusp extension technique in rheumatic valve disease. Annals of Thoracic Surgery. 2004;77(4):1272-1276.

101 Grinda J, Latremouille C, Berrebi AJ, et al. Aortic cusp extension valvuloplasty for rheumatic aortic valve disease: midterm results. Annals of Thoracic Surgery. 2002;74(2):438-443.

102 Carr J, Savage EB. Aortic valve repair for aortic insufficiency in adults: a contemporary review and comparison with replacement techniques. European Journal of Cardiothoracic Surgery. 2004;25(1):6-15.

103 Arabkhani B, Bekkers JA, Andrinopoulou ER, et al. Allografts in aortic position: Insights from a 27-year, single-center prospective study. The Journal of Thoracic and Cardiovascular Surgery. 2016;152(6):1572-1579.

104 Yap C, Yii M. Allograft aortic valve replacement in the adult: a review. Heart Lung Circulation. 2004;13(1):41-51.

105 Lund O, Chandrasekaran V, Grocott-Mason R, et al. Primary aortic valve replacement with allografts over twenty-five years: valve related and procedure related determinants of outcome. Journal of Thoracic and Cardiovascular Surgery. 1999;117(1):77-90.

106 El-Hamamsy I, Eryigit Z, Stevens LM, et al. Long-term outcomes after autograft versus homograft aortic root replacement in adults with aortic valve disease: a randomised trial. Lancet. 2010;376(9740):524-531.

107 Sievers H, Stierle U, Charitos EI et al. Major adverse cardiac and cerebrovascular events after the Ross procedure. A report from the German– Dutch Ross registry. Circulation. 2010;122(S11):S216-S223.

108 Tan Tanny SP, Yong MS, d' Udekem Y, et al. Ross procedure in children: 17-year experience at a single institution. Journal of the American Heart Association. 2013;2(2):e000153.

109 Feier H, Collart F, Ghez O, et al. Risk factors, dynamics and cutoff values for homograft stenosis after the Ross procedure. Annals of Thoracic Surgery. 2005;79(5):1669-1675.

110 Stukak J, Burkhardt HM, Sundt TM, et al. Spectrum and outcome of reoperations after Ross procedure. Circulation. 2010;122:1153-1158.

111 Chizner MA, Pearle DL, de Leon AC. The natural history of aortic stenosis in adults. American Heart Journal. 1980;99(4):419-424.

112 Schwarz F, Baumann P, Manthey J, et al. The effect of aortic valve replacement on survival. Circulation. 1982;66(5):1105-1110.

113 Nadir MA, Wei L, Elder DHJ, et al. Impact of renin-angiotensin system blockade therapy on outcome in aortic stenosis. Journal of the American College of Cardiology. 2011;58(6):570-576.

114 Briand M, Dumesnil JG, Kadem L, et al. Reduced systemic arterial compliance impacts significantly on left ventricular afterload and function in aortic stenosis: implications for diagnosis and treatment. Journal of the American College of Cardiology. 2005;46(2):291-298.

115 Généreux P, Stone GW, O'Gara PT, et al. Natural history, diagnostic approaches, and therapeutic strategies for patients with asymptomatic severe aortic stenosis. Journal of the American College of Cardiology. 2016;67(19):2263-2288.

116 Rosenhek R, Binder T, Porenta G, et al. Predictors of outcome in severe, asymptomatic aortic stenosis. The New England Journal of Medicine. 2000;343(9):611-617.

117 Roques F, Nashef SA, Michel P, et al. Risk factors and outcome in European cardiac surgery: analysis of the EuroSCORE multinational database of 19030 patients. European Journal of Cardio-Thoracic Surgery. 1999;15(6):816-822; discussion 22-23.

118 O'Brien SM, Feng L, He X, et al. The Society of Thoracic Surgeons 2018 Adult Cardiac Surgery Risk Models: Part 2-statistical methods and results. Annals of Thoracic Surgery. 2018;105(5):1419-1428.

119 Leon MB, Smith CR, Mack MJ, et al. Transcatheter or surgical aortic-valve replacement in intermediate-risk patients. The New England Journal of Medicine. 2016;374(17):1609-1620.

120 Mack MJ, Leon MB, Thourani VH, et al. Transcatheter aortic-valve replacement with a balloon-expandable valve in low-risk patients. The New England Journal of Medicine. 2019;380(18):1695-1705.

121 Popma JJ, Deeb GM, Yakubov SJ, et al. Transcatheter aortic-valve replacement with a self-Expanding valve in low-risk patients. The New England Journal of Medicine. 2019;380(18):1706-1715.

122 Blackman DJ, Saraf S, MacCarthy PA, et al. Long-term durability of transcatheter aortic valve prostheses. Journal of the American College of Cardiology. 2019;73(5):537-545.

123 Søndergaard L, Ihlemann N, Capodanno D, et al. Durability of transcatheter and surgical bioprosthetic aortic valves in patients at lower surgical risk. Journal of the American College of Cardiology. 2019;73(5):546-553.

124 Jabbour R, Dick R, Walton AS. Aortic balloon valvuloplasty – review and case series. Heart Lung Circulation. 2008;17(S4):S73-S81.

125 Riffaie O, El-Itriby A, Zaki T, et al. Immediate and long-term outcome of multiple percutaneous interventions in patients with rheumatic valvular stenosis. Eurointervention. 2010;6(2):227-232.

126 Jones DR, Chew DP, Horsfall MJ, et al. Effect of Balloon Aortic Valvuloplasty on Mortality in Patients with Severe Aortic Stenosis Prior to Conservative Treatment and Surgical or Transcatheter Aortic Valve Replacement. Heart Lung and Circulation. 2020;29(5):719-728.

127 Lieberman EB, Bashore TM, Hermiller JB, et al. Balloon aortic valvuloplasty in adults: failure of procedure to improve long-term survival. Journal of the American College of Cardiology. 1995;26(6):1522-1528.

128 Marangou J, Rankin J, Larbalestier R, Yong G. Emergency Transcatheter Aortic Valve Replacement Versus Balloon Aortic Valvuloplasty for the Management of Decompensated Aortic Stenosis. Heart Lung and Circulation. 2017;26:S205.

129 Demir O, Lanzillo G, Mangieri A, et al. TCT-571 Outcomes of percutaneous balloon aortic valvuloplasty for severe aortic stenosis in patients presenting with cardiogenic shock. Journal of the American College of Cardiology. 2018;72(13, Supplement):B228-B229.

130 Nath J, Foster E, Heidenreich PA. Impact of tricuspid regurgitation on long-term survival. Journal of the American College of Cardiology. 2004;43(3):405-409.

131 Vassileva CM, Shabosky J, Boley T, et al S. Tricuspid valve surgery: the past 10 years from the Nationwide Inpatient Sample (NIS) database. The Journal of Thoracic and Cardiovascular Surgery. 2012;143(5):1043-1049.

132 Dreyfus GD, Corbi PJ, Chan KMJ, Bahrami T. Secondary tricuspid regurgitation or dilatation: which should be the criteria for surgical repair? Annals of Thoracic Surgery. 2005;79(1):127-132.

133 Van de Veire NR, Braun J, Delgado V, et al. Tricuspid annuloplasty prevents right ventricular dilatation and progression of tricuspid regurgitation in patients with tricuspid annular dilatation undergoing mitral valve repair. The Journal of Thoracic and Cardiovascular Surgery. 2011;141(6):1431-1439.

134 Unger P, Clavel MA, Lindman BR, et al. Pathophysiology and management of multivalvular disease. Nature Reviews Cardiology. 2016;13(7):429-440.

135 Unger P, Rosenhek R, Dedobbeleer C, et al. Management of multiple valve disease. Heart. 2011;97(4):272-277.

136 Egbe AC, Poterucha JT, Warnes CA. Mixed aortic valve disease: Midterm outcome and predictors of adverse events. European Heart Journal. 2016;37(34):2671-2678.

137 January CT, Wann LS, Alpert JS, et al. 2014 AHA/ACC/HRS Guideline for the Management of Patients with Atrial Fibrillation. A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and the Heart Rhythm Society. Circulation. 2014;130(23):e199-e267.

138 Connolly SJ, Ezekowitz MD, Yusuf S, et al. Dabigatran versus warfarin in patients with atrial fibrillation. The New England Journal of Medicine. 2009;361(12):1139-1151.

139 Patel MR, Mahaffey KW, Garg J, et al. Rivaroxaban versus warfarin in nonvalvular atrial fibrillation. The New England Journal of Medicine. 2011;365(10):883-891.

140 Granger C B, Alexander J H, McMurray JJV, et al. Apixaban versus warfarin in patients with atrial fibrillation. The New England Journal of Medicine. 2011;365(11):981-992.

141 Caldeira D, David C, Costa J, et al. Non-vitamin K antagonist oral anticoagulants in patients with atrial fibrillation and valvular heart disease: systematic review and meta-analysis. European Heart Journal Cardiovascular Pharmacotherapy. 2018;4(2):111-118.

142 Renda G, Ricci F, Giugliano RP, De Caterina R. Non-Vitamin K Antagonist Oral Anticoagulants in Patients with Atrial Fibrillation and Valvular Heart Disease. Journal of the American College of Cardiology. 2017;69(11):1363-1371.

143 Kim WK, Kim HJ, Kim JB, et al. Clinical outcomes in 1731 patients undergoing mitral valve surgery for rheumatic valve disease. Heart (British Cardiac Society). 2018;104(10):841-848.

144 Connolly SJ, Karthikeyan G, Ntsekhe M, et al; INVICTUS Investigators. Rivaroxaban in Rheumatic Heart Disease-Associated Atrial Fibrillation. N Engl J Med. 2022;387(11):978-988.

145 Eikelboom JW, Connolly SJ, Brueckmann M, et al. Dabigatran versus warfarin in patients with mechanical heart valves. The New England Journal of Medicine. 2013;369(13):1206-1214.

146 Thomas DP. An audit of INR control in the Australian Indigenous setting. Australian Family Physician, 2009;36(11): 959-961.

147 Gill J, Landis MK. Benefits of a mobile, point-of-care anti-coagulation therapy management program. The Joint Commission Journal on Quality Improvement. 2002;28(11):625-630.

148 Brieger D, Amerena J, Attia J, et al. National Heart Foundation of Australia and the Cardiac Society of Australia and New Zealand: Australian Clinical Guidelines for the Diagnosis and Management of Atrial Fibrillation 2018. Heart Lung and Circulation. 2018;27(10):1209-1266.

149 Galiè N, Humbert M, Vachiery J, et al. 2015 ESC/ERS Guidelines for the Diagnosis and Treatment of Pulmonary Hypertension. Revista Espanola De Cardiologia. (English Ed) 2016;69(2):177.

150 Silaruks S, Thinkhamrop B, Tantikosum W, et al. A prognostic model for predicting the disappearance of left atrial thrombi among candidates for percutaneous transvenous mitral commissurotomy. Journal of the American College of Cardiology. 2002;39(5):886-891.

151 Klein A, Grimm RA, Murray RD, et al. Assessment of cardioversion using transesophageal echocardiography investigators. Use of transoesophageal echocardiography to guide cardioversion in patients with atrial fibrillation. New England Journal of Medicine. 2001;344(19):1411-1420.

152 Milne O, Barthwal R, Agahari I, et al. Management and Outcomes of Prosthetic Valve Thrombosis. An Australian Case Series from the Northern Territory. Heart Lung and Circulation. 2020;29(3):469-474.

153 Cahill TJ, Prendergast BD. Infective endocarditis. The Lancet. 2016;387(10021):882-893.

154 Baddour LM, Wilson WR, Bayer AS, et al. Infective Endocarditis in Adults: Diagnosis, Antimicrobial Therapy, and Management of Complications: A Scientific Statement for Healthcare Professionals from the American Heart Association. Circulation. 2015;132(15):1435-1486.

155 Baskerville CA, Hanrahan BB, Burke AJ, et al. Infective endocarditis and rheumatic heart disease in the north of Australia. Heart Lung Circulation. 2012;21(1):36-41.

156 Thornhill MH, Dayer M, Lockhart PB, et al. A change in the NICE guidelines on antibiotic prophylaxis. British Dental Journal. 2016;221:112-114.

157 Dayer MJ, Jones S, Prendergast B, et al. Incidence of infective endocarditis in England, 2000-13: a secular trend, interrupted time-series analysis. The Lancet. 2015;385(9974):1219-1228.

158 Habib G, Lancellotti P, Antunes MJ, et al. 2015 ESC Guidelines for the management of infective endocarditis: The Task Force for the Management of Infective Endocarditis of the European Society of Cardiology (ESC). Endorsed by: European Association for Cardio-Thoracic Surgery (EACTS), the European Association of Nuclear Medicine (EANM). European Heart Journal. 2015;36(44):3075-3128.

159 Antibiotic Expert Groups. Therapeutic Guidelines: Antibiotic. Version 15. Melbourne, Australia: Therapeutic Guidelines Limited; 2014.

160 RHDAustralia (ARF/RHD writing group), Australian guideline for prevention, diagnosis and management of acute rheumatic fever and rheumatic heart disease (2nd edition). 2012

161 Wilson W, Taubert KA, Gewitz M, et al. Prevention of infective endocarditis: guidelines from the American Heart Association: a guideline from the American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee, Council on Cardiovascular Disease in the Young, and the Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and the Quality of Care and Outcomes Research Interdisciplinary Working Group. Circulation. 2007;116(15):1736-1754.

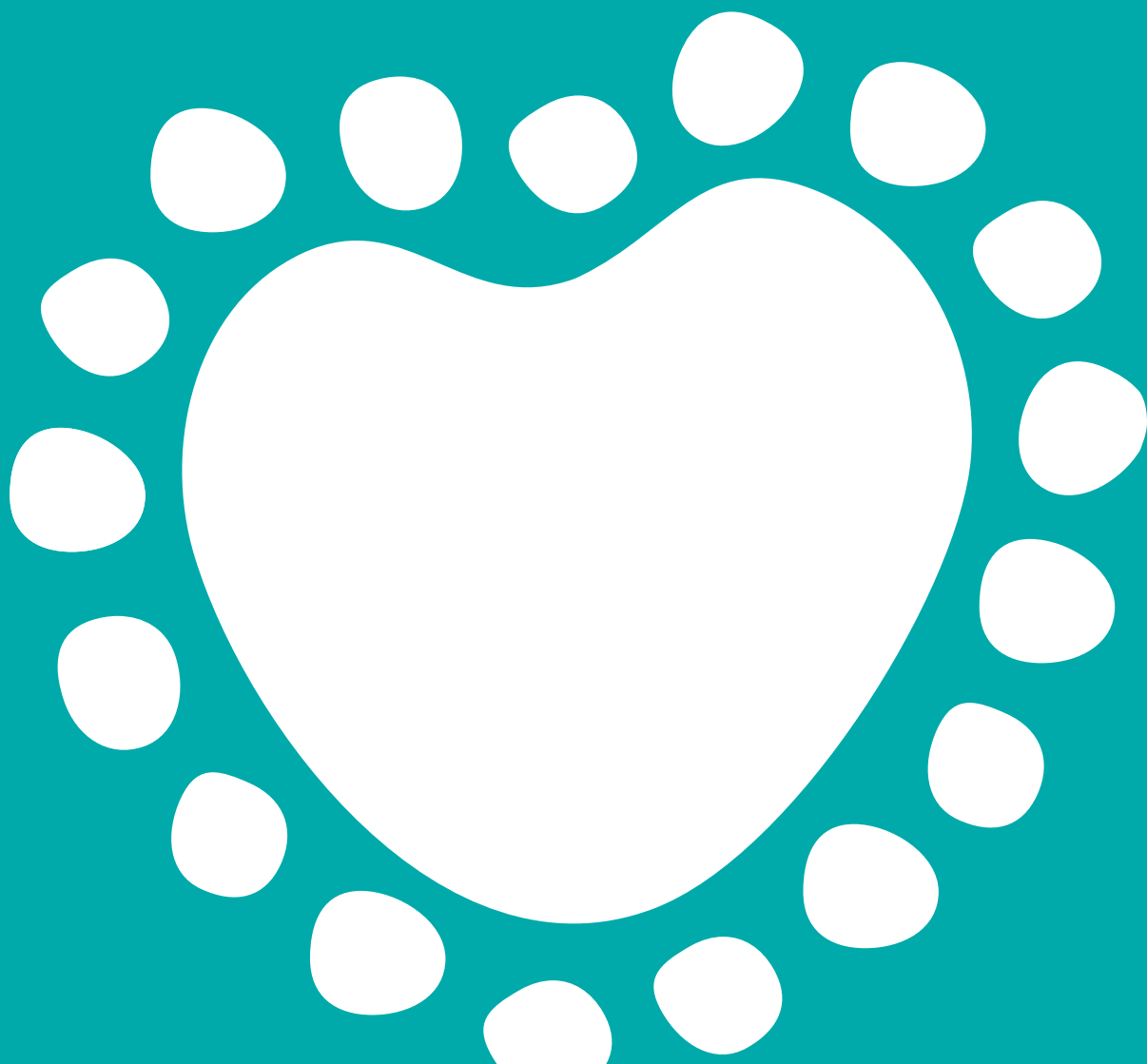
162 Silvestre FJ, Gil-Raga I, Martinez-Herrera M, et al. Prior oral conditions in patients undergoing heart valve surgery. Journal of Clinical and Experimental Dentistry. 2017;9(11):e1287-e1291.

163 Maharaj B, Vayej AC. Oral health of patients with severe rheumatic heart disease. Cardiovascular Journal of Africa. 2012;23(6):336-339.

164 Jamieson LM, Elani HW, Mejia GC, et al. Inequalities in Indigenous Oral Health: Findings from Australia, New Zealand, and Canada. Journal of Dental Research. 2016;95(12):1375-80.

CHAPTER 12

Women and girls with rheumatic heart disease



Women and girls with rheumatic heart disease

IMPORTANT CHANGES IN THIS CHAPTER

Emerging importance of early access to echocardiography for pregnant women in high-risk populations

Statement about Birthing on Country under Key Information (updated August 2025)

Updated information for metoprolol, labetalol, bisoprolol and diltiazem in Table 12.2 (updated August 2025)

KEY INFORMATION

- Effective multidisciplinary, community-centred care that is age-appropriate, encompasses reproductive health as well as cardiac and other health care and continues through the lifespan is imperative.
- Many women with RHD can safely conceive and have children. Women with mild RHD who are well-managed during their pregnancy may be able to birth on Country.
- Birthing on Country is a cultural tradition that connects First Nations pregnant women and fathers, birthing, and newborns with their ancestors' land, known as Country. It does not refer purely to geographical location; it is the provision of culturally safe care with women pregnant with a First Nations baby.
- Pre-conception diagnosis of RHD allows optimisation of management including surgical management, before pregnancy.
- There is a low threshold for performing echocardiography as part of antenatal care for any woman at high risk of RHD.
- Recommended contraceptives are long-acting reversible contraceptives (intra-uterine contraceptive device or etonogestrel implant such as *Implanon*). Oestrogen-containing contraceptives are associated with elevated risk of thrombosis and should be avoided.
- Women with RHD contemplating pregnancy or who are pregnant require coordinated health care. Aim to avoid multiple appointments incurring high travel costs and requiring time away from children and from community
- Anticoagulation is needed for all women and girls with mechanical prosthetic valves to prevent valve thrombosis, stroke and other thromboembolic disease and may be needed for atrial fibrillation depending on thromboembolic risk assessment. All anticoagulants pose risks in pregnancy. Risks to the mother include both antepartum and post-partum haemorrhage. Risks to the fetus include teratogenicity and stillbirth (warfarin). Similarly, prosthetic valve thrombosis carries a high risk of mortality. An approach to balancing risks and benefits is provided in these guidelines.
- When low molecular weight heparin is used in pregnancy to replace warfarin, monitoring of anti-Xa levels and appropriate dose adjustment is essential.
- Women with valve lesions posing problems in pregnancy (moderate or greater mitral stenosis, severe mitral or aortic regurgitation, severe aortic stenosis, pulmonary hypertension or heart failure) are at high risk with elevated chance of cardiac events during pregnancy and adverse fetal outcomes. They require specialist care and close monitoring.
- A left ventricular ejection fraction of <30% or reduced systolic function with New York Heart Association (NYHA) class III/IV symptoms is associated with high risk of maternal morbidity or mortality, and pregnancy is strongly discouraged.
- A pregnant or post-partum woman at higher risk of or diagnosed with RHD who presents with breathlessness, orthopnoea, wheeze or worsening fatigue should be investigated with an echocardiogram as a matter of priority.
- Normal vaginal delivery is preferred. Epidural anaesthesia – after appropriately-timed short-term cessation of anticoagulation – may be indicated to reduce tachycardia and hypertension that can precipitate acute heart failure during delivery.

Table 12.1. Summary – Care pathways for women and girls with RHD

ASPECT	DETAILS	GRADE
TRANSITION TO ADULT CARDIAC CARE & PRECONCEPTION CARE		
Transition to adult cardiac care	Begins at adolescence. Include paediatric and adult cardiology teams, family planning, primary health services with the adolescent girl and her family.	1C 2B
Reproductive health & contraception	Refer to obstetrician/gynaecologist and/or family planning clinic (may be done through First Nations child and family programs) as relevant. Promote effective contraception to help plan safe timing of pregnancies. Avoid oestrogen-containing contraceptives.	1C 1B
Preconception care (PCC) & planning pregnancy	Full assessment and echocardiogram. Assess co-morbidities. Check vaccination status, rubella/varicella immunity and cervical screening. Review medications, especially warfarin or ACE inhibitors/angiotensin receptor blockers (ARBs). Consider a wallet card with RHD alert and key points related to care requirements and medications.	1C 1A 2C
Surgery & other interventions pre-pregnancy	Consider choices (prosthetic type/repair/PBMV) in context of future pregnancy and associated risk. Discussion with adolescent/woman, her family and appropriate primary health services together with specialist. Pre-pregnancy intervention recommended in patients with asymptomatic severe or symptomatic mitral stenosis (MS), symptomatic severe aortic stenosis (AS) or symptomatic severe valve disease.	1C 1B
DURING PREGNANCY		
Diagnosis of RHD in pregnancy	Attentive history-taking and careful cardiovascular examination. Low threshold for echocardiogram and cardiac referral in at-risk populations.	1C 1C
Integrated care	Includes cardiac (or obstetric physician), obstetric, anaesthetic, midwifery, primary health teams, First Nations health services, Māori, Pacific Islanders or refugee health workforce support (other disciplines/sectors as relevant) with women and family. Incorporate Birthing on Country models of care principles.	1C

Table 12.1. Summary – Care pathways for women and girls with RHD (continued)

ASPECT	DETAILS	GRADE
Cardiac risk assessment & general principles of care	Clinical risk assessment at booking and as required during pregnancy. Baseline echocardiography at booking and as required during pregnancy according to risk (Figure 12.1). Anaesthetic assessment. Treatment in specialised centres by a multi-disciplinary pregnancy heart team for high-risk patients. Appropriate anticoagulation regimen where relevant. Interpreter services as required. Dental review. Assessment of social circumstances. Facilitate access to care depending on individual needs. Develop comprehensive birth plan as early as possible. Review/modify as needed. Discuss contraception: identify women who may desire tubal ligation at caesarean section or intrauterine device insertion at time of delivery.	1C 1C 1C 1C 2B 2B 2C 2C 1C 2C
Identify as high risk	Prior cardiac event (heart failure, transient ischaemic attack, stroke, arrhythmia) or events during pregnancy. Decreased left ventricular systolic function. Moderate or severe aortic and/or mitral stenosis. Pulmonary hypertension (PH). Mechanical valve prostheses or cardiac disorder requiring anticoagulation. Current heart failure or arrhythmia.	
RHD Register	Ensure the woman is on RHD Register in relevant jurisdictions. If not (or if not sure), contact RHD Register.	2B
Secondary prophylaxis	Determine ongoing need to be on secondary prophylaxis (usually 3–4 weekly benzathine benzylpenicillin G [BPG] injection) to prevent further rheumatic fever infection. If she is currently on regimen, check when next injection/oral antibiotic is due. Secondary prophylaxis is safe in pregnancy for mother and baby so should continue where prescribed.	1A
Mechanical heart valves & anticoagulation	Associated with high maternal and fetal risk. Discussion early in first trimester but ideally preconception to avoid warfarin in early pregnancy. Risk of warfarin embryopathy in first trimester. Risk of warfarin fetopathy in second and third trimesters. Highest risk of maternal thromboembolic complications with poor adherence to anticoagulation and/or monitoring, lack of appropriate multidisciplinary expertise especially when transitioning between different anticoagulant therapies.	1A 1C 1A 1A 1C

Table 12.1. Summary – Care pathways for women and girls with RHD (continued)

ASPECT	DETAILS	GRADE
Red flags	Symptoms and signs requiring urgent medical assessment: • new onset or progressive breathlessness or cough • need to sleep sitting up (orthopnoea) • significant reduction in exercise tolerance • syncope or presyncope (light headedness) • persistently fast heart rate (tachycardia) • wheeze and/or leg oedema	1C
LABOUR & BIRTH		
Labour & birth	Multi-disciplinary team approach (for First Nations women, include the First Nations Liaison Officer). Individualised birth plan taking account of cardiovascular and obstetric issues. Vaginal birth recommended unless obstetric and/or cardiovascular conditions preclude. Requirement for intrapartum intensive or invasive monitoring should be individualised depending on severity of underlying valvular disease. Follow anticoagulation protocol where relevant. Routine antibiotic prophylaxis for bacterial endocarditis not recommended and antibiotics should be given as per local obstetric indications. Aim for early epidural analgesia as tachycardia or hypertension may not be well tolerated because of maternal valvular disease. Oxytocin: administer slowly by infusion in third stage of labour. Avoid ergometrine in severe RHD, unless life-threatening bleeding.	2B 1C 2C 1A 1A 2C 2C 2C
POST-PARTUM & POST-DISCHARGE		
Post-partum	Consider need for diuretic therapy to assist with haemodynamic shifts post-partum. Follow anticoagulation protocol where relevant. Investigate post-partum/ post-discharge dyspnoea or new-onset cough promptly. Encourage breastfeeding and review safety of cardiac medications with lactation. Discuss family planning and contraception.	2C 1A 1A 1C 2C
Post-discharge	Follow-up cardiac review according to priority. Clinical communication follow-up with primary health services/GP/Aboriginal Medical Service and other relevant services. Maintain high degree of suspicion for presentation of dyspnoea.	1C 2C 1C
Information for health services & women	'Sharing a Heartbeat' Parts 1 & 2 short films and posters – for women and health services. eLearning modules (including Women and girls with RHD and RHD in Pregnancy).	

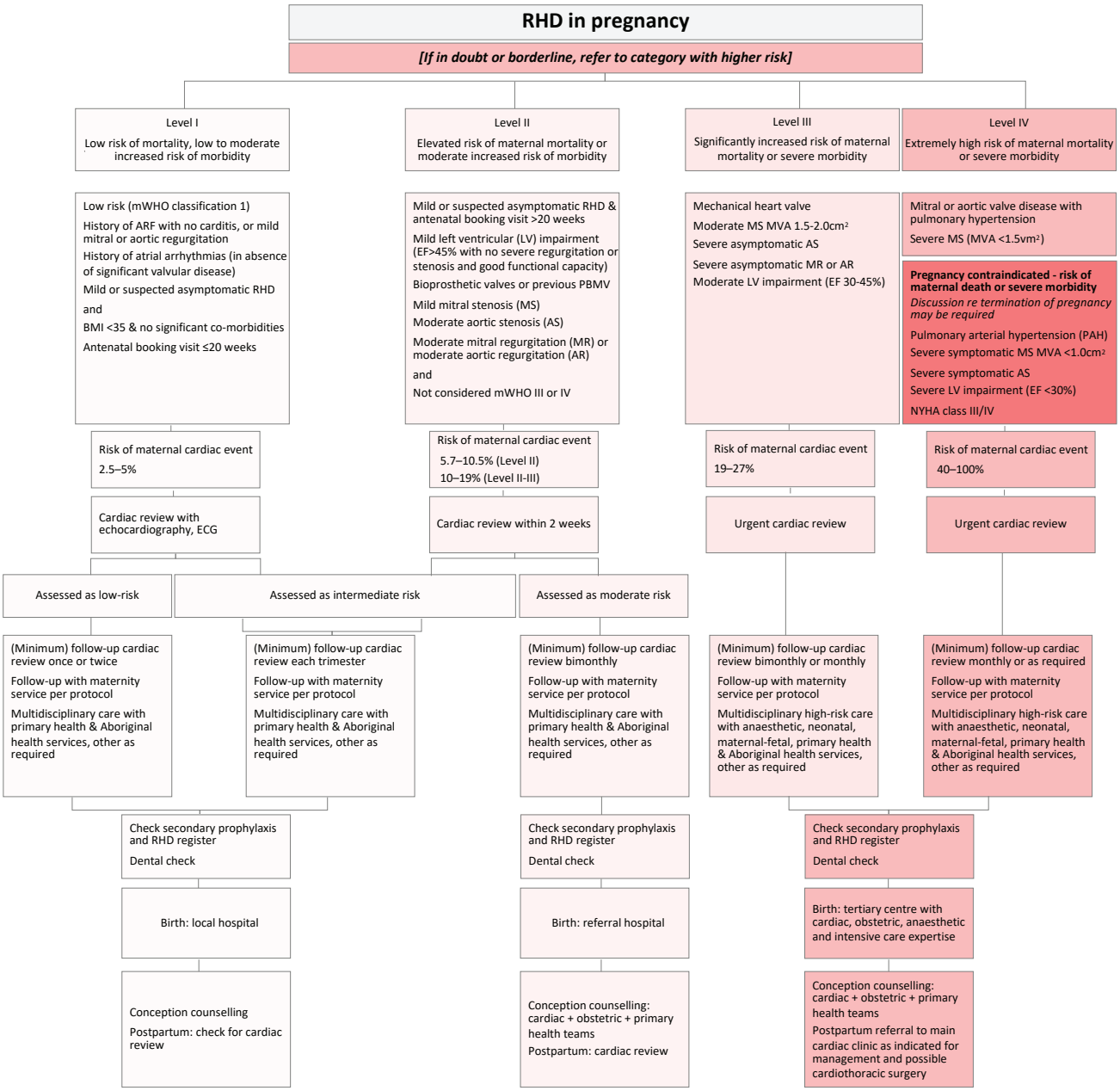


Figure 12.1. Care pathways and referral algorithm for pregnant women with RHD

Adapted with permission from Regitz-Zagrosek (2018),[1] and Sliwa (2014),[2]

NOTE: this and other guidelines addressing RHD during pregnancy are mostly based on case series and observational studies, often part of broader studies of all-valvular or all cardiovascular disease. Existing literature on preconception and reproductive health care is predominantly focused on congenital heart disease rather than RHD. Specific research to test the evidence is required to strengthen the rigour of recommendations, better understand the effects of pregnancy and choose the best individualised plan for ongoing care.

Abbreviations: Modified World Health Organization (mWHO), a system of classifying cardiac abnormalities in pregnancy; mitral regurgitation (MR); aortic regurgitation (AR); tricuspid regurgitation (TR); left ventricular (LV); pulmonary hypertension (PH); aortic stenosis (AS); mitral stenosis (MS); pulmonary arterial hypertension (PAH); mitral valve area (MVA); ejection fraction (EF).

Mild RHD: MVA >2 cm² AND EF=50–70% AND mitral or aortic or tricuspid regurgitation = none or mild AND no AS.

PAH: LV filling pressure <15 mmHg & pulmonary vascular resistance >3 Wood units

Significant co-morbidities include diabetes, BMI >35, chronic kidney disease, drug or alcohol dependency.

Risk of maternal cardiac event: according to modified World Health Organization classification of maternal cardiovascular risk adapted from Regitz-Zagrosek (2018).

DISCUSSION

"There's a need to make more informative resources for RHD clients. I felt there was a lack of information for young women in regard to pregnancy and having RHD. Young women and girls want answers to questions like, 'am I putting myself at risk if I want to have a baby?"

RHD Champion, 2019.

Overview

Rheumatic heart disease (RHD) is twice as common in women as in men.[3-7] In high-risk communities it is common for RHD to exist across multiple generations, with an additional burden of managing care and prevention in families, particularly where women are the primary caregivers. The 2018 World Health Assembly resolution recognises this, with a call to align RHD strategies with existing women's, children's and adolescent health programs.[8]

A woman's journey with RHD often starts well before pregnancy. Decisions during childhood about treatment interventions for RHD, such as surgery and anticoagulation, may be required. These decisions will have lifelong consequences. Health services must assume that an adolescent girl or woman may wish to become pregnant at some point in her life and assist her to make an informed choice against an often complex and challenging clinical background. Conversations about treatment and pregnancy planning with the woman, her caregiver, other family and partner as appropriate to age and circumstance should begin in adolescence and continue through reproductive years.

Pregnancy for women with RHD may reveal clinical symptoms in previously undiagnosed cardiovascular disease, resulting in complications and adverse outcomes for mother and baby.[9]

However, pregnancy also provides an important opportunity to re-engage with cardiovascular and RHD services. Optimal care, including early review and regular monitoring, reduces risk in pregnancy and can minimise maternal and fetal complications.[1,9,10] Women with mild RHD who receive appropriate care and reviews often have uncomplicated pregnancies, giving birth to a healthy baby at their local hospital. This chapter outlines core standards in the spectrum of whole-of-life care, including transition to adult cardiac care; sexual and reproductive health; preconception counselling, valvular lesions in pregnancy, surgery and other interventions; antenatal care including risk assessment; medications including anticoagulation; labour and birth; post-partum and post-discharge care.

These standards require a woman-centred, multi-disciplinary approach that is underpinned by a shared understanding of the impact of RHD with women and their families. They take account of culture and community practice: consistent with good maternity care.[11] As well as health literacy for women, girls and communities about the impact of RHD particularly in pregnancy, this chapter emphasises education and knowledge for the health workforce including primary health as well as tertiary care.

The clinical recommendations in this chapter provide broad principles of care that will vary according to level and type of health service, severity of RHD, and a woman's personal health circumstances and wishes. Most women with RHD in Australia are First Nations women (78% of women in a recent study of RHD in pregnancy).[9] Good care acknowledges the importance that Birthing on Country holds for First Nations women, which in turn can impact directly on pregnancy outcomes.[11-16] It takes an individualised approach: a First Nations woman living in Perth is likely to have different needs to a Torres Strait Islander woman on remote Badu Island. Their needs are shaped by their own situation, as well as cultural beliefs and practices, language, history, and place of residence.[17] This is similarly true for other high-risk populations – including Māori and Pacific Islander women residing in Australia, and women migrating to Australia from resource-poor countries.

Recommendations are intended to facilitate decision-making. However, the final decisions concerning an individual must be made by the treating health professional in consultation with the adolescent girl or woman, caregivers and family as appropriate, and in accordance with health protocols.

The care of women with other cardiovascular conditions such as coronary artery disease, cardiomyopathies and aortopathies may also be high risk requiring specialist input but are not covered in these guidelines.

Lastly, this and other guidelines addressing RHD during pregnancy are mostly based on case series and observational studies, often part of broader studies of all-valvular or all-cardiovascular disease. Existing literature on preconception and reproductive health care is predominantly focused on congenital heart disease rather than RHD. Specific research to test the evidence is required to strengthen the rigour of recommendations, better understand the effects of pregnancy and choose the best individualised plan for ongoing care.

Transitional care

Transition to adult reproductive health and preconception care

Planning for adulthood includes reproductive health and preconception care as well as the transition to adult cardiovascular care. Consultations should involve the cardiology (or obstetric physician) and obstetric specialists, primary health team and other disciplines such as the midwife, First Nations child and family teams, First Nations Health Practitioner or Māori, Pacific or refugee health workforce support, interpreter (as required) and family members as requested. Other intersectoral collaboration with, for example, school staff (particularly where a girl is at boarding school) may be required to support care plans for adolescents with RHD. All aim for a shared understanding of recommendations, concerns and care plans.

Obstetric and related care can be frightening for some young women. Check their preference of who should attend (partner, parent, health care worker), including if female health staff should conduct the examination.

As with all other RHD care, the transition to adulthood, reproductive health and preconception care considers social as well as clinical context. (See Jamaya's Story) Two-way communication between a known primary care provider and specialists, accompanied by discussion with the adolescent girl or woman and her team, may be the best way to promote a shared understanding of needs and risks so informed decisions can be made. This is particularly important where English is a second language or where health literacy is low.

Transition to adult cardiovascular care

Collaboration between paediatric and adult cardiovascular care should commence in early adolescence. Primary health services play a crucial role by providing individualised continuity of care and helping to educate both the young woman and her family. This will need re-assessment as she matures and reproductive and cardiac health needs change.[18]

It should not be assumed that everything discussed regarding care will be understood and remembered (See Dee's Story).[18-21] There are numerous studies that show women with heart disease display a significant lack of accurate contraception and pregnancy knowledge. Taking responsibility for health choices should be encouraged in a scaffolded fashion according to age and maturity level. While there is no known research specifically on the transition to adulthood for adolescent girls with RHD, studies exploring the impact of other chronic diseases,[22] ARF,[23] and congenital heart disease[24] in school-age children all emphasise the need for intersectoral collaboration including mentoring and a local support person and school staff as appropriate, in addition to family and health services.[25]

Pregnancy and childbirth in women with RHD need to be considered in the context of the risk that it brings. Care planning should support choices for future potential pregnancy as much as possible, addressing the possible need for cardiac valve surgery and its consequences.

(See Preconception care and planning, Prosthetic heart valve considerations and Anticoagulation therapy).

Pre-pregnancy

Contraception and reproductive health

Choosing a contraception method must consider risk and efficacy from a cardiac perspective as well as the usual considerations of reproductive health provision in a safe, respectful environment.[26,27]

All girls, adolescents, and women should receive counselling regarding risk and discussion about the optimal timing of pregnancy to improve the chances of an uncomplicated pregnancy.[28] Conversations should include clinical providers, the First Nations health staff, the adolescent or woman's family and interpreter, as indicated. Check with the woman regarding her partner being present: apart from personal preference, Women's Business may preclude partner involvement in discussions. Respect this choice wherever possible with the gender of clinical care providers.

In high-risk girls, adolescents and women who may need future cardiac intervention or surgery, the use of long-acting reversible contraception (Intra-Uterine Contraceptive Device (IUCD) including Mirena or etonogestrel implant such as Implanon) should be strongly encouraged if there is a risk of pregnancy.[28] Oestrogen containing contraceptives are associated with a higher risk of thrombosis and should be avoided.[29-31]

High-risk cardiovascular disease requires discussion about the safety of any pregnancy. Tubal ligation may be considered if women agree that they do not wish to have any (or any additional) children. This typically needs several discussions which should not take place in emergency settings.

Anticoagulation requires specific contraceptive and reproductive health considerations. Intramuscular injections can be safely provided if the international normalised ratio (INR) is ≤4.5 (See Chapter 10. Secondary Prophylaxis, Special considerations; bleeding disorders). By inference, contraceptive implant insertion is likely also to be safe up to an INR of 4.5 but waiting until the INR has decreased to the recommended reference

range is recommended to reduce bleeding and bruising risk. The increased effect of warfarin in the presence of oral contraceptives may require more frequent INR monitoring.[32] The increased risk of bleeding associated with nonsteroidal anti-inflammatory drugs such as Ibuprofen contraindicates its use in dysmenorrhoea or menorrhagia.[32] Tranexamic acid may be used where other treatments have failed. In severe circumstances of menorrhagia an endometrial ablation may be considered (concomitant contraception will still be required) in women where fertility is not desired or recommended, or family is complete. Refer to a gynaecologist for further discussion of individualised treatment.

Contraceptive choice should also consider living circumstances. For example, some women may face challenges such as privacy, maintaining hygiene in crowded houses with poorly functioning home health-hardware and lack of access to sanitary products.

Preconception care and planning

The overall aim of preconception care is to improve health status and optimise pregnancy outcome through identifying and reducing risk before conception occurs.[33] It addresses the maternal and infant mortality and morbidity that exists disproportionately in marginalised communities: highly relevant for women with RHD.[34] There are few studies specifically on preconception care for women with RHD, although there is increasing literature for women with all-cardiovascular disease,[1,34] particularly congenital heart disease.[18] There is a growing suite of educational resources including short films in multiple languages highlighting the impact of RHD for women.[35] (See Jamaya's Story)

Preconception assessment includes a full history and examination, with functional assessment, a detailed echocardiographic study and possible exercise testing.[1] There may be other health problems that need to be addressed, particularly iron deficiency anaemia or other chronic diseases such as diabetes.[26] Cervical screening, vaccination status (including influenza), rubella/varicella immunity, folic acid and iodine supplements are important elements of care.[26,36,37]

Preconception care provides a good opportunity to discuss why a visit to the local health centre or doctor soon after the first missed period and regular antenatal review is so important.[26]

Medication considerations pre-pregnancy

Preconception care includes consideration of medications not safe in pregnancy and planning for any necessary medication withdrawal or substitution.

Pregnant women with mechanical valves are at a very high risk, as all anticoagulant options carry maternal and/or fetal risks. (Table 12.2) (See Prosthetic heart valve considerations and Anticoagulation therapy).

Pregnancy planning and risk

If a woman is already symptomatic with moderate or severe RHD or has asymptomatic clinically significant mitral stenosis (MS), interventional therapy such as Percutaneous Balloon Mitral Valvuloplasty (PBMV) or surgery prior to pregnancy is likely to be required, to avoid the risk of life-threatening complications. Consider and discuss the risks and benefits of options for all surgical interventions, including mechanical prostheses, bioprostheses and repair.[38]

Some women with severe RHD may be advised against becoming pregnant. They need to be able to discuss and make choices about risks associated with pregnancy and the impact of not having children. Final decision-making lies with women and their families and must be respected, even if it differs from medical advice.[20]

There are few studies on the lived experience of RHD in pregnancy. Fear and vulnerability for women are common themes identified in studies of all-cardiovascular disease in pregnancy.[39] By contrast, a study of First Nations women's journeys with RHD in the Northern Territory found that self-care and awareness of the impact of RHD in pregnancy competed with basic concerns such as food security and complex social challenges.[40] Other concerns identified relate to financial burden of disease, fear of abandonment and social stigma.[21] All studies identified the need for responsive, respectful care that supported shared decision-making.

During pregnancy

Antenatal care

Multi-disciplinary care with early antenatal review for women with RHD contributes to the likelihood of safe pregnancy.[1,2,9,10,41-44] However, the type and degree of this care will vary according to individual risk. In high-risk women, multi-disciplinary care is required, including cardio-obstetric services as well as neonatology, fetal and anaesthetic specialisations. In contrast, if a thorough assessment indicates a woman is low risk, women may be referred to their local hospital for antenatal care and birth. For most women this is a preferred option, preventing the dislocation of birthing long distances away from Country and better supporting a woman-focused holistic model of care throughout pregnancy and postpartum.[45]

In many cases, the first point of contact of care will be with the midwife, First Nations Health Practitioner, nurse, GP or other remote primary care provider. These services play a critical role in conducting early reviews in pregnancy and providing continuity of care.

Optimal health care for women with RHD must take place in a secure environment with culturally aware and competent practitioners.[26,40] When available, First Nations Mothers and Babies health services and other strength-based partnership programs such as the Australian Nurse Family Partnership Program should be offered as an integral part of care. Evaluations of these programs for First Nations women have consistently shown success in improving uptake (and timing) of antenatal care as well as supporting other healthcare interventions.[17,46-52]

First Nations Mothers and Babies health services are Australian jurisdiction-based programs where midwives partner with First Nations Health Workers and Health Practitioners to provide culturally appropriate holistic support and care throughout pregnancy. They are known by various names across Australia: NSW Aboriginal Maternal Infant Health Services; SA Aboriginal Maternal and Infant Care; NT Top End Midwifery Group Practice; NT Central Australia Midwifery Group Practice; Qld Birthing in Our Country; WA Boodjari Yorgas Midwifery Group Practice.

General principles of care and access to services

In the Northern Territory, 2-3% of First Nations women who journey through pregnancy have RHD,[53] and 42% of residents do not speak English at home.[54] Interpreter services support health service providers to understand women's wishes and informed decision-making by women and their families.

Can the girl or woman hear satisfactorily in conversation? First Nations children experience some of the highest rates of chronic otitis media in the world, with associated risk of hearing loss as an adult.[55]

A dental check and any required treatment for teeth decay or gum disease[56] should be done as early as possible to minimise the risk of bacterial infection.

Continuity of care

Women with multiple co-morbidities interact with many health care providers throughout the course of pregnancy. This can be confusing and frustrating and may impact on quality of care, discharge planning and follow-up.[57,58] As far as possible, continuity of care should include specific known care providers throughout pregnancy and post-partum (See Alicia's Story).

Antenatal care that supports the specific needs of rural and remote women in accessing services[11,59] also helps reduce cardiac risk. Remote communities may only have a cardiology team visit once or twice a year. This may affect access to an early cardiology review during pregnancy, without travelling considerable distances. Coordinate investigations and reviews and provide active measures such as appointment reminders and transport, to minimise long-distance travel and assist young women to maintain antenatal contact.[51] The use of telehealth services can facilitate an early cardiology review and timing of further investigations. Prompt clinical communication and handover to all relevant health services throughout pregnancy and post-partum is essential.[53,56,60]

Cardiovascular physiology during pregnancy

The first presentation of RHD may be during pregnancy or in the early post-partum period. High suspicion and early diagnosis, along with appropriate follow-up, are key elements for successful outcome for mother and child.[18]

Pregnancy is associated with a 40–50% increase in cardiac output and workload which exacerbates pre-existing valvular disease. These haemodynamic changes begin during the first trimester, with continued impact through to post-partum. Systemic blood pressure decreases in first trimester and increases towards pre-gestational levels prior to term. Because of this hyper-dynamic circulation, innocent, soft mid-systolic murmur are common during pregnancy, particularly along the left sternal border. However, in high-risk populations, all women with a murmur (or regardless of the presence or absence of murmur in some settings) should be investigated clinically (e.g. using a six-minute walk test or other assessment of exertional capacity) and with an echocardiogram.

Labour and delivery are associated with significant demands on the cardiovascular system, with pain, anxiety and uterine contractions leading to increased heart rate and blood pressure. With birth, there is a relief of caval pressure and return of circulating volume from uterine contraction to the systemic circulation, with an associated risk of precipitating heart failure post-partum, particularly in the first 24 to 48 hours. Haemodynamics continue to normalise over the following two weeks, reaching normal, non-pregnant levels at up to 24 weeks.

In severe RHD, women often do not achieve the required cardiovascular response to pregnancy, sometimes resulting in a relatively low cardiac output state with significant functional impairment. These are the high-risk patients who may have no cardiovascular reserve to cope with the additional demands of labour, delivery and complications of pregnancy.

Failure to increase cardiac output with advancing pregnancy is also a risk for neonatal events including pre-term birth and low birth weight, neonatal respiratory distress and death.[61]

Screening and new diagnosis in pregnancy

There have been few studies assessing the impact of antenatal echocardiography screening on maternal or neonatal outcomes, and a lack of studies comparing screening with standard antenatal care.[62] Limited data from low-middle income countries demonstrates a high prevalence of undiagnosed RHD in pregnant women. One cross-sectional study in Eritrea showed a high prevalence of previously undiagnosed RHD[63] and a large Ugandan longitudinal study using existing infrastructure to screen pregnant women and follow outcomes[64] found pre-existing cardiovascular disease (nearly 90% due to RHD which was unknown pre-pregnancy in all but 3% of women) was responsible for a substantial risk of adverse maternal outcomes in low-resource settings.[65] Furthermore, this study reported that the echocardiographic identification of RHD enabled changes to the antenatal management for those individual women.[65] Echocardiography screening as part of antenatal care appears feasible.[66] Despite the limited evidence, there is growing recognition of the importance of early access to echocardiography for pregnant women in high-risk populations.[67,68]

New detection of RHD during pregnancy requires sensitivity in conveying the diagnosis and explaining management, ensuing that the client feels as supported as possible. The psychosocial impacts of a new chronic condition diagnosis are likely to be compounded in the context of pregnancy. Psychosocial needs should be assessed and appropriately responded to.

A cardiovascular risk assessment should be obtained in all pregnant women, with or without symptoms per pregnancy guidelines.[11,18] Attentive history-taking for RHD is required particularly in high-risk populations. While individuals may be unaware of their RHD diagnosis, they may recall regular penicillin injections, previous echocardiograms, prolonged hospital admissions especially with symptoms of ARF, or other family members with ARF or RHD. There should be a low threshold to consider performing echocardiography as part of this evaluation in populations at high risk of RHD with early referral for cardiology review if any concerns or abnormalities detected.

Cardiac risk assessment

A pregnant or post-partum woman at higher risk of or diagnosed with RHD who presents with breathlessness, orthopnoea, wheeze or worsening fatigue should be investigated with an echocardiogram.

Appropriate and early antenatal risk assessment helps determine the appropriate level of care that women will require during pregnancy. Available risk prediction scores[1,43] are mostly based on heterogeneous groups of women in pregnancy with congenital and valvular cardiac disease and international registries. The modified World Health Organization classification of maternal cardiovascular risk (mWHO) provides reliable risk assessment and associated recommendations of level of specialist care management required for the pregnancy.[1] The mWHO has been applied in low-resource settings for suspected and known maternal cardiovascular disease with good results.[2]

A retrospective analysis of 95 pregnancy outcomes in 54 women with RHD (predominantly First Nations women) was undertaken at a regional north Queensland centre.[42] A modified cardiac risk assessment score[69] based on an index developed for mixed aetiology maternal heart disease was applied. Findings suggested that women with a score of 0 according to this cardiac risk scoring system could safely birth their child in a non-tertiary hospital.[42] Notably, four patients in the study were first diagnosed with RHD after developing acute pulmonary oedema during the peripartum period, emphasising this as an ongoing critical risk period.[42]

Figure 12.1 details the predictors of risk in a pregnant woman with RHD and provides guidance on decision-making regarding birthing from the perspective of maternal and cardiac health.[1,2,42,43,70-72]

Cardiac risk factors must be seen in an overall cardiac context. A prior cardiac event (heart failure, transient ischaemic attack, stroke, arrhythmia) or cardiac medications prior to pregnancy are all predictors of risk. Any degree of reduced left ventricular systolic function in the presence of severe MR carries a high risk of maternal heart failure, morbidity and possible mortality. Similarly, in combined AR and MR, the combination of the moderate lesions may be associated with a higher risk of heart failure. Self-reporting of functional NYHA status may not be reliable. Exercise testing in women may provide additional risk stratification, as can a stress echocardiogram in MR and AR, however its use to predict outcomes in pregnancy is not established.[73]

Women with severe RHD or otherwise assessed as high risk require ongoing review at a tertiary centre with intensive care, obstetric, cardiology, and anaesthetic services.

Further risk stratification can be performed with baseline and serial B-type natriuretic peptide (BNP) levels. BNP levels <100 pg/mL at 20 weeks' gestation, or on serial assessment, have been associated with a high negative predictive value for maternal cardiac events.[74,75] However, the haemodynamic changes throughout pregnancy, and BNP levels reflecting one point in time, suggest larger studies are required. Routine access to BNP testing and regular echo services may be difficult outside of major centres.

Risk assessment for women with RHD during pregnancy includes a consideration of their individual circumstances, preference of where to give birth, engagement with medical services, adherence with medical therapies, co-morbidities and access to services as well severity of RHD. It takes account of non-clinical factors as well as other co-morbidities. Barclay et al,[76] in their assessment of risk related to pregnancy and childbirth in rural and remote Australia, suggest that social, cultural, social financial risks can exacerbate clinical factors and compound overall risk.[75] An extended definition has been proposed that considers the full range of risks and their interaction and recognises the importance of Birthing on Country.[14,16,76]

Birthing on Country – why it matters for women with RHD

Birthing on Country addresses the integral connection between birthing, land (country) and place of belonging for First Nations women. The term is often not well understood. The Birthing on Country position statement describes it as '…a metaphor for the best start in life for First Nations babies and their families' which provides an appropriate transition to motherhood and parenting, and an integrated, holistic and culturally appropriate model of care for all.[13]

Birthing on Country models can be described as maternity services that are designed, developed, delivered and evaluated with and for First Nations women that encompass the following:

- Community based and governed.
- Provide for inclusion of traditional practices.
- Involve connections with land and country.
- Incorporate a holistic definition of health.
- Value First Nations culture as well as other ways of knowing and learning; and
- Encompass risk assessment and service delivery and are culturally competent.

These principles underpin care pathways that promote optimal outcomes for women with RHD and their babies and should be incorporated into all aspects of care.

Birthing on Country models can be incorporated into any setting,[13] including urban as well as regional and remote Australia.

Termination of pregnancy

Termination of pregnancy (TOP) may occur according to a woman's preference or if medically indicated, such as Level III or IV RHD in pregnancy severity (Figure 12.1). The choice of medical versus surgical TOP will depend on gestation, the woman's choice, her cardiac condition and clinician experience. Both medical and surgical procedures are effective, with similar rates of major complications in women with cardiovascular disease.[1,77,78] The greater need for unanticipated intervention favours the surgical approach in high-risk women.[1]

Providing the termination service as close to home as possible, with known health care providers who can provide continuity of care. Financial costs can be a significant barrier where only private clinics are available, requiring long distance travel to the closest centre. If medical termination is chosen, close observation and back-up expertise is essential should a failed medical termination require subsequent surgical intervention.

High-risk patients should receive care in a tertiary centre. Refer to cardiac guidelines,[1] local hospital termination guidelines, legislation, and recommendations.[26,79] In most Australian states and territories, the same laws governing consent and confidentiality will apply in the case of a young woman seeking termination, as with any other form of health care. Check where parental or guardian consent or court order may be required.[26,80-82]

Termination of pregnancy may be emotionally traumatic, particularly where it is medically advised. An individualised approach is guided by the same principles of care as in pregnancy to support decision-making.[79] Consider additional support that may be required, such as accommodation, childcare, transport and pre- and post-termination counselling, which would involve recommendations for surgery and discussions about contraception and future pregnancy risk.

Specific cardiac valve lesions and complications

Mitral or aortic regurgitation

A single lesion of mild MR or mild AR is generally well tolerated during pregnancy.[1,83] The increase in blood volume and cardiac output in pregnancy increases left ventricular (LV) volume overload but the decrease in systemic vascular resistance partly compensates for this. However, combined rheumatic aortic and mitral disease as well as mixed valve disease may be under-represented in studies, and an individual approach to pregnancy risk must always be considered.

Mitral stenosis

Mitral stenosis (MS) that is asymptomatic before pregnancy may be poorly tolerated in pregnancy because the fixed stenotic mitral valve limits the required increase in cardiac output of advancing pregnancy. Mild MS may be well tolerated but a decline in functional class and development of heart failure has been reported in up to 15% of women.[84,85] Women diagnosed or presenting late in pregnancy have an increased risk of complications.[9,86] Women with moderate or severe MS often show a functional deterioration in pregnancy which will require treatment.

A pre-pregnancy functional status of NYHA II or more is an independent predictor for adverse events but women with MS are often asymptomatic until faced with the increased cardiac work of pregnancy.[85] A reduction in functional state is often gradual so the first diagnosis of MS in pregnancy may be with severe symptoms including acute heart failure. Mitral valve area (MVA) by accurate planimetry is used as the reference value in determining severity, as it is independent of cardiac output, which increases in pregnancy along with increased mitral valve gradient.

In patients with mild or moderate symptoms during pregnancy, medical therapy with beta blockers and diuretics may be sufficient. The development of atrial fibrillation (AF) with rapid ventricular rates may precipitate acute heart failure, requiring emergency treatment, including use of beta blockers for rate control. Digoxin can be added to beta-blocker therapy for rate control in AF if required.[1] In patients with severe MS, the prophylactic use of beta blockers should be considered to reduce the risk of rapid ventricular rates if AF develops.[38,87]

Consider PBMV prior to pregnancy for women with moderate-severe MS (orifice area <1.5 cm^2), even if asymptomatic or mildly symptomatic.

There are very high rates of heart failure (up to 50%) in women with severe MS which can persist post-partum, with significant risks of acute pulmonary oedema, atrial arrhythmias, stroke or need for intervention during pregnancy, as well as fetal risks.[85]

There is a small risk of traumatic MR resulting from PBMV; however, this can usually be managed medically, without the need for surgery until after pregnancy. The haemodynamic effects of lesions as well as functional status should guide risk stratification and medical therapies.

Indications for PBMV during pregnancy include NYHA class III or IV symptoms (despite medical therapy), MVA <1–1.5 cm^2, suitable valve characteristics[88] and no atrial thrombus.[89-90] The exact timing of the procedure requires a multi-disciplinary team consultation.[81,92] (See Chapter 11. Management of RHD)

Atrial fibrillation in mitral stenosis

Atrial fibrillation is poorly tolerated in MS and associated with a very high risk of atrial thrombus, requiring anticoagulation (See Anticoagulation therapy) as well as rate control. Anticoagulation also may be considered for women in sinus rhythm with very severe left atrial dilatation, spontaneous echo contrast on echo, or heart failure, as the risks of AF and thrombus formation are much higher. Beta blockers are recommended as first-line therapy for rate control. Digoxin may be added for additional rate control if required.[87,93] Higher than standard digoxin doses may be needed due to protein binding. Beta blockers have been well studied in pregnancy and are considered relatively safe (Table 12.2).[94]

Direct current cardioversion should be used to restore sinus rhythm when the tachyarrhythmia is causing cardiac symptoms and haemodynamic instability.[87,93] Trans-oesophageal echocardiogram (TOE) directed cardioversion should be used as per current guideline, considering anaesthetic risk and likelihood of success.

Aortic stenosis

Isolated severe rheumatic aortic stenosis (AS) is rare. It may be seen with bioprosthetic valve degeneration and is associated with a significant risk of adverse maternal and fetal outcomes.[43] Heart failure can occur during pregnancy in initially asymptomatic women but is more common in those with pre-pregnancy symptoms. Severe AS is associated with low birth weight and higher rates of caesarean sections.[95]

In asymptomatic women with AS, exercise testing is recommended to assess functional status and haemodynamic response preferably before pregnancy, or in early pregnancy. An abnormal blood pressure response to stress is associated with an increase in cardiac events and poor prognosis.[38]

Aortic valve area is the preferred measure of AS grade in combination with aortic valve gradient, as the increased cardiac output that occurs during pregnancy is associated with increased aortic gradients.[95,96]

Tricuspid regurgitation

Tricuspid regurgitation (TR) is usually secondary to left heart valvular disease in RHD and may be associated with pulmonary hypertension. Severe TR with right ventricular dysfunction may be associated with heart failure and atrial arrhythmias in pregnancy. It can usually be managed with diuretic therapy alone, with management directed as appropriate for left heart disease, and surgery performed at the time of aortic or mitral surgery pre- or post-partum.

Left ventricular systolic dysfunction

In RHD, the impact of impaired left LV function is variable according to the valve lesion. In women with severe MR, hyperdynamic systolic function (high ejection fraction (EF)) is expected. An LVEF <60% in these patients is a sign of LV decompensation and may be poorly tolerated.

In general, an LVEF <30% or reduced systolic function with NYHA class III/IV symptoms is associated with a high risk of maternal morbidity and possible mortality, and pregnancy is strongly discouraged.[69,97] In contrast, mild LV systolic dysfunction has a better prognosis.

Heart failure medications

Angiotensin-converting enzyme (ACE) inhibitors, angiotensin receptor blockers (ARBs), angiotensin receptor neprilysin inhibitors (ARNIs), mineralocorticoid receptor antagonists (MRAs), and ivabradine are all contraindicated in pregnancy and should be stopped as soon as pregnancy is confirmed.

Hydralazine and nitrates may be used as alternative agents in the absence of ACE inhibitors and ARBs. Loop diuretics are given for clinical evidence of heart failure, with cautious monitoring due to risks of reduction in placental blood flow. Beta blockers should be continued or introduced once the patient is euvolemic.

Post-partum, all heart failure therapies should be re-introduced (Table 12.2). Safety in lactation advice is shown in Table 12.2.

Pulmonary hypertension

Idiopathic pulmonary arterial hypertension is known to be associated with high rates of morbidity and mortality in pregnancy. There are few data available on pulmonary hypertension (PH) secondary to left heart disease in pregnancy. Hospitalisation, frequently due to heart failure, is common in women with significant pulmonary hypertension (>50 mmHg) secondary to left heart disease. Heart failure often occurs late in the second trimester, early third trimester or in the post-partum period due to the changing haemodynamic demands.[72] Emergency caesarean-section rates and rates of early delivery are higher.[98] Outcomes with mild pulmonary hypertension (pulmonary artery systolic pressure <45-50 mmHg) are better than those with moderate, or severe (pulmonary artery systolic pressure >50 mmHg). Morbidity increases with worsening symptoms and severity of pulmonary hypertension.

Ergometrine and prostaglandin F analogues are contraindicated in pulmonary hypertension due to the effects of pulmonary vasoconstriction.[99]

Other cardiac risk

Preeclampsia in women with RHD is a medical emergency. The associated vasoconstriction, hypertension and pulmonary oedema which can occur exacerbates valvular heart disease and is associated with a significantly increased risk of heart failure.[72]

Prosthetic heart valve considerations

The choice of valve prosthesis in adolescents and women requires careful judgement of the need for later reoperation and associated mortality and morbidity risks. While a mechanical heart valve is extremely durable, these valves require lifelong anticoagulation with warfarin, which may potentially harm the fetus.

Tissue or bioprosthetic valves have the major advantage of not requiring anticoagulation if the patient is in sinus rhythm. However, bioprosthetic valve replacement inevitably leads to reoperation later in life because of structural valve degeneration (SVD). This may occur as early as two to three years after the initial valve replacement and has been reported as high as 50% of people at 10 years and in 90% at 15 years.[100] Higher rates of deterioration occur in the mitral position compared with aortic or tricuspid bioprosthetic valve replacement.[101] Due to the higher rate of SVD in young people, annual review with echocardiography is recommended. While some reports had originally suggested a more rapid deterioration of bioprostheses following pregnancy, this was not seen in other studies,[100] and is confounded by a younger population at higher risk for SVD.[101]

Most women with normally functioning bioprosthetic valves tolerate the haemodynamic changes of pregnancy well, in the absence of other significant risk factors. However, heart failure or atrial arrhythmias may develop, especially if the LV function is impaired or there is significant left atrial dilatation.

Anticoagulation therapy

Anticoagulation is required for all girls and women with mechanical prosthetic valves, and may be required with atrial fibrillation, depending on thromboembolic risk.

Pregnant women with mechanical heart valves are a very high-risk group, in whom all anticoagulation options carry significant maternal and/or fetal risks (WHO risk classification III). Anticoagulation is vital to prevent prosthetic valve thrombosis and associated complications, which carries a high risk of mortality. The choice of anticoagulation involves balancing the risks of therapy with prevention of prosthetic valve complications. (Table 12.2).

Fetal risk with warfarin

Warfarin embryopathy is characterised by nasal or mid-facial hypoplasia and epiphyseal stippling leading to limb deformities. The risk of embryopathy beyond six weeks' gestation is approximately 5-8%,[103,104] although higher rates have been reported.[105,106] Warfarin fetopathy due to use of this agent in the second and third trimesters can cause bleeding in an over anticoagulated fetus, leading to stillbirth or neurological conditions such as optic atrophy and intracranial haemorrhage.

A dose-dependent effect of warfarin on rates of embryopathy has not been established but fetal loss and stillbirth escalate with increasing doses of warfarin during pregnancy.[1,106-109] Fetal risks were similar with low dose (<5 mg daily) warfarin to those of women taking Low molecular weight heparin (LMWH) throughout pregnancy.[107,110]

Despite these recommendations, it is important to counsel the woman that there is no safe dose of warfarin;[108,109,111] however, there is clear maternal benefit with lower thromboembolic events[1,104] than LMWH.

Be aware that many women know that warfarin can have adverse effects in their unborn child and may not take it during pregnancy.

Taking no anticoagulant during pregnancy – when it is required – poses the highest risk to a woman and her infant.

Use of low molecular weight heparin

LMWH is associated with significantly better fetal outcomes (up to 95% live birth rates),[104,112] at the expense of increased maternal thromboembolic complications. All women on LMWH should have access to facilities to monitor anti-Xa levels and expertise for dose adjustment[56] given complications seen with sub-therapeutic levels.

LMWH is administered subcutaneously every 12 hours with anti-Xa monitoring. In pregnancy, an initial dose of 1 mg/kg twice daily is recommended; however, the dose must be adjusted to maintain a trough (pre-dose) anti-Xa level of 0.6-0.7 U/mL. Peak levels 3-4 hours post-dose should be 1.0–1.2 U/mL and should not exceed 1.5 U/mL. Both peak and trough levels should be performed, as therapeutic peak anti-Xa levels do not guarantee therapeutic trough levels, leading to thrombotic events.[113-116]

LMWH dose changes, guided by anti-Xa levels, are usually required in pregnancy[113,116] in response to physiological changes. Weight-based dosing alone without monitoring will lead to insufficient anticoagulation.[115] Where dose adjustments are required, increase or decrease by increments of 10 mg twice daily. Monitor peak and trough anti-Xa levels every three days until in the appropriate range and stable. The subsequent frequency of monitoring should be guided by the treating physician, but monthly testing would be the recommended minimum.

Sequential treatment with LMWH use in first trimester to avoid risks of warfarin embryopathy, followed by VKA/warfarin treatment in second and third trimesters to provide the best maternal protection, is often used and is outlined below.

Aspirin

Low-dose aspirin is recommended in combination with anticoagulation in mechanical prostheses.[96,117-120]

Direct Oral Anticoagulants (rivaroxaban, dabigatran, apixaban) should not be used for anticoagulation in any patient with mechanical prosthetic valves.

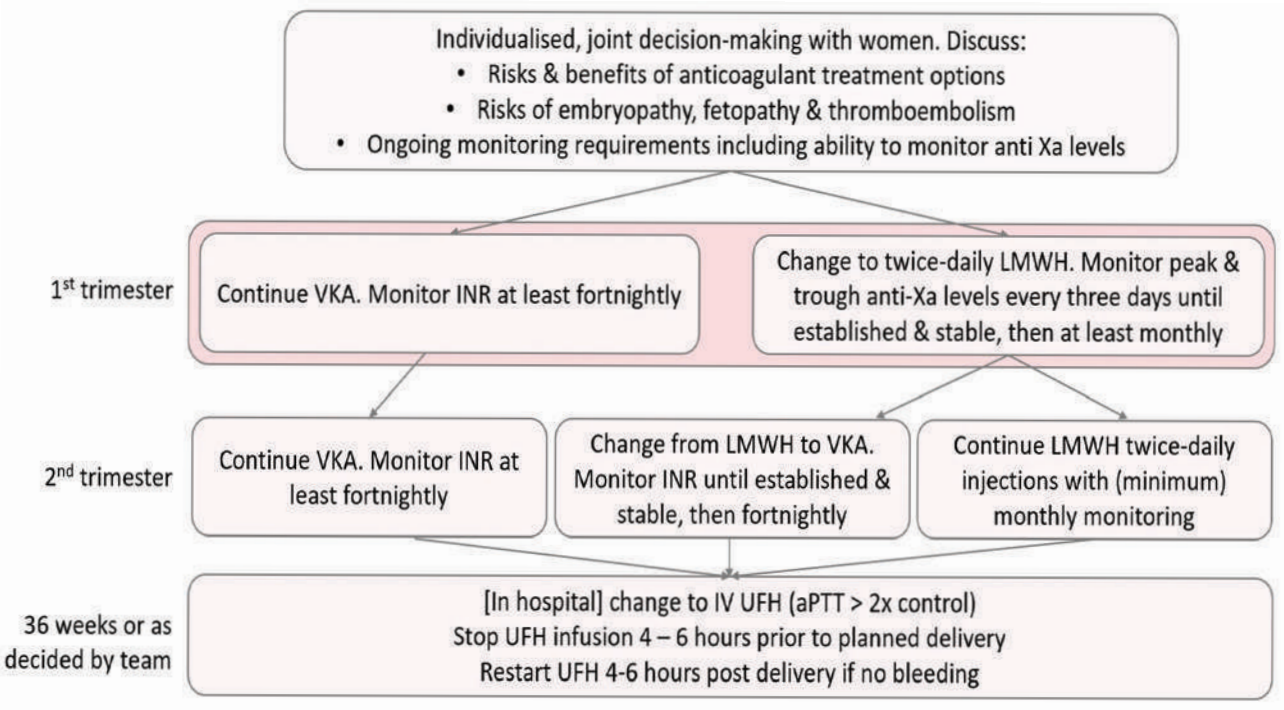


Figure 12.2. Anticoagulation pathways for pregnant women on Vitamin K antagonist (VKA) regimen

VKA: Vitamin K antagonist (e.g. Warfarin, Acenocoumarol), LMWH: Low Molecular Weight Heparin; UFH: Unfractionated heparin, aPT: activated Partial Thromboplastin Time

Clinical recommendations for anticoagulation in pregnancy

There are limited good-quality studies available on anticoagulant options, and no randomised comparative studies have been (or are likely to be) performed. Literature reviews have been undertaken to provide best practice guidance.[104,107,108,121,122] There is a choice of three recommended anticoagulant regimens during pregnancy for patients with mechanical prostheses (Level of Evidence GRADE 2C): (Figure 12.2)

- Low molecular weight heparin (LMWH, enoxaparin) throughout pregnancy.
- LMWH in first trimester; warfarin (Vitamin K antagonist – VKA) in second and third trimesters; peripartum switch to LMWH/ unfractionated heparin (UFH).
- Warfarin throughout pregnancy.

Balancing risk

Balancing maternal and fetal risks and individualising the preferred method of anticoagulation is best done by a team with expertise in prosthetic valve and anticoagulation management in pregnancy.[111] This risk is compounded by gaps in expert care and variable anticoagulant monitoring. Each management strategy should be discussed with the woman so that she can make a truly informed choice, including the option of not continuing the pregnancy or alternatively, risking personal health in favour of the child.

Early involvement of an anaesthetist concerning anticoagulation decisions is essential, since there are formal obstetric anaesthesia guidelines that determine the timing of cessation and recommencement of anticoagulation when regional anaesthetic techniques are used in labour, especially epidural analgesia.

Once a joint treatment plan on anticoagulation has been decided, close clinical follow-up and a birth plan are essential.[104] There is an increased risk for thrombotic complications transitioning between different anticoagulant therapies, and strict monitoring of all therapies is required. Irrespective of the anticoagulation regimen chosen, the highest risk of maternal events and poor outcomes relates to sub-therapeutic anticoagulation.

Any woman requiring anticoagulation should have access to routine and appropriate monitoring of anticoagulation as close to home as possible, including point-of-care monitoring for patients in rural and remote settings.[56] Where this is not available, early referral to a centre with expertise for review is essential.

Vaginal delivery is recommended for anticoagulated women in the absence of obstetric indications if there is no significant prosthetic valve dysfunction or other significant cardiac indication. If caesarean delivery is necessary for fetal or maternal indications, care is required with post-partum anticoagulant management.

Mechanical valve thrombosis

Mechanical valve thrombosis is a life-threatening complication of inadequate anticoagulation in pregnancy. It usually results in varying degrees of valve obstruction, with or without regurgitation, with consequent heart failure, arrhythmias, shock or embolisation such as stroke. It is a medical emergency and if suspected, patients need immediate transfer to a centre that can at a minimum provide TOE guided thrombolysis, or if required, cardiac surgery. The most experience is with fibrinolytic treatment with tPA (Alteplase), traditionally given as an infusion of 50-100 mg over five hours,[123] however smaller doses of 25 mg over five hours can be effective if bleeding risk is high and have been reported in pregnant populations.[124] If there is a very high bleeding risk and the patient is NYHA class I or II, consider a heparin infusion at therapeutic dose with further management guided by haemodynamic stability and imaging findings. Streptokinase is not considered as effective in populations where there is endemic streptococcal infection.[125,126] Follow-up transthoracic echo is usually adequate in assessing valve recovery. Further thrombolysis dosing can be used if valve function has not normalised (Level of Evidence GRADE 1C) and if the benefit is thought to outweigh the risk after clinical assessment and detailed imaging. Ongoing therapeutic anticoagulation is essential, with review of the previous regime. The risk of thromboembolic events, major bleeding and re-thrombosis are important considerations and management decisions should be made by a multi-disciplinary team.

Cardiac surgery during pregnancy

When medical management during pregnancy fails, options are early delivery (beyond 28 weeks' gestation) or surgical intervention during pregnancy (which is associated with an increased risk of fetal loss).

Rarely, very severe maternal cardiac valvular disease cannot be managed by medical therapy alone and early delivery is required if the fetus is viable, to allow optimal maternal management and relief from the haemodynamic demands of pregnancy. Cardiac surgery during pregnancy is recommended when medical therapies or interventional procedures fail and there is a risk to the mother's life. It is associated with a high risk of fetal loss (~20%) and morbidity, including late developmental delays in the child. The decision must be made on an individual basis in consultation with relevant specialists in centres with expertise. Beyond 28 weeks' gestation, delivery before surgery should be considered.[1,127,128]

Other drugs in pregnancy and lactation

Safety of all prescribed pharmaceuticals in pregnancy and lactations needs close attention (Table 12.2). Breastfeeding should be encouraged to promote better long-term health for infant and mother and facilitate bonding. There can be variations in safety between cardiac drugs of the same class. Medications where there is greater experience in pregnancy are noted in the relevant sections in this chapter (See Heart failure medications and Medications to treat post-partum haemorrhage). Refer to the usual resources for comprehensive detail before prescribing during pregnancy and lactation. There are also several online resources for reviewing safety and use, as well as pregnancy guidelines and reviews.[1,129]

- Infant Risk Centre (Texas Tech University Health Sciences Centre).
- The Australian categorisation system for prescribing medicines in pregnancy (Therapeutic Goods Administration).
- Drugs and lactation database (LacMed, National Institutes of Health).
- Drug safety in lactation (MEDSAFE, New Zealand Medicines and Medical Devices Safety Authority).

Secondary prophylaxis (BPG injections, oral penicillin and erythromycin) is safe during pregnancy and breastfeeding and should continue if indicated. The importance of continuing secondary prophylaxis during a time of higher risk should be discussed with the woman and her family prior to a planned pregnancy, or as soon as possible during an unplanned pregnancy.

Labour, birth and the post-partum period

Method of birth

Vaginal birth is associated with less risk of blood loss, infection, and venous thromboembolic complications compared to caesarean section, and is advised for most women with RHD.[1] In most patients with heart failure controlled with medication, vaginal delivery is recommended if obstetric factors are favourable, with adequate heart rate control and analgesia.[86] A caesarean section is usually recommended for women on oral anticoagulant therapy presenting in pre-term labour, or those with high-risk aortopathies, severe heart failure or severe pulmonary hypertension. However, individual management approaches are determined by the multi-disciplinary team. Maternal deterioration with failure to respond to medical therapies may require premature delivery for maternal safety.[1]

During labour, cardiac output increases as heart rate and blood pressure rise. An inability to increase cardiac output secondary to moderate to severe RHD (particularly obstructive left sided lesions) may lead to pulmonary oedema. Early epidural administration will help minimise tachycardia, by limiting pain and hypertensive responses that may precipitate heart failure.

The increased systemic vascular resistance and venous return with labour and birth often necessitate the use of diuretic therapy in women with significant valvular disease. Peri-delivery and post-partum care in an intensive-care setting may be required for high-risk women.

Infective endocarditis prophylaxis

Currently, there is insufficient evidence to recommend extra antibiotic prophylaxis against endocarditis during vaginal delivery or caesarean section in addition to the standard antibiotics recommended in Therapeutic Guidelines: Antibiotic for surgical prophylaxis for caesarean section or for prolonged labour or premature rupture of the membranes.[1,130,131]

Medications to treat post-partum haemorrhage

Oxytocin and carbetocin can cause vasodilation, resulting in hypotension and reflex tachycardia and has been associated with coronary vasoconstriction. Cautious use including limiting boluses and using a continuous slow infusion is generally tolerated.

Ergometrine, an alpha-adrenergic receptor agonist, may cause coronary vasospasm, pulmonary vasoconstriction and hypertension. Depending on the severity of RHD, it should be avoided, particularly if the woman has pulmonary hypertension.

Carboprost, a smooth muscle contractor, should be avoided. It may cause hypertension, increased pulmonary vascular resistance and severe bronchospasm in asthmatics. Misoprostol, a prostaglandin E1 analogue, is better tolerated.[129]

In general anaesthesia, eliminating or reducing volatile anaesthetic use and converting to intravenous anaesthesia can remove the negative effect of volatiles on uterine tone.

Calcium gluconate or chloride supplementation will increase uterine tone and is often required to offset citrate effects with blood product administration, however, observe caution with transient cardiac and vascular effects if administered as a bolus.

Management strategies must be balanced against maternal risk and life-threatening bleeding.

Pre-discharge

Discharge plan

Review the discharge plan with the woman (and her partner and family as wished), including treatment, medication, future management plans and future conception planning. Ensure that discussions are culturally sensitive, empowering and are in the patient's first language.

Conception planning

Discussion with women regarding cardiovascular health, future pregnancy risk and inter-pregnancy planning should take place before discharge and followed up in the primary health setting. A shared understanding about risk and preference promotes informed decisions about pregnancy planning and contraception. Long-acting reversible contraception can be provided prior to discharge, after discussion with the woman (See Contraception and reproductive health).[32,133] (See Alicia's Story and Jamaya's Story)

RHD Register and secondary prophylaxis

The woman should be included on the RHD Register in relevant jurisdictions and the date and location for her next secondary prophylaxis dose (if applicable) confirmed.

Post-discharge

A vital aspect of preconception care is the post-partum and inter-pregnancy periods. High-risk women should be referred to tertiary care centres with required expertise.[134]

Early involvement of primary care services is crucial to ensure a smooth transition post-partum.[18] Information about the woman's treatment, medication, future management plans and conception planning should reach her specialist and primary care providers including First Nations Mothers and Babies health services and referring hospital (where relevant) within 48 hours of discharge.[56] This will include clear information regarding RHD diagnosis, treatments and interventions, pregnancy and birth, routine recall plans and specific information about non-routine care requirements.[53,60] All women without a designated GP or primary care provider should be integrated into a community program for home- or centre-based therapy and education following hospital discharge and be assisted to access appropriate primary care services.[56]

Table 12.2. Medications in pregnancy and lactation

DRUGS	CLASSIFICATION	PLACENTA PERMEABLE	BREASTMILK EXCRETION	CLINICAL USE	AUSTRALIAN CLASSIFICATION †
Anticoagulation (See also Clinical recommendations for anticoagulation in pregnancy)					
Warfarin	Vitamin K antagonist	Yes	Yes	**Pregnancy:** *Fetal risk.* Relatively contraindicated. Associated with embryopathy (1st trimester exposure) and fetopathy (second and third trimester use), fetal bleeding, fetal loss. **Breastfeeding:** considered safe. Very low levels expressed in breastmilk.	D
Low molecular weight heparin	Heparin	No	No	**Pregnancy:** *Maternal risk.* Increased maternal thromboembolic risk. Considered safe to fetus. **Breastfeeding:** Considered safe.	C
Unfractionated heparin	Heparin	No	No	Refer to *Clinical recommendations for anticoagulation in pregnancy* section	C
Aspirin	Antiplatelet	Yes	Yes	**Pregnancy:** Low dose recommended (75–100 mg). Higher doses associated with bleeding, premature closure of patent ductus arteriosus teratogenicity. **Breastfeeding:** Low-dose aspirin considered safe.	C
Thrombolytics		Yes	Yes	**Pregnancy:** *Fetal risk.* Relatively contraindicated, with use limited to life-threatening risk to mother and per prosthetic valve management guidelines.	B1/C
Rivaroxaban, dabigatran, apixaban	Non-vitamin K antagonist oral anticoagulants (NOACs)	Yes	Yes	**Pregnancy:** Contraindicated **Breastfeeding:** Contraindicated	C
Antihypertensives and antiarrhythmics; Diuretics					
Metoprolol	Beta blocker (ß1 selective)	C Yes	Yes	**Pregnancy:** Preferred beta blocker. Relative safety. Increased pregnancy dose frequently required. Monitor for fetal bradycardia, intrauterine growth restriction and hypoglycaemia. **Breastfeeding:** Minimal excretion in breastmilk, undetectable levels in neonate.	C

† The Therapeutic Goods Administration/Federal government is reviewing the use of the Australian Drug Evaluation Committee classification.

Table 12.2. Medications in pregnancy and lactation (continued)

DRUGS	CLASSIFICATION	PLACENTA PERMEABLE	BREASTMILK EXCRETION	CLINICAL USE	AUSTRALIAN CLASSIFICATION †
Labetalol	ß/ß blocker	Yes	Yes	**Pregnancy:** Extensive experience in pregnancy. Low risk of fetal bradycardia, hypoglycaemia and IUGR. **Breastfeeding:** Low levels expressed in breastmilk.	C
Bisoprolol	Beta blocker (ß1 selective)	Yes	Yes	**Pregnancy:** Pregnancy: risk of fetal bradycardia, hypoglycaemia, IUGR. **Breastfeeding:** Appears safe for use in breastfeeding in small studies.	C
Carvedilol	Beta blocker	Yes	Yes	**Pregnancy:** No human data available. Preference for alternative beta blockers e.g. Metoprolol. **Breastfeeding**: Increased mortality in animal studies, inadequate human data. Other beta blockers preferred.	C
Atenolol	Beta blocker	Yes	Yes	**Pregnancy:** *Fetal risk.* Associated with higher rates of IUGR and possible birth defects. Alternative beta blockers recommended. **Breastfeeding:** Recommendation to avoid in breastfeeding if alternative agents available.	C
Ivabradine	If channel blocker	Yes	Yes	**Pregnancy:** *Fetal risk.* Inadequate human data. Teratogenic in animal studies. **Breastfeeding:** Inadequate human data. Contraindicated.	D
Sotalol	Antiarrhythmic	Yes	Yes	**Pregnancy:** Bradycardia and hypoglycaemia. **Breastfeeding:** Extensive excretion in breastmilk, avoid where possible.	B
Amiodarone	Antiarrhythmic (class III)	Yes	Yes	**Pregnancy:** *Fetal risk.* Relatively contraindicated in pregnancy as can cause fetal thyroid, mild neurological and congenital abnormalities. Use if maternal life-threatening arrhythmias cannot be treated with alternative agents. **Breastfeeding:** Expressed in breastmilk in unpredictable levels, breastfeeding not recommended.[127,133]	D
Flecainide	Antiarrhythmic (class IC)	Yes	Yes	**Pregnancy:** Appears safe in small studies. **Breastfeeding:** Limited data. Clinically insignificant breastmilk levels <200 mg.	B3

† The Therapeutic Goods Administration/Federal government is reviewing the use of the Australian Drug Evaluation Committee classification.

Table 12.2. Medications in pregnancy and lactation (continued)

DRUGS	CLASSIFICATION	PLACENTA PERMEABLE	BREASTMILK EXCRETION	CLINICAL USE	AUSTRALIAN CLASSIFICATION †
Diltiazem	Calcium channel blocker	Yes	Yes	**Pregnancy:** *No evidence of human teratogenicity (animal teratogenicity at doses 5–10 times greater than usual therapeutic doses). Limited clinical data.* **Breastfeeding:** Limited data, low levels expressed in breastmilk.	C
Verapamil	Calcium channel blocker	Yes	Yes	**Pregnancy:** Limited data. Appears relatively safe. Recommended as second– line treatment if beta blockers fail or not tolerated. **Breastfeeding:** Limited data, not associated with adverse outcomes.	C
Digoxin	Cardiac glycoside	Yes	Yes	**Pregnancy:** Appears safe in pregnancy, however digoxin intoxication associated with fetal death. Digoxin serum levels in pregnancy not reliable. **Breastfeeding:** Low levels expressed in breastmilk.	A
ACE inhibitors; Angiotensin receptor blockers or neprilysin inhibitors	ACE inhibitors; Angiotensin receptor blockers or neprilysin inhibitors	Yes	Yes	**Pregnancy:** *Contraindicated. Fetal risk.* Associated with renal tubular dysplasia, IUGR, lung hypoplasia, oligohydramnios, skull ossification disorders, joint abnormalities, fetal death. **Breastfeeding:** Enalapril and captopril assessed in small studies: considered safe. Others not well studied.	D
Frusemide	Loop diuretic	Yes	Yes	**Pregnancy:** *Fetal and neonatal risk.* Associated with oligohydramnios, electrolyte imbalance. Lowest dose for clinical effect recommended. **Breastfeeding:** Safe. Milk production can be reduced.	C
Spironolactone Eplerenone	Aldosterone antagonist	Yes	Yes	**Pregnancy:** *Fetal risk.* Contraindicated in pregnancy: congenital and antiandrogen effects. **Breastfeeding:** Very low levels expressed in breastfeeding, limited data suggest safety.	D
Secondary prophylaxis					
Benzathine benzylpenicillin G (BPG)	Antibiotic	Yes	Yes	**Pregnancy:** No adverse fetal effects reported. Continue injections every 3–4 weeks as prescribed. **Breastfeeding:** Considered safe.	AB
Erythromycin	Antibiotic: oral substitute for BPG	Yes	Yes	**Pregnancy:** No fetal adverse effects reported. Continue regimen as prescribed. **Breastfeeding:** Considered safe.	AB

† The Therapeutic Goods Administration/Federal government is reviewing the use of the Australian Drug Evaluation Committee classification.

Australian classification for medicines in pregnancy

A: Drugs which have been taken by a large number of pregnant women without proven increase in frequency of malformations or harmful effects on the fetus observed. **B1:** Drugs which have been taken by only a limited number of women without an increase in the frequency of malformations or harmful effects on the fetus observed. **B2:** Drugs which have been taken by only a limited number of pregnant women without an increase in the frequency of malformations or harmful effects on the fetus observed, and animal studies are inadequate or lacking. **B3:** As previous but studies in animals show an increased occurrence of fetal damage, the significance of which is uncertain in humans. **C:** Drugs which, owing to their pharmacological effects, have cause or are suspected of causing harmful effects on the human fetus or neonate without causing malformations. **D:** Drugs which have caused, or are suspected to have caused, an increased incidence of human fetal malformations or irreversible damage. These drugs may also have adverse pharmacological effects. **X:** Drugs which have such a high risk of causing permanent damage to the fetus that they should not be used in pregnancy or when there is a possibility of pregnancy.[135]

CASE STUDIES

These stories highlight principles of care. Names and details have been changed.

Alicia's Story

Background: Alicia is a 28-year-old Wiradjuri woman first diagnosed with RHD 33 weeks into her second pregnancy after presenting in heart failure with severe rheumatic mitral stenosis and pulmonary hypertension. She and her baby survived and subsequently moved to a different Local Health District with no cardiac or post-partum follow-up and no access to existing medical information after discharge.

Pregnancy: Alicia was not well in her next (third) pregnancy. She attended the local Emergency Department via ambulance a few times from 29 weeks' gestation with shortness of breath, wheeze and tiredness. She was treated for asthma and a respiratory infection and then went home.

At 32 weeks' gestation, Alicia had a home visit from the Aboriginal Mothers and Babies (AMB) team, who found her extremely short of breath with pitting oedema and a moist audible wheeze. This time she agreed to hospital admission. The midwife was concerned that Alicia's symptoms could be cardiac-related were followed by a physician review that confirmed Alicia was again in heart failure caused by RHD. She was transferred to a tertiary centre at 34 weeks and treated for severe pulmonary oedema. At 36 weeks' gestation, Alicia had a premature vaginal birth. Her premature baby was admitted to neonatal intensive care with an Apgar of 7. Alicia and baby were discharged home with follow-up by the AMB team. Before discharge, after discussion between Alicia, obstetrician, cardiologist and AMB team, Alicia had an etonogestrel implant inserted.

Discussion: It is common for some First Nations women to move between communities, regions and hospitals, making their pregnancy journey more difficult, particularly if important medical information is missed. Alicia's RHD was not picked up despite it being diagnosed in a previous pregnancy. There were gaps in clinical communication and assessment. The journey can also be complicated by women moving between Aboriginal Community Controlled Services and mainstream services.

Electronic information about the woman's diagnosis, treatment, medication and future management plans should reach the patient's primary care providers and referring hospital (where appropriate) within 48 hours of discharge. The clinical communication must include clear information regarding RHD diagnosis, recall plans and care requirements with access between health districts and sites. Consider a medical bracelet or wallet card with RHD alert and key points related to care routine.

Encourage health providers to maintain a high degree of suspicion of cardiac disease, where there is persistent or worsening breathlessness, tiredness or wheeze in pregnancy.

Alicia's children will be at higher risk of Strep A infection and ARF. Discuss this with the mother and about working with her children's health services.

Alicia did not engage with maternity or cardiac services. Could earlier involvement with the First Nations Mothers and Babies team have made a difference? Wherever available and relevant, offer and actively refer to specific antenatal programs and services for First Nations women; these improve early antenatal care uptake. If this is not available, promote the local Aboriginal Medical Service with a First Nations Health Worker or Health Practitioner as part of the woman's care pathway.

Dee's Story

Background: Twenty-four-year-old Dee lives in a remote community in northern Australia. She speaks Kriol, with English as a second language. Dee had a mechanical valve replacement at 13 years of age after being diagnosed with severe rheumatic mitral stenosis and now takes warfarin anticoagulation ≤5 mg. After being away from community for a few weeks without medication, Dee took double her dose for a few days 'to catch up'. Dee's most recent echocardiogram was three years ago.

Pregnancy: After her first pregnancy with Codie (now six years old), Dee believed she could not get pregnant again because of her cardiac disease. However, for about a month Dee felt pregnant and recently noticed a small vaginal blood loss. The obstetrician who cared for Dee during her first pregnancy was in town, so Dee visited the clinic. Urine and blood tests confirmed a pregnancy – estimated at 22 weeks' gestation. Dee was surprised. "I didn't think I could get pregnant," she said. "I was told that I couldn't get pregnant because of that RHD."

The obstetrician consulted with a cardiac colleague and Dee was flown to the nearest tertiary centre for urgent cardiac review, echocardiogram and fetal ultrasound. Her INR (blood clotting time) was 3.4.

The fetal ultrasound suggested nasal hypoplasia consistent with warfarin embryopathy. Dee's vaginal blood loss increased. Sadly, she gave birth to a stillborn baby with warfarin-induced fetal intracranial haemorrhage.

Discussion: Anticoagulation in pregnancy carries high maternal and fetal risk.

Dee did not fully understand the relationship between RHD and becoming pregnant, or the risk of pregnancy on her cardiac health. Skilful education and discussion with appropriate interpreter services should be part of ongoing care for women with RHD.

In this instance, the trauma of losing her baby creates an added dimension of grief.

Cultural factors need to be considered regarding the death and burial of her baby, and how she and her family will cope with the loss.

Conversations and education should take place for all women with RHD. In high-risk women, the use of contraception with a low failure rate should be strongly encouraged and monitored. Oestrogen-containing contraceptives are associated with a higher risk of thrombosis.

Any woman receiving anticoagulation should have access to routine anticoagulation monitoring as close to home as possible, with appropriate health service expertise.

Naomi's Story

Background: Naomi is a 19-year-old who lives in a remote community and was visibly pregnant with her second child. She had recently moved to the area and had not received any antenatal care. She was unsure how long she would stay in town because she lived between several communities.

Ebony is a local First Nations Health Worker who met Naomi by chance. Ebony spoke to Naomi about the Aboriginal Mothers and Babies program and offered a home visit to Naomi. But she declined because she was worried about other people at the house hearing her business. Ebony then offered a pick-up appointment.

Pregnancy: Naomi attended the first antenatal visit with her daughter. Her fundal measurement indicated 33 weeks' gestation. Naomi denied all previous illnesses including cardiac conditions but did mention anaemia and a previous blood transfusion. The midwife arranged a visit with the obstetrician at the nearest birthing facility for further investigations and antenatal care.

Naomi attended the obstetric appointment with Ebony. This time, Naomi remembered she 'had two holes in the heart'. On examination, a cardiac murmur was heard, although Naomi did not remember having rheumatic fever as a child or receiving any treatment. The obstetrician organised an immediate echocardiogram, which showed mild RHD.

Naomi attended a subsequent cardiac review with Ebony, where she commenced four-weekly BPG injections and agreed to be registered with the RHD Control Program. The multidisciplinary team met to discuss her birth plan. Naomi wanted to stay in town to have her baby, and her low cardiac risk suggested that – pending a satisfactory cardiac review at 37 weeks – she could have her baby at the local hospital rather than be transferred for higher-level care.

At 39 weeks' gestation, Naomi gave birth to another healthy daughter. She decided to stay in this town and was scheduled to have a follow-up review in six weeks. Naomi agreed to have her history shared with the Aboriginal Health Service at the other community where she lives.

Discussion: Women may not remember having rheumatic fever.

Skilful and respectful consultation, with time allowed for responses, should include questions about sore throat, skin sores, regular injections and heart history. Also ask about family history – have any siblings or children had ARF or antibiotic treatment for sore throats or skin sores? Think RHD in high-risk populations.

It is important to have an First Nations Health Worker or Health Practitioner in discussions for cultural support and to assist in understanding. First Nations women may live in complex social situations. Home visits may be uncomfortable, inconvenient or stressful for them, so offer alternative venues wherever possible.

Access to services includes consideration of transport and accommodation access – particularly in remote and regional areas, streamlining appointments, access, provision of support person and interpreter where required.

Jamaya's Story

Background: Jamaya is a Wirangu nation young woman from rural South Australia. She was diagnosed with ARF at five years of age. She received support from her grandmother and the local Aboriginal Medical Service (AMS) for her three-weekly BPG injections over the years. At age 17, Jamaya had been with her partner for a couple of years. She had recently stopped using contraception and thought she may be pregnant.

Jamaya attended her annual cardiac appointment with visiting paediatric cardiologist Dr Ken, accompanied by partner Todd. She was comfortable with Dr Ken: she had been under his care for the past 12 years. She was excited at the possibility of being pregnant, but she and Todd were both a bit nervous about how Jamaya's heart would cope.

Pregnancy: A full cardiac assessment was performed including history, examination and functional assessment. The echocardiogram showed mild RHD. A dating scan confirmed pregnancy of nine weeks' gestation. Blood tests showed mild anaemia but were otherwise normal.

It was agreed that Jamaya would have her care transferred to the adult cardiologist based at a regional hospital. Her cardiac status remained unchanged and at the follow-up appointment with the adult cardiologist, they discussed the birth plan.

Jamaya stressed she did not want to leave her grandmother. Jamaya and Todd chose a Shared Maternity Care model, with her general practitioner (GP), the First Nations Mothers and Babies midwife and First Nations Health Practitioner providing antenatal care. Assuming there were no complications, they wanted to give birth at the local town hospital and for the baby to be born on Country. Jamaya would see the cardiologist once more and knew if her condition changed, to contact the AMS or her Aboriginal Mothers and Baby team. Her cardiologist consulted with the hospital obstetrician who agreed with this plan.

Pregnancy was uneventful. Jamaya's anaemia was managed with iron supplements, she continued her secondary prophylaxis and had a dental procedure for tooth decay. A second echocardiogram showed mild mitral regurgitation that had not worsened.

At 38 weeks, Jamaya had a normal vaginal birth with no complications. Afterwards, she confided in her midwife that she did not want another baby 'for ages' and an etonogestrel contraceptive device was inserted. Jamaya went home where she lived with Todd and her grandmother, with follow-up from Child and Family Health services and her local GP.

Discussion: Women known to have RHD should be assessed as early as possible before pregnancy, including a full history and examination, with functional assessment and an echocardiographic study.

Birthing on Country is culturally significant for many women, and if safe to do so, it can be achieved with the proper care and coordination.

Transitioning from child to adult cardiac care can be frightening, and it is important that this is acknowledged and considered when changing from paediatric services to adult services.

Emphasise that – whether pregnancy is intended and especially where it is not recommended – women should attend the health service as early as possible and not avoid check-up through embarrassment or shame.

Secondary prophylaxis where indicated, should continue throughout pregnancy.

A dental care check and good oral hygiene reduce potential sources of bacterial infection including infective endocarditis, particularly in women with mechanical heart valves.

REFERENCES

1 Regitz-Zagrosek V, Roos-Hesselink JW, Bauersachs J, et al. 2018 ESC Guidelines for the management of cardiovascular diseases during pregnancy. European Heart Journal. 2018;39(34):3165-3241.

2 Sliwa K, Libhaber E, Elliott C, et al. Spectrum of cardiac disease in maternity in a low-resource cohort in South Africa. Heart. 2014;100(24):1967-1974.

3 Zühlke L, Engel ME, Karthikeyan G, et al. Characteristics, complications, and gaps in evidence-based interventions in rheumatic heart disease: The Global Rheumatic Heart Disease Registry (the REMEDY study). European Heart Journal. 2015;36(18):1115-1122a.

4 Australian Institute of Health and Welfare. Acute rheumatic fever and rheumatic heart disease in Australia. Cat. no: CVD 100. Australian Institute of Health and Welfare, Canberra, 2024.

5 Sandhu AT, Kathikeyan G, Bolger A, et al. Abstract 19839: Clinical and economic burden of rheumatic heart disease in low-income nations: Estimating the cost-of-illness in India and Uganda. Circulation. 2014;130(2).

6 Belguith AS, Abdelkafi AK, El Mhamdi S, et al. Rheumatic heart disease in a developing country: Incidence and trend (Monastir; Tunisia: 2000-2013). International Journal of Cardiology. 2017;228:628-632.

7 Sani U, Karaye KM, Borodo MM. Prevalence and pattern of rheumatic heart disease in the Nigerian savannah: an echocardiographic study. Cardiovascular Journal of Africa. 2007;18(5):295-299.

8 World Health Organisation (WHO) Executive Board. Rheumatic fever and rheumatic heart disease: Report by the Director-General. Seventy-First World Health Assembly A71/25. Geneva, Switzerland 2018.

9 Sullivan E, Vaughan G, Li Z, et al. The high prevalence and impact of rheumatic heart disease in pregnancy in First Nations populations in a high-income setting: a prospective cohort study. BJOG: British Journal of Obstetrics & Gynaecology. 2020;127:47–56.

10 Ongzalima C, Greenland M, Vaughan G, et al. Rheumatic heart disease in pregnancy: Profile of women admitted to a Western Australian tertiary obstetric hospital. Australian and New Zealand Journal of Obstetrics and Gynaecology, 2019.

11 Australian Department of Health. Clinical Practice Guidelines: Pregnancy Care. Canberra: Australian Government Department of Health. 2018.

12 Jones JN. Birthing: Aboriginal women. Journal of Indigenous Policy. 2012.

13 Congress of Aboriginal and Torres Strait Islander Nurses and Midwives ACoM, CRANAplus. Birthing on Country Position Statement. 2017.

14 Kildea S, Tracy S, Sherwood J, Magick-Dennis F, Barclay LM. Improving maternity services for Indigenous women in Australia: moving from policy to practice. The Medical Journal of Australia. 2016;205(8):374-379.

15 Kildea S. Birthing business in the bush: it's time to listen: Centre for Family Health and Midwifery, University of Technology, Sydney. 2005.

16 Kildea S, Lockey, R; Roberts, J; Magick Dennis, F. Guiding Principles for Developing a Birthing on Country Service Model and Evaluation Framework, Phase 1. Brisbane 2016.

17 Clarke M, Boyle J. Antenatal care for Aboriginal and Torres Strait Islander women. Australian Family Physician. 2014;43(1):20-24.

18 Hameed A, Morton C, Moore A. Improving Health Care Response to Cardiovascular Disease in Pregnancy and Postpartum. Developed as a collaboration between: The Cardiovascular Disease In Pregnancy And Postpartum Task Force, California Maternal Quality Care Collaborative, Stanford University, Maternal, Child And Adolescent Health Division, Center For Family Health, California Department Of Public Health; 2017.

19 Chor J, Oswald L, Briller J, et al. Reproductive health experiences of women with cardiovascular disease. Contraception. 2012;86(5):464-469.

20 Kovacs AH, Harrison JL, Colman JM, et al. Pregnancy and contraception in congenital heart disease: what women are not told. Journal of the American College of Cardiology. 2008;52(7):577-578.

21 Chang AY, Nabbaale J, Nalubwama H, et al. Motivations of women in Uganda living with rheumatic heart disease: A mixed methods study of experiences in stigma, childbearing, anticoagulation, and contraception. PLOS One. 2018;13(3):1932-6203 (Electronic)

22 Titmuss A, Davis EA, Brown A, Maple Brown LJ. Emerging diabetes and metabolic conditions among Aboriginal and Torres Strait Islander young people. Medical Journal of Australia. 2019;210(3):111-223.

23 Mitchell AG, Belton S, Johnston V, Ralph AP. Transition to adult care for Aboriginal children with rheumatic fever: a review informed by a focused ethnography in northern Australia. Australian Journal of Primary Health. 2018;24(1):9-13.

24 Sable C, Foster E, Uzark K, et al. Best practices in managing transition to adulthood for adolescents with congenital heart disease: the transition process and medical and psychosocial issues: a scientific statement from the American Heart Association. Circulation. 2011;123(13):1454-1485.

25 Shiu S. Positive interventions for children with chronic illness: Parents' and teachers' concerns and recommendations. Australian Journal of Education. 2004;48(3):239-252.

26 Remote Primary Health Care Manuals. Women's Business Manual, 7th edition. 2022, CC-BY-NC

27 World Health Organization. Selected practice recommendations for contraceptive use, 3rd ed. Geneva, 2016.

28 Roos-Hesselink J W, Cornette J, Sliwa K, et al. Contraception and cardiovascular disease. European Heart Journal. 2015;36(27):1728-1734.

29 Lidegaard Ø, Løkkegaard E, Jensen A, et al. Thrombotic Stroke and Myocardial Infarction with Hormonal Contraception. The New England Journal of Medicine. 2012;366(24):2257-2266.

30 Lidegaard Ø, Løkkegaard E, Svendsen AL, Agger C. Hormonal contraception and risk of venous thromboembolism: national follow-up study. British Medical Journal. 2009;339:b2890.

31 Dinger J, Bardenheuer K, Heinemann K. Cardiovascular and general safety of a 24-day regimen of drospirenone-containing combined oral contraceptives: final results from the International Active Surveillance Study of Women Taking Oral Contraceptives. Contraception. 2014;89(4):253-263.

32 US Government. FDA Highlights of prescribing information: Coumadin. In: FDA, ed. Washington USA, 2017.

33 World Health Organization. Meeting to develop a global consensus on preconception care to reduce maternal and childhood mortality and morbidity: World Health Organization Headquarters, Geneva, 6–7 February 2012: meeting report. In: Communication I, editor. Meeting report; 2013 6–7 February 2012; Geneva: World Health Organization Headquarters; 2013.

34 Zühlke L, Acquah L. Pre-conception counselling for key cardiovascular conditions in Africa: optimising pregnancy outcomes. Cardiovascular Journal of Africa. 2016;27(2):79-83.

35 RHDAustralia. Sharing a heartbeat: love, pregnancy, and living with rheumatic heart disease. 2017;

36 Australian and New Zealand Intensive Care Influenza Investigators and *Australasian Maternity Outcomes Surveillance System*: Seppelt I, Sullivan E, et al. Critical illness due to 2009 A/H1N1 influenza in pregnant and postpartum women: population-based cohort study. British Medical Journal. 2010;340(c1279).

37 Royal Australia and New Zealand College of Obstetrics and Gynaecology (RANZCOG). Statement: Influenza vaccination during pregnancy (and in women planning pregnancy). In. Vol C-Obs45. Melbourne: RANZCOG; 2013:9.

38 Nishimura RA, Otto CM, Bonow RO, et al. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. The Journal of Thoracic and Cardiovascular. Surgery 2014;148(1):e1-e132.

39 Dawson AJ, Krastev Y, Parsonage WA, et al. Experiences of women with cardiac disease in pregnancy: a systematic review and metasynthesis. British Medical Journal (Open). 2018;8(9):e022755.

40 Belton S, Kruske S, Jackson Pulver L, et al. Rheumatic heart disease in pregnancy: How can health services adapt to the needs of Indigenous women? A qualitative study. Australian and New Zealand Journal of Obstetrics and Gynaecology. 2017;58(4):425-431.

41 Curtis SL, Marsden-Williams J, Sullivan C, et al. Current trends in the management of heart disease in pregnancy. International Journal of Cardiology. 2009;133(1):62-69.

42 Sartain JB, Anderson NL, Barry JJ, et al. Rheumatic heart disease in pregnancy: cardiac and obstetric outcomes. Internal Medicine Journal. 2012;42(9):978-984.

43 Silversides CK, Grewal J, Mason J, et al. Pregnancy Outcomes in Women with Heart Disease: The CARPREG II Study. Journal of the American College of Cardiology. 2018;71(21):2419-2430.

44 Kanwar R, Sharma M, Marwah S, et al. Heart Disease in Pregnancy-Evaluation of Spectrum, Association of Predictors with Obstetric Outcome and Need for Comprehensive Medical Care. Journal of Clinical and Diagnostic Research. 2018;12(1):QC20-QC24.

45 Kildea S. Risky business: contested knowledge over safe birthing services for Aboriginal women. Health Sociology Review. 2006;15(4):387-396.

46 Kildea S, Gao Y, Hickey S, et al. Reducing preterm birth amongst Aboriginal and Torres Strait Islander babies: A prospective cohort study, Brisbane, Australia. EClinical Medicine. 2019;12:43-51.

47 Josif CM, Barclay L, Kruske S, Kildea S. 'No more strangers': Investigating the experiences of women, midwives and others during the establishment of a new model of maternity care for remote dwelling Aboriginal women in northern Australia. Midwifery. 2014;30(3):317-323.

48 Bertilone CM, McEvoy SP, Gower D, et al. Elements of cultural competence in an Australian Aboriginal maternity program. Women and Birth. 2017;30(2):121-128.

49 NSW Health. NSW Aboriginal Maternal and Infant Health Strategy Evaluation. North Sydney 2005.

50 Kildea S, Stapleton H, Murphy R, et al. The Murri clinic: a comparative retrospective study of an antenatal clinic developed for Aboriginal and Torres Strait Islander women. BMC Pregnancy and Childbirth. 2012;12(1):159.

51 Reibel T, Morrison L, Griffin D, et al. Young Aboriginal women's voices on pregnancy care: factors encouraging antenatal engagement. Women and Birth. 2015;28(1):47-53.

52 Brown S, Weetra D, Glover K, et al. Improving Aboriginal women's experiences of antenatal care: findings from the Aboriginal families study in South Australia. Birth. 2015;42(1):27-37.

53 Vaughan G, Tune K, Peek M, et al. Rheumatic heart disease in pregnancy: strategies and lessons learnt implementing a population-based study in Australia. International Health. 2018;10(6):480-489.

54 Australian Bureau of Statistics. 2016 Census: Northern Territory. 2016 Census reveals the changing face of the Northern Territory; 2017.

55 Australian Medical Association. A Report Card on Indigenous Health: A National Strategic Approach to Ending Chronic Otitis Media and its Lifelong Impacts in Indigenous Communities. Australian Medical Association. Sydney, 2017.

56 Brown A, O'Shea RRL, Mott K, et al. Essential service standards for equitable national cardiovascular care for Aboriginal and Torres Strait Islander people. Heart Lung and Circulation. 2015;24(2):126-141.

57 Kelly J, Medway P, Miller D, Catt L, Lawrence M. Managing Two Worlds Together. Stage 3: Improving Aboriginal Patient Journeys—Maternity Case Studies. Melbourne: The Lowitja Institute, 2015.

58 Kelly J, Ramage M, Perry D, et al. Managing Two Worlds Together. Stage 3: Improving Aboriginal Patient Journeys - Cardiac Case Studies. Melbourne: The Lowitja Institute, 2015.

59 Boyle J, Eades S. Closing the gap in Aboriginal women's reproductive health: some progress, but still a long way to go. Australian and New Zealand Journal of Obstetrics and Gynaecology. 2016;56(3):223-224.

60 Vaughan G, Dawson A, Peek M, et al. Standardizing clinical care measures of rheumatic heart disease in pregnancy: a qualitative synthesis. Birth: Issues in Perinatal Care. 2019;46(4):560-573.

61 Wald RM, Silversides CK, Kingdom J, et al. Maternal Cardiac Output and Fetal Doppler Predict Adverse Neonatal Outcomes in Pregnant Women with Heart Disease. Journal of the American Heart Association. 2015;4(11):e002414.

62 Seitler S, Ahmad M, Ahuja SAC, et al. Routine Antenatal Echocardiography in High-Prevalence Areas of Rheumatic Heart Disease: A WHO-Guideline Systematic Review. Global Heart. 2024;19(1):39.

63 Otto H, Saether SG, Banteyrga L, et al. High prevalence of subclinical rheumatic heart disease in pregnant women in a developing country: An echocardiographic study. Echocardiography. 2011;28(10):1049-1053.

64 Beaton A, Okello E, Destigter K, et al. PM023 Impact of rheumatic heart disease on maternal outcomes in pregnancy: Leveraging existing infrastructure to address a critical knowledge gap. Global Heart. 2016;11(2 SUPPL. 1):e75.

65 Beaton A, Okello E, Scheel A, et al. Impact of heart disease on maternal, fetal and neonatal outcomes in a low-resource setting. Heart. 2019;105(10):755-760.

66 Nascimento BR, Sable C, Nunes MCP, et al. Echocardiographic screening of pregnant women by non-physicians with remote interpretation in primary care. Fam Pract. 2021;38(3):225-230.

67 Wyber R, Johnson T, Perkins S, et al. Tools for Implementing RHD Control Programmes (TIPS) Handbook, 2nd edition. Geneva Switzerland, 2018.

68 Nascimento Watkins DA, Beaton AZ, Carapetis JR, et al. Rheumatic Heart Disease Worldwide: JACC Scientific Expert Panel. Journal of the American College of Cardiology. 2018;72(12):1397-1416.

69 Siu SC, Sermer M, Colman J, et al. Prospective Multicenter Study of Pregnancy Outcomes in Women with Heart Disease. Circulation. 2001;104:515-521.

70 Elkayam U, Bitar F. Valvular Heart Disease and Pregnancy. Journal of the American College of Cardiology. 2005;46(2):223-230.

71 van Hagen IM, Boersma E, Johnson MR, et al. Global cardiac risk assessment in the Registry of Pregnancy and Cardiac disease: results of a registry from the European Society of Cardiology. European Journal of Heart Failure. 2016;18(5):523-533.

72 Ruys TPE, Roos-Hesselink JW, Hall R, et al. Heart failure in pregnant women with cardiac disease: data from the ROPAC. Heart. 2014;100(3):231.

73 Picano E, Pibarot P, Lancellotti P, L MJ, O BR. The emerging role of exercise testing and stress echocardiography in valvular heart disease. Journal of the American College of Cardiology. 2009;54(24):2251-2260.

74 Tanous D, Siu SC, Mason J, et al. B-type natriuretic peptide in pregnant women with heart disease. Journal of the American College of Cardiology. 2010;56(15):1247-53.

75 Kampman MA, Balci A, van Veldhuisen DJ, et al. N-terminal pro-B-type natriuretic peptide predicts cardiovascular complications in pregnant women with congenital heart disease. European Heart Journal. 2014;35(11):708-715.

76 Barclay L, Kornelsen J, Longman J, et al. Reconceptualising risk: Perceptions of risk in rural and remote maternity service planning. Midwifery. 2016;38:63-70.

77 Guiahi M, Davis A. First-trimester abortion in women with medical conditions. Contraception. 2012;86(6):622-630.

78 Bagga R, Choudhary N, Suri V, et al. First and second trimester induced abortions in women with cardiac disorders: A 12-year analysis from a developing country. Journal of Obstetrics and Gynaecology. 2008;28(7):732-737.

79 Royal Australia and New Zealand College of Obstetrics and Gynaecology (RANZCOG). Statement: Abortion. In. Vol C-Gyn-17. Melbourne: RANZCOG; 2019:9.

80 Chown P, Kang M, Robards F, et al. Youth Health Resource Kit: An Essential Guide for Workers. Sydney, Australia: NSW Kids and Families. 2014.

81 Office of the Australian Information Commissioner. Fact sheets on health, eHealth and privacy. In. Canberra 2013.

82 Kang M, Sanders J. Medicolegal issues in adolescent health care. In M Kang, S Rachel Skinner, L A Sanci and S M Sawyer (Eds.), Youth Health and Adolescent Medicine, (pp. 66-75). Melbourne: IP Communications. 2013.

83 Elkayam U, Bitar F. Valvular heart disease and pregnancy part I: native valves. Journal of the American College of Cardiology. 2005;46(2):223-230.

84 Silversides CK, Colman JM, Sermer M, Siu SC. Cardiac risk in pregnant women with rheumatic mitral stenosis. American Journal of Cardiology. 2003;91(11):1382-1385.

85 van Hagen IM, Thorne SA, Taha N, et al. Pregnancy Outcomes in Women with Rheumatic Mitral Valve Disease. Circulation. 2018;137(8):806-816.

86 Desai DK, Adanlawo M, Naidoo DP, et al. Mitral stenosis in pregnancy: a four-year experience at King Edward VIII Hospital, Durban, South Africa. BJOG: British Journal of Obstetrics and Gynaecology. 2000;107(8):953-958.

87 Kirchhof P, Benussi S, Kotecha D, et al. 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS. European Heart Journal: European Society of Cardiology. 2016;37(38):2893-2962.

88 Nunes MCP, Ramos Nascimento B, Lodi-Junqueira L, et al. Update on percutaneous mitral commissurotomy. Heart. 2016;102(7):500-507.

89 Nobuyoshi M, Arita T, Shirai S, et al. Percutaneous balloon mitral valvuloplasty: a review. Circulation. 2009;119(8):e211-e219.

90 De Souza JA, Martinez EE Jr, Ambrose JA, et al. Percutaneous balloon mitral valvuloplasty in comparison with open mitral valve commissurotomy for mitral stenosis during pregnancy. Journal of the American College of Cardiology. 2001;37(3):900-903.

91 Routray S, Mishra TK, Swain S, et al. Balloon mitral valvuloplasty during pregnancy. International Journal of Gynecology & Obstetrics. 2004;85(1):18-23.

92 Esteves CA, Munoz JS, Braga S, et al. Immediate and long-term follow-up of percutaneous balloon mitral valvuloplasty in pregnant patients with rheumatic mitral stenosis. American Journal of Cardiology. 2006;98(6):812-816.

93 Brieger D, Amerena J, Attia J, et al. National Heart Foundation of Australia and the Cardiac Society of Australia and New Zealand: Australian Clinical Guidelines for the Diagnosis and Management of Atrial Fibrillation 2018. Heart Lung and Circulation. 2018;27(10):1209-1266.

94 Halpern DG, Weinberg CR, Pinnelas R, et al. Use of Medication for Cardiovascular Disease During Pregnancy: JACC State-of-the-Art Review. Journal of the American College of Cardiology. 2019;73(4):457-476.

95 Orwat S, Diller GP, van Hagen IM, et al. Risk of Pregnancy in Moderate and Severe Aortic Stenosis: From the Multinational ROPAC Registry. Journal of the American College of Cardiology. 2016;68(16):1727-1737.

96 Baumgartner H, Falk V, Bax JJ, et al. 2017 ESC/EACTS Guidelines for the Management of Valvular Heart Disease. European Heart Journal. 2017;71(2):2739-2791.

97 Grewal J, Siu SC, Ross HJ, et al. Pregnancy outcomes in women with dilated cardiomyopathy. Journal of the American College of Cardiology. 2009;55(1):45-52.

98 Sliwa K, van Hagen IM, Budts W, et al. Pulmonary hypertension and pregnancy outcomes: data from the Registry of Pregnancy and Cardiac Disease (ROPAC) of the European Society of Cardiology. European Journal of Heart Failure. 2016;18(9):1119-1128.

99 Monagle J, Manikappa S, Ingram B, Malkoutzis V. Pulmonary hypertension and pregnancy: the experience of a tertiary institution over 15 years. Annals of Cardiac Anaesthesia. 2015;18(2):153-160.

100 Elkayam U, Bitar F. Valvular heart disease and pregnancy part II: prosthetic valves. Journal of the American College of Cardiology. 2005;46(3):403-410.

101 North RA, Sadler L, Stewart AW, et al. Long-term survival and valve-related complications in young women with cardiac valve replacements. Circulation. 1999;99(20):2669-2676.

102 Cleuziou J, Hörer J, Kaemmerer H, et al. Pregnancy does not accelerate biological valve degeneration. International Journal of Cardiology. 2010;145(3):418-421.

103 McLintock C. Anticoagulant options in pregnancy for women with mechanical valves. BJOG: An International Journal of Obstetrics & Gynaecology. 2017;124(9):1421.

104 D'Souza R, Silversides CK, McLintock C. Optimal anticoagulation for pregnant women with mechanical heart valves. Seminars in Thrombosis and Hemostasis. 2016;42:798-804.

105 Chan W, Anand S, Ginsburg JS. Anticoagulation of pregnant women with mechanical heart valves: a systemic review of the literature. Archives of Internal Medicine 2000; 160:191-196.

106 Cotrufo M, De Feo M, De Santo LS, et al. Risk of warfarin during pregnancy with mechanical valve prostheses. Obstet Gynecol. 2002;99(1):35-40.

107 Steinberg ZL, Dominguez-Islas CP, Otto CM, et al. Maternal and fetal outcomes of anticoagulation in pregnant women with mechanical heart valves. Journal of the American College of Cardiology. 2017;69(22):2681-2691.

108 McLintock C. Anticoagulant therapy in pregnant women with mechanical prosthetic heart valves: no easy option. Thrombosis Research. 2011;127(S3):S56-S60.

109 Soma-Pillay P, Nene Z, Mathivha TM, MacDonald AP. The effect of warfarin dosage on maternal and fetal outcomes in pregnant women with prosthetic heart valves. Obstetric Medicine. 2011;4(1):24-27.

110 De Santo L, Romano G, Della Corte A, et al. Mechanical aortic valve replacement in young women planning on pregnancy. Journal of the American College of Cardiology. 2012;59(12):1110-1115.

111 van Hagen IM, Roos-Hesselink JW, Ruys TPE, et al. Pregnancy in women with a mechanical heart valve: data of the European Society of Cardiology Registry of Pregnancy and Cardiac Disease (ROPAC). Circulation. 2015;132(2):132-142.

112 McLintock C, McCowan LME, North RA. Maternal complications and pregnancy outcome in women with mechanical prosthetic heart valves treated with enoxaparin. BJOG: British Journal of Obstetrics & Gynaecology. 2009;116(12):1585-1592.

113 Barbour LA, Oja JL, Schultz LK. A prospective trial that demonstrates that dalteparin requirements increase in pregnancy to maintain therapeutic levels of anticoagulation. American Journal of Obstetrics and Gynecology. 2004;191(3):1024-1029.

114 Patel JP, Green B, Patel RK, et al. Population pharmacokinetics of enoxaparin during the antenatal period. Circulation. 2013;128(13):1462-1469.

115 Berresheim M, Wilkie J, Nerenberg KA, et al. A case series of LMWH use in pregnancy: should trough anti-Xa levels guide dosing? Thrombosis Research. 2014;134(6):1234-1240.

116 Snape E, Thachil J, Clarke B, Vause S. Anti-Xa based dose changes during low molecular weight heparin anticoagulation for mechanical prosthetic heart valves during pregnancy. Obstetrics & Gynecology. 2018;38(5):721-722.

117 Meschengieser SS, Fondevila CG, Frontroth J, et al. Low-intensity oral anticoagulation plus low-dose aspirin versus high-intensity oral anticoagulation alone: A randomized trial in patients with mechanical prosthetic heart valves. Journal of Thoracic and Cardiovascular Surgery. 1997;113(5):910-916.

118 Turpie AG, Gent M, Laupacis A, et al. A comparison of aspirin with placebo in patients treated with warfarin after heart-valve replacement. The New England Journal of Medicine. 1993;329(8):524-529.

119 Nishimura R, Otto C, Bonow RO, et al. 2017 AHA/ACC Focused Update of the 2014 AHA/ACC Guideline for the Management of Patients with Valvular Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation. 2017;135:e1159–1195.

120 Xu Z, Fan J, Luo X, et al. Anticoagulation regimens during pregnancy in patients with mechanical heart valves: a systematic review and meta-analysis. Canadian Journal of Cardiology. 2016;32(10):1248 e1-e9.

121 D'Souza R, Ostro J, Shah PS, et al. Anticoagulation for pregnant women with mechanical heart valves: a systematic review and meta-analysis. European Heart Journal. 2017;38(19):1509-1516.

122 Elkayam U, Goland S, Pieper PG, Silverside CK. High-Risk Cardiac Disease in Pregnancy Part I. Journal of the American College of Cardiology. 2016;68(4):396-410.

123 Özkan M, Gündüz S, Biteker M, et al. Comparison of different TEE-guided thrombolytic regimens for prosthetic valve thrombosis: the TROIA trial. JACC: Cardiovascular Imaging. 2013;6(2):206-216.

124 Özkan M, Çakal B, Karakoyun S, et al. Thrombolytic therapy for the treatment of prosthetic heart valve thrombosis in pregnancy with low-dose, slow infusion of tissue-type plasminogen activator. Circulation. 2013;128(5):532-540.

125 Blackwell N, Hollins A, Gilmore G, RN. Antistreptokinase antibodies: implications for thrombolysis in a region with endemic streptococcal infection. Journal of Clinical Pathology. 2005;58(9):1005-1007.

126 Urdahl KB, Mathews JD, Currie B. Antistreptokinase antibodies and streptokinase resistance in an Aboriginal population in northern Australia. Australian and New Zealand Journal of Medicine. 1996;26(1):49-53.

127 Mahli A, Izdes S, Coskun D. Cardiac operations during pregnancy: review of factors influencing fetal outcome. Annals of Thoracic Surgery. 2000;69(5):1622-1626.

128 Elassy SM, Elmidany AA, Elbawab HY. Urgent Cardiac Surgery During Pregnancy: A Continuous Challenge. Annals of Thorac Surgery. 2014;97(5):1624-1629.

129 Pieper PG. Use of medication for cardiovascular disease during pregnancy. Nature Reviews Cardiology. 2015;12(12):718-729.

130 Habib G, Lancellotti P, Antunes MJ, et al. 2015 ESC Guidelines for the management of infective endocarditis: The Task Force for the Management of Infective Endocarditis of the European Society of Cardiology (ESC). Endorsed by: European Association for Cardio-Thoracic Surgery (EACTS), the European Association of Nuclear Medicine (EANM). European Heart Journal. 2015;36(44):3075-3128.

131 Antibiotic Expert Groups. Therapeutic Guidelines: Antibiotic. Version 15. In. Melbourne: Therapeutic Guidelines Limited; 2015.

132 World health Organization. Report of a WHO technical consultation on birth spacing: 13-15 June 2005. Geneva Switzerland, 2007.

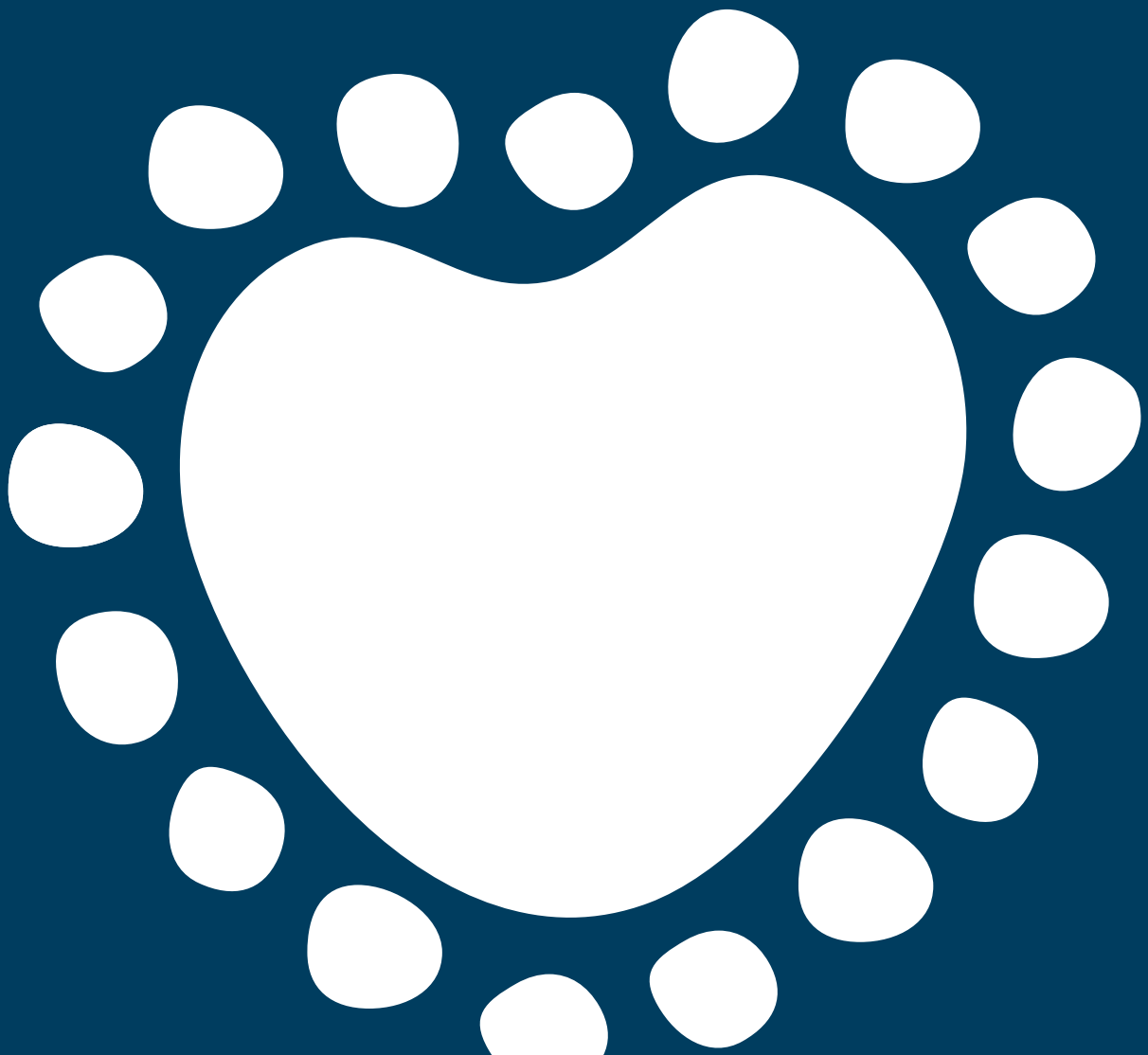
133 Conde-Agudelo A, Rosas-Bermúdez A, Kafury-Goeta AC. Birth spacing and risk of adverse perinatal outcomes: a meta-analysis. Journal of the American Medical Association. 2006;295(15):1809-1823.

134 Regitz-Zagrosek V, Gohlke-Bärwolf C, Iung B, Pieper PG. Management of Cardiovascular Diseases During Pregnancy. Current Problems in Cardiology. 2014;39(4):85-151.

135 Department of Health TGA. Medicines and TGA classifications. 2019.

CHAPTER 13

Rheumatic heart disease control programs



Rheumatic heart disease control programs

IMPORTANT CHANGES IN THIS CHAPTER

Updated status of RHD control programs in the Australian context

Addition of notifiable conditions to include Victoria (Table 13.1)

Updated notification process and consent requirements (Table 13.2)

Updated key performance targets and metrics for RHD Control Programs (Table 13.3)

KEY INFORMATION

- Comprehensive RHD control programs which address the social and environmental determinants of health and the primary and secondary prevention of ARF, can be effective in reducing the burden of RHD.[1,2,3]
- RHD control programs:
  - Maintain register and recall systems to support secondary prophylaxis delivery and clinical management.
  - Support patient care by maintaining a skilled health workforce, promoting culturally appropriate care, supporting education and health promotion for patients and communities, and working with patients and primary healthcare staff to optimise delivery of secondary prophylaxis.
  - Promote primary prevention aimed at preventing initial episodes of ARF.
  - Provide jurisdiction-wide data for epidemiological reporting.

Box 13.1. Recommended elements of RHD control programs[4]

Commitment from national, regional and local organisations, particularly to ensure long-term funding and governance support.
An effective program advisory committee that includes First Nations health service organisations and members from the First Nations health workforce, medical specialists, general practitioners, epidemiologists, nurses, public health practitioners, and relevant community representatives.

The ability to find new cases of ARF and RHD and to assess and monitor the burden of disease.

An electronic patient register that contains data elements to support quality patient management, and internal and external reporting requirements.

Advocacy for improved environmental health.

Support for delivery of primary antibiotic treatment and secondary antibiotic prophylaxis delivered within the framework of primary healthcare.

Planning and advocacy for a stable supply of benzathine benzylpenicillin G (BPG), and the establishment of plans for sustainable secondary prophylaxis in the event of supply limitations.

A commitment to partnerships between clinicians and public health services to support the needs of people with ARF and RHD and the community.

Education and training for the health workforce, and supported health education for patients, families, and communities.

Activities guided by locally relevant, evidence-based guidelines.

Legislation and/or regulations warranting the notification of ARF and RHD supported by public health surveillance activities at the State or Territory level.

A mechanism for monitoring disease, delivery of secondary prophylaxis, and ongoing care.

Evaluation of patient management and program activities.

DISCUSSION

"Just get organised and coordinate my needles with the nearest clinics or the CDC. I've had injections while working in Mataranka, Katherine, Bulman, Lajamanu, Palmerston, Robertson River, and Minyerri. I've even had a nurse come out and give me an injection in the car park of my trade school."

RHD Champion, 2019.

Program model

Register-based control programs reduce recurrence of ARF, decrease hospitalisations, and help to avoid costly and life-threatening heart surgery for young First Nations peoples. However, ARF and RHD can only be eliminated by addressing underlying environmental risk factors, and by providing timely and effective healthcare to ensure that throat and skin infections do not progress to ARF.[5]

The World Health Organization recommends a coordinated, public health approach where there are substantial populations with ARF or RHD.[4] RHD control programs aim to improve timely diagnosis and the delivery of secondary prophylaxis, which is the most cost-effective approach to RHD control.[4,6] RHD programs are also well-placed to advocate for, and support, activities aimed at preventing ARF and RHD (primordial prevention) (Table 4.1).

A dedicated coordinating team is critical to the success of the jurisdictional RHD control program. Combined capacity should include skills in data management and reporting, education and training, basic epidemiology and clinical medicine. To ensure that the program continues to function well despite staffing changes, program activities must be integrated into the established public health system.

Program implementation should be stepwise;[7] starting in one or more defined areas to test whether the structure and processes are appropriate within the local context, with gradual extension of the program to regional and statewide coverage. RHD control programs should support existing healthcare services and be managed in line with local healthcare frameworks.

Registers and recall systems

Indigenous peoples worldwide are reaffirming their sovereignty rights around the collection and use of medical and personal data that describes themselves or their living circumstances. In Australia, many First Nations leaders and academic institutes are calling for a national approach to data sovereignty and data governance.[8]

The right to own, collaborate, analyse and use data is reflected in the United Nations Rights of the Indigenous Peoples.[9] Data related to ARF and RHD are collected locally and aggregated nationally, with an emphasis on rates and prevalence of disease. Under a data sovereignty and data governance approach, local communities would be more active in determining which data should be collected, and how and who it should be shared with. This approach allows community ownership, empowerment, collaboration and partnerships to occur. Data presented back to communities would also help make sense of the data from a different lens and world-view.

ARF/RHD registers are an important component of comprehensive RHD control programs, and a key element of RHD control at individual, community and national levels.[1,2] Contemporary, local evaluation of the impact of RHD control programs is difficult due to the lack of appropriate comparative groups, and because program activities (improving the detection and reporting of ARF and RHD) inherently have the effect of increasing case notifications at least in the short term. However, at different historical times and in various geographical settings, register-based programs have been shown to:

- Improve case detection.[10-15]
- Increase adherence to secondary prophylaxis.[3,14,15]
- Reduce recurrences of ARF.[14-19]
- Decrease hospitalisations due to ARF/RHD.[14,15]

Ideally ARF/RHD registers should be linked to local primary care registers and a national disease reporting system. This may be a centralised dedicated database, or part of a more comprehensive chronic disease register maintained by program staff. Satellite registers, including clinic-based patient management systems and secondary prophylaxis injection books that are managed by dedicated staff, can link or report into regional registers. All patient registers should maintain patient confidentiality, conform to privacy legislation, and be established with relevant approvals.

In addition to reporting on disease epidemiology and providing other information necessary to monitor program activities, registers should provide individual and community reports and recall lists for visiting specialists and primary healthcare staff. Registers may also provide reports to funders and researchers.

Registry data can be used to contribute to epidemiological knowledge of ARF and RHD by linking with population denominator data to allow calculation of ARF prospective incidence and RHD prevalence data.

RHD control programs in Australian

A First Nations workforce should be embedded into the RHD control program, to provide guidance and support to program activities, and to help translate health promotion into culture and practice. Further consideration should be given to partnering with local First Nations health programs and organisations to facilitate disease control across social and cultural pathways.

RHD control activities have been established in Australia since 1997. From 2009, programs in the Northern Territory (NT), South Australia (SA), Queensland (QLD) and Western Australia (WA) have been primarily funded under the Rheumatic Fever Strategy Federal Funding Agreement.[120,21] These agreements outline improved detection, monitoring and management of ARF and RHD through:

- Improved clinical care, including improved delivery of and adherence to secondary prophylaxis antibiotics.
- Provision of education and training for healthcare providers, individuals, families and communities.
- Collection and provision of agreed data to the Australian Institute of Health and Welfare for national monitoring and reporting of ARF and RHD, and measuring program effectiveness in the detection and management of ARF and RHD.
- Maintenance of dedicated statewide patient register and recall systems for ARF and RHD.

The New South Wales (NSW) program is funded by the NSW Government, and its aims align with the other programs.[22]

Australia's first register-based RHD control program was established in the Top End of the NT in 1997.[23] A second NT program was established in Central Australia in 2000, and the Top End and Central Australia programs have since amalgamated. The NT program employs a small team, including Clinical Nurse Specialists, Register Coordinators and a Data Analyst based in Darwin and Alice Springs. The program works closely with NT Health and First Nations Community Controlled Health Services across the NT, supporting patient care-coordination and providing education to patients, their families and health professionals. This occurs across a range of settings including hospital based acute care, primary health care (urban and remote), cardiology outreach visits to remote communities and participation in screening programs such as the Deadly Heart Trek.

An RHD Register and Control Program was established in QLD in 2009. The program includes both clinical and non-clinical staff and coordinates a service across the State. The program governance transferred to Queensland Public Health and Scientific Services in 2023 and notifications of ARF and RHD were integrated into established public health systems for management by public health units.

The WA program was established in Broome in 2009. Since July 2017, the program has been based in Perth, and managed by the WA Country Health Service, Population Health. The WA program focuses on providing leadership and clinical support, and education for the health workforce and community. Clinical nurses based in the Kimberley and in Perth provide state-wide support to health service providers.

The SA program and register were established in Adelaide in 2010. A dedicated nurse also coordinates patient care and cardiology outreach for people with ARF and RHD living in the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands across northern SA. Program staff work with communities and government and First Nations controlled primary care services to improve primary and secondary prevention and provide health workforce education and training.

The NSW program was established in 2015, with a register commencing the following year. A coordinator provides support in each local health district. The program focuses on raising awareness about ARF and RHD among primary healthcare providers, including the First Nations Community Controlled Health sector and networks representing people from the Pacific region. The NSW program also works with established environmental health programs to improve housing for First Nations peoples.

Legislated notification of ARF and RHD

The National Notifiable Diseases Surveillance System (NNDSS) was established in Australia in 1990 to coordinate surveillance of communicable diseases.[24] Notifications are managed in each jurisdiction.

Diseases may be nationally notifiable or may be notifiable only in specific States and Territories. National and jurisdictional legislation applies to diseases becoming notifiable, and to the process of enrolling people in RHD registers.

ARF and RHD have been designated notifiable diseases in several Australian jurisdictions (Table 13.1).

The notification process comprises notification of demographic, clinical and diagnostic data by clinicians, which differs from most other notifiable conditions where notifications are made by laboratories. Lack of awareness by clinicians of the need to notify, or of the process to do so, can result in missed opportunities for inclusion of ARF or RHD cases in registers. Furthermore, notification by clinicians requires contact with different agencies in some jurisdictions (e.g. the RHD Register and the Notifiable Diseases database), and multiple agencies for cross-border patients (Table 13.2). This may pose a barrier to enrolling people on registers, resulting in further missed opportunities for inclusion as well as delivery of coordinated care.

It may be possible to simplify notification of ARF and RHD at a jurisdictional level by mapping notification pathways and seeking opportunities to increase capacity for online notification and ARF data reporting from different sources (e.g. primary healthcare facilities, laboratory providers and hospital admissions).

Discussion about the suitability of ARF as a nationally notifiable disease in Australia has been underway for many years.[27] National notification of ARF was considered by the Communicable Diseases Network Australia (CDNA) in 2004, 2010, and 2022, however, it did not progress. National notification of both ARF and RHD was proposed by the National Aboriginal Community Controlled Health Organisation in 2023, and this is under review by the CDNA.

RHD meets fewer of the CDNA criteria for notification than ARF but there are good reasons for considering its candidacy. Almost half of First Nations peoples living with RHD would not be identified by relying on ARF notification alone, because ARF diagnoses in people with established RHD have often been missed.

In a 2015 review, ARF and RHD both met the threshold for national notification to be considered further.[28] Incorporating ARF into the NNDSS would mandate a standardised national approach to notification with a potential range of benefits: clinicians working across different jurisdictions would be familiar with a standardised approach to notification, and case reporting could be managed across jurisdiction boundaries. Registered patients who move across jurisdictional boundaries may be less likely lost to follow-up.

The development of a national register has been discussed for some years. Several reviews have recommended a national register, including the Audit and Best Practice for Chronic Disease 2 study in 2016.[29] However, local registers have been established due to the staggered timing of program development and variations for legislated notification (Table 13.1).

Active case finding for RHD and improved diagnosis of ARF cause an increase in apparent disease rates as previously undetected and unnotified cases are identified. Therefore, successful RHD control programs can be associated with increases in reported disease rates while simultaneously having population-level benefits by linking newly detected cases to treatment.

Similarly, improved and coordinated access to specialist care may also result in higher rates of valvular surgery (a proxy measure for RHD severity and therefore, control program performance, where the aim is to decrease the numbers of people needing surgery) in the initial years after commencing an RHD control program.

Table 13.1. Evolution of ARF and RHD notification and RHD program establishment in Australia

	NT	QLD	WA	SA	NSW	VIC§	TAS, ACT
RHD Control Program established	1997†	2009	2009	2010	2015		
ARF/RHD Register established	1997	2006	2009	2012	2016		
Confirmed (definite) ARF notifiable	1996	1999	2007	2016	2015	2023	
Probable ARF notifiable	2019	2018	2015	2016	2015	2023	
Possible ARF notifiable		2018	2015	2016	2015	2023	
RHD Stage B, C and D notifiable	2019	2018	2015	2016	2015‡	2023	
RHD Stage A notifiable		2018	2015	2016	2015	2023	

† The Top End Control Program was established in Darwin in 1997, and expanded in 2000 to include the whole NT.
‡ Notification of RHD only in persons aged less than 35 years.
§ Notification commenced from 31 July 2023.

Table 13.2. Processes for notification and inclusion on registers, April 2025

JURISDICTION	NOTIFICATION PROCESS	PATIENT CONSENT
NSW	Medical Practitioner or hospital CEO notifies the NSW Public Health Unit by telephone, or by completing and submitting a notification form.[25]	Notification – consent not required. Register – informed, opt-in consent.
SA	Medical Practitioner notifies the SA Communicable Disease Control Branch by telephone or by completing and submitting a Notifiable Conditions reporting form within three days of suspecting or confirming a diagnosis (online form option available), AND Medical Practitioner notifies the SA RHD Register by telephone, or by completing and submitting a notification form.[26]	Consent not required.†
QLD	Medical Practitioners, medical superintendents (or delegates) notify Queensland Health by completing and submitting an ARF notification form or RHD notification form which is recorded in the Notifiable Conditions System. Cases are referred to the Qld RHD Register.	Consent not required.‡
NT	Medical Practitioner notifies the relevant Public Health Unit at first suspicion, by contacting the NT RHD Control Program in Darwin or Alice Springs.	Consent not required for notification. (Consent requested for sharing information)
WA	Medical Practitioner or Nurse Practitioner notifies the WA RHD Register and Control Program by completing and submitting a notification form together with copies of diagnostic tests (including echocardiogram) and copies of each medical specialist's report (secure file transfer options available).¶	Consent not required.§
VIC	Medical Practitioner notifies the Victorian Department of Health by completing and submitting a notification via the Notification Portal. The notification is allocated to the relevant Public Health Unit for follow up.	Consent not required.

†Consent was required for all patients prior to 2019. From 2019 an opt-out option is available.
‡ Consent was required for patients with RHD registered prior to 2018
§ Notification required within 30 days of the medical specialist report.
¶ An individual can request in writing to the Chief Health Officer that there only be limited disclosure of identifying information on the register.

ARF and RHD surveillance

Surveillance of ARF usually depends on case identification from healthcare providers who report cases to registers through established notification channels (Table 13.2). Historically, this has underestimated the burden of disease, due to inaccuracies and incompleteness.[30]

A three-year study of ARF in Australian children between October 2007 and December 2010 also demonstrated under-reporting. The study was conducted by the Menzies School of Health Research in conjunction with the Australian Paediatric Surveillance Unit (APSU).[31] The APSU notification mechanism relies on voluntary reporting from clinicians working in paediatrics and child health. The voluntary nature of reporting, together with the lack of core data for some reported cases, resulted in an underestimate when compared with the number of cases reported on registers in the same period.[30]

Case ascertainment by the registers was compared with hospital data in 2020.[33] While between 17 and 40% of hospital cases were not included on the registers, not all register cases were found in hospital data either. Younger, Indigenous people with ARF and RHD living across northern Australia were more likely to be included on the registers. Interestingly, and despite clear recommendations for all people with ARF to be hospitalised, 25% of people with ARF on registers were not included in the hospital data.

Ideally, active surveillance should be used to expand on passive surveillance.[30] This requires mechanisms to identify new cases of ARF and RHD, and to update information about known cases. In under-resourced settings, the deficiencies of passive surveillance are exacerbated by the high turnover of hospital and primary care staff and lack of awareness of ARF and RHD among many healthcare providers. Therefore, processes should be automated where possible.

A diverse range of activities has been used for active ARF and RHD data capture to inform the registers. Examples include hospital separation data, specialist and radiological reports, automated alerting of registered patients on presentation to hospital, review of patients' presenting complaints, and community and staff education aimed at improving case identification. Active case finding of RHD may include systematic echocardiographic screening in settings with high rates of disease (Table 9.3).

Evaluating RHD control

Key reporting indicators for RHD control programs are outlined in Table 13.3. General recommended measures to track program performance include:

- Rates of disease occurrence (ARF and RHD numbers and population-adjusted rates respectively).

Delivery of secondary prophylaxis for individuals and per community for the group prescribed ARF secondary prophylaxis, using the metrics of percent delivery of prescribed BPG infections and days at risk (See Chapter 10. Secondary Prophylaxis, Measuring BPG injection adherence).

- ARF recurrence rate and as a proportion of all ARF cases.
- Indicators of satisfactory care specified in best-practice guidelines.
- Deaths among people with ARF and RHD, including cause of death where possible.

Further consideration should be given to assessment of the quality and reach of patient care, including:

- The delivery of specialist cardiology services.
- Availability and accessibility of echocardiography and dental care.
- Trends in need for cardiac surgery.
- Medical and surgical referral practices and structures.
- Patient support and appropriate follow-up processes.
- Transition from paediatric to adult services.

RHD programs should be evaluated on how well they identify people with ARF and RHD and support the health system to provide appropriate care. Monitoring should be conducted at regular intervals on:

1. Which program activities are being implemented.
2. The extent to which program objectives are being met.
3. Progress towards program goals.[1]

An independent evaluation of the Australian Rheumatic Fever Strategy and associated program activity was conducted in 2016.[5] Overall, the evaluation reported multiple successes including improved monitoring and surveillance of ARF and RHD, increased awareness of the disease among the health workforce, and improved secondary prophylaxis delivery in some areas. Recommendations included continued, longer-term funding to enable the programs to:

- Broaden efforts around primordial and primary prevention of ARF while continuing to improve secondary prevention.
- Further develop the registers and streamline data sharing for national epidemiological reporting;
- Strengthen clinical education.

A review of epidemiological changes during the years 2010 to 2017 found that while the proportion of people receiving 100% of BPG injections increased under program control, ARF case numbers which are not influenced by secondary prophylaxis increased, primarily due to increased surveillance.[3]

The availability of, and support for, routine primary healthcare is essential for preventing ARF and controlling RHD. Indicators used to evaluate RHD control should be relevant, structured, measurable, routinely available and affordable. They should not overburden primary healthcare providers and should lead to improved clinical results.

Most people in Australia enrolled on ARF/RHD registers are First Nations peoples (Figure 3.6). This is mostly attributable to the recognised differential disease burden but partly attributable to reporting practices which deliberately or accidentally exclude people with RHD above a certain age (who are more likely to be non-Indigenous) (See Chapter 3. Burden of ARF and RHD, Demographic distribution of ARF and RHD), or from low-risk populations in Australia. Reporting for ARF and RHD should support accountability in measuring progress towards agreed outcomes, and should be accessible to First Nations communities and healthcare organisations, in line with the Council of Australian Governments (COAG) Implementation Principles of 2019.[34]

Key performance indicators

Key reporting indicators to monitor and report ARF and RHD activity vary both within Australia and internationally. Issues with availability and accuracy of data, and with denominators for rate calculations, caution against recommending complex reporting requirements.

The RHD Endgame Strategy[35] highlights important targets and indicators for primary care services and jurisdictional RHD programs to help eliminate new cases of ARF and RHD by 2030 (Table 13.3).

For consistency, the same frequency of reporting, and the same definitions and methods for calculation should be used across regions and jurisdictions. The true picture of ARF and RHD within Australia and the progress of RHD control regionally and nationally, will only be possible with national legislated notification of ARF and RHD and a national data collection and reporting system.

Table 13.3. Key reporting indicators

1.1 Number and rate of new cases of ARF each year, by	1.1.1 Episode type (definite, probable, possible) 1.1.2 Age group 1.1.3 Sex 1.1.4 Ethnicity 1.1.5 Region of onset
1.2 Proportion of ARF recurrences each year, by	1.2.1 Episode type (definite, probable, possible) 1.2.2 Rate per 100 patient-years for patients prescribed prophylaxis (both oral and BPG)
1.3 Number and rate of RHD incidence (new cases) each year, and RHD prevalence (total number of cases) each year, by	1.3.1 Age group 1.3.2 Sex 1.3.3 Ethnicity 1.3.4 Stage (A, B, C and D)
1.4. Proportion of people who need secondary prophylaxis each year and receive	1.4.1 100% 1.4.2 80–99% 1.4.3 40–79% 1.4.4 1–39% 1.4.5 0%

REFERENCES

1 Wyber R, Johnson T, Perkins S, et al. Tools for Implementing RHD Control Programmes (TIPS) Handbook, 2nd edition. Geneva Switzerland, 2018.

2 Dougherty S, Carapetis J, Wilson N. Control programmes, registries, and access to care. Acute rheumatic fever and rheumatic heart disease Elsevier; 2020. ISBN 9780323639828

3 Stacey I, Ralph A, de Dassel J, et al. The evidence that rheumatic heart disease control programs in Australia are making an impact. Australian and New Zealand Journal of Public Health. 2023;47(4):100071.

4 World Health Organization. Rheumatic fever and rheumatic heart disease: report of a WHO expert consultation, Geneva, 29 October–1 November 2001. WHO Technical Report Series 923. 2004.

5 Health Policy Analysis. Evaluation of the Commonwealth Rheumatic Fever Strategy – Final Report. Canberra Australia, 2017.

6 Carapetis JR, Steer AC, Mulholland K, Weber M. The global burden of group A streptococcal diseases. The Lancet Infectious Diseases 2005;5(11):685-694.

7 Robertson K, Volmink JA, Mayosi BM. Towards a uniform plan for the control of rheumatic fever and rheumatic heart disease in Africa – The Awareness Surveillance Advocacy Prevention (A.S.A.P.) program. South African Medical Journal 2006;96(3 II):241-245.

8 Kukutai T, Taylor J. Indigenous data sovereignty: toward an agenda. Canberra: Australian National University Centre for Aboriginal Economic Policy Research College of Arts and Social Sciences. 2016.

9 United Nations. UN Declaration on the Rights of Indigenous Peoples. 2007.

10 Bach J, Chalons S, Forier E, et al. 10-year educational program aimed at rheumatic fever in two French Caribbean islands. The Lancet 1996;347:644-648.

11 Brown A, Purton L, Schaeffer G, et al. Central Australian rheumatic heart disease control program: a report to the Commonwealth November 2002. NT Disease Control Bulletin 2002;10(1):1-8.

12 Kelly A. Top End rheumatic heart disease program: a report to the Commonwealth, February-November 2002. NT Disease Control Bull. 2004;10:9-11.

13 Gordis L, Lilienfeld A, Rodriguez R. An evaluation of the Maryland rheumatic fever registry. Public Health Report 1969;84(4):333-339.

14 Strasser T. Cost-effective control of rheumatic fever in the community. Health Policy. 1985;5(2):159-164.

15 World Health Organization. The WHO global program for the prevention of rheumatic fever and rheumatic heart disease: Report of a consultation to review progress and develop future activities, 29 November–1 December 1999. 2000. Geneva.

16 Lennon D. Rheumatic fever, a preventable disease? The New Zealand experience, in Streptococci and streptococcal disease: entering the new millennium. 2000, ESR: Porirua. 503-512.

17 Neutze J, Clarkson P. Rheumatic fever: an unsolved problem in New Zealand. The New Zealand medical Journal. 1984;97(763):591-593.

18 Kumar R, Thakur JS, Aggarwal A, et al. Compliance of secondary prophylaxis for controlling rheumatic fever and rheumatic heart disease in a rural area of northern India. Indian Heart Journal. 1997;49(3):283-288.

19 Kumar R, Raizada A, Aggarwal AK, et al. A community based rheumatic fever/rheumatic heart disease cohort: twelve-year experience. Indian Heart Journal. 2002;54(1):54-58.

20 Federal Financial Relations. Rheumatic Fever Strategy. National Partnership Agreement on specified projects. Canberra: Commonwealth of Australia, 2018.

21 Federal Financial Relations. Rheumatic Fever Strategy. National Partnership. Canberra: Commonwealth of Australia, 2022.

22 NSW Agency for Clinical Innovation. Acute Rheumatic Fever and Rheumatic Heart Disease in NSW Chronic Care for Aboriginal People. Chatswood NSW, 2017.

23 Noonan S, Edmond KM, Krause V, et al. The Top End rheumatic heart disease control program 1: report on program objectives. NT Disease Control Bulletin. 2001;8(2):15-18.

24 Australian Department of Health. Introduction to the National Notifiable Diseases Surveillance System. 2015.

25 NSW Health. Acute rheumatic fever and rheumatic heart disease control guideline. 2024

26 SA Health. SA Rheumatic Heart Disease (RHD) Register.

27 Binns P, Krause V. Should acute rheumatic fever and rheumatic heart disease be nationally notifiable? The NT Disease Control Bulletin 2004;11(3):25-9.

28 Yapa C. Communicable disease control in New South Wales and globally. Canberra: Australian National University; 2015.

29 Bailie J, Matthews V, Laycock A, Bailie RS. Aboriginal and Torres Strait Islander Acute Rheumatic Fever and Rheumatic Heart Disease Care: Final Report, ESP Project. Darwin: Menzies School of Health Research, 2016.

30 Rice M, Kaplan E. Rheumatic fever in Minnesota 2: evaluation of hospitalized patients and utilization of a state rheumatic fever registry. American Journal of Public Health. 1979;69(8):767-771.

31 Noonan S, Zurynski YA, Currie BJ, et al. A national prospective surveillance study of acute rheumatic fever in Australian children. The Pediatric Infectious Disease Journal.2013;32(1):e26-e32.

32 Agenson T, Katzenellenbogen JM, Seth R, et al. Case Ascertainment on Australian Registers for Acute Rheumatic Fever and Rheumatic Heart Disease. Int J Environ Res Public Health. 2020;17(15):5505.

33 Yankauer A (Editor). State registries and the control of rheumatic fever. American Journal of Public Health. 1979;69(8):761-762.

34 Australian Government Department of the Prime Minister and Cabinet. Closing the Gap Report 2019.

35 Wyber R, Noonan K, Halkon C, et al. The RHD Endgame Strategy: The blueprint to eliminate rheumatic heart disease in Australia by 2031. Perth: The END RHD Centre of Research Excellence, Telethon Kids Institute, 2020.

CHAPTER 14

New technologies

New technologies

IMPORTANT CHANGES IN THIS CHAPTER

Introduction to the SubCutaneous Infusions of high dose benzathine Penicillin G (SCIP) trial

Updated discussion on Strep A vaccine development

KEY INFORMATION

- This chapter reviews research underway in Australasia which aims to discover better alternatives to benzathine benzylpenicillin G (BPG), develop a Strep A vaccine, and develop a diagnostic test for ARF.
- Promising data from Phase I trials has led to Phase II trials of delivery of high-dose subcutaneous infusions to make secondary prophylaxis hurt less and last longer.
- Development of a better BPG formulation is dependent on answering existing knowledge gaps relating to lowest effective dose of penicillin against Strep A and ideal route of delivery.
- Major national and international initiatives, including the Australian Strep A Vaccine Initiative (ASAVI), aim to fast-track development of a Strep A vaccine, with the goal to commence field trials including sites in Australia as soon as possible. Strep A vaccine challenges include the need to cover hundreds of different Strep A types and to avoid immune complications that could trigger ARF-like outcomes.
- Diagnostic tests for autoimmune disease usually rely on disease-specific antibodies and other immune markers such as complement levels, but no diagnostic test for ARF has yet been discovered. Research is underway to determine if biomarkers (molecules, genes, immune or other markers which can identify a disease process) measurable in blood may be discoverable which distinguish ARF from non-ARF presentations. If a distinguishing biomarker profile is discovered, then it may be possible to develop an ARF diagnostic test suitable for use in clinical diagnostic laboratories.

PENICILLIN DELIVERY

Community engagement is critically important to ensure that First Nations peoples are actively engaged in decisions about priorities and directions for research. Research into ARF and RHD must align with community needs, with consultation of community members about project design and implementation.

Long-acting penicillin, in the form of intramuscular BPG injections, has been an integral part of preventing recurrent acute rheumatic fever (ARF) since the 1950s. This unique depot injection has been shown to have detectable levels in humans for up to four weeks,[1,2] and is tolerated in most people requiring secondary prevention for ARF.[3,4] For more than 60 years, Strep A bacteria have remained sensitive to penicillin; there have been no documented penicillin-resistant strains of Strep A. Non-penicillin antibiotics are used for individuals with a penicillin allergy; however, they are generally considered inferior, and resistance can develop.[5,6]

Research into better understanding the pathogenesis of Strep A and ARF has been extensive.[7] However, little has changed with regards to the type, dose and frequency of penicillin used since early studies demonstrated intramuscular penicillin to be superior to other antibiotics for secondary prevention.[5]

Despite the long-term effectiveness of penicillin in managing ARF, there have been significant issues. A relatively small market for BPG and low financial profit margins have resulted in a lack of innovation from manufacturers. Stock shortages of the pre-filled syringe product (Bicillin L-A®) across Australia at different times have required a temporary switch to powdered alternatives used in other parts of the world.[8] While there have been changes in recommended injection administration technique to manage pain and distress of injections with some effect,[9,10] the active ingredient and route of delivery has remained largely unchanged since its development.[11]

Most of the antibiotic comparison studies were conducted in the 1950s and consisted of cohorts of Caucasian children, which is a vastly different population to that most commonly affected by ARF today.[12,13] Further studies in the 1990s and 2000s highlighted significant differences in blood concentrations between individuals without clear explanation.[1,14] Early lab studies (in vitro) attempting reformulation showed some promise with a nanoparticle impregnated with penicillin. A long-acting penicillin implant prototype has been developed. Despite a favourable release rate and safety profile in animals, a solid core implant will be too large for routine use in humans.[15,16,17]

Further work is underway to explore other possible delivery methods. SCIP has shown promising results. In a Phase I study, 24 healthy volunteers in Australia received three, six or nine times the standard dose of penicillin as a single subcutaneous infusion into abdominal subcutaneous tissue.[18] Safety assessments, pain scores, and penicillin concentrations were measured for 16 weeks post dose. Despite some anxiety prior to SCIP and some people experiencing minor pain during needle insertion, positive patient experiences were described and prolonged elevated penicillin concentrations were observed, enabling injections every 3 months, rather than monthly.[19, 20]

There is also a Phase II trial of SCIP in progress among more than 40 Māori and Pacific young people in New Zealand who receive regular secondary prophylaxis. Reporting that this route of administration, 'hurts less and lasts longer', nearly all have indicated their preference to continue to receive secondary prophylaxis with SCIP. Similar studies in Australian First Nations communities are being planned.

Two key questions about penicillin delivery remain to be answered:

- What is the minimum required penicillin concentration dose to prevent Strep A infection?
- Can a new formulation of long-acting penicillin be developed and manufactured in Australia?

Several studies are underway to help answer these questions.

Blood levels of penicillin considered protective against Strep A are interpreted from laboratory tests, and current dosing regimens usually provide adequate protection against Strep A and recurrent ARF.[21,22] However, demonstration of the true protective level of penicillin in people (in vivo) is much more difficult. There has not been the technology to test in vivo whether a reduction in penicillin concentration will continue to be protective.

- The development of a human challenge model for Strep A infection[23] has been a significant breakthrough. A team at the Murdoch Children's Research Institute in Melbourne has been able to expose healthy individuals to Strep A (Strep A 'challenge') to develop a sore throat. With this controlled infection model, it will be possible to establish the true minimum protective penicillin level against Strep A, rather than assume from laboratory values. If this protective level can be identified and is found to be lower than the previously determined concentration of 0.02 mg/L, it will allow for smaller implants to be developed, a major barrier identified preventing reformulation.[24]
- At a global level, fragmented BPG manufacturing, supply and procurement has led to recurrent global shortages, both of Bicillin-LA® and powdered formulations. These shortages have directly led to increased incidence of syphilis cases.[1] There are four manufacturers of the active pharmaceutical ingredient (API), with three Chinese companies producing 95% of the global supply, and only one producing API under good manufacturing practice conditions. Due to low profitability, production of powdered BPG is only triggered by large minimum orders. Large procurement agencies are unable to smooth out supply constraints because of a lack of confidence in manufacturing quality.[4] As part of its commitment to First Nations health and regional health security Australia should consider a proactive response to BPG shortages. Australian researchers are currently exploring autonomous manufacturing capacity to ensure a quality-assured and reliable supply of BPG which results in a smaller volume dose given through a smaller needle which is stable at tropical temperatures. Together, these studies will help ensure that future long-acting penicillin reformulations are effective and acceptable to patients and health systems. Together, these studies will help ensure that a penicillin reformulation is effective and acceptable to patients and health systems.

STREP A VACCINE DEVELOPMENT

An effective vaccine is likely to reduce Strep A infection and subsequent ARF and RHD. However, vaccination will not address social inequity or improve the socioeconomic conditions in which high risk populations live.

Vaccines are a safe and effective way of reducing and eliminating illnesses caused by bacteria such as meningitis (brain infection) and pneumonia (lung infection) due to *Haemophilus influenzae* type B, *Streptococcus pneumoniae*, and *Neisseria meningitidis*.[25]

Strep A vaccines have been studied since the 1920s.[26] As well as reducing pharyngitis ('strep throat'), impetigo (skin sores), ARF and RHD,[27] an effective Strep A vaccine given in early childhood would prevent other Strep A diseases including rheumatic fever, post-streptococcal glomerulonephritis (kidney disease), cellulitis (skin infection), severe and frequently fatal invasive disease including bacteraemia (blood infection), toxic shock syndrome, necrotising fasciitis, and infections in pregnant women and newborn babies.[28,29] First Nations peoples experience these conditions at a much higher rate than non-Indigenous Australians, and are therefore most likely to benefit from a vaccine.[30-32] By preventing disease across the Strep A spectrum, a vaccine would also reduce the non-communicable disease burden of Strep A diseases, including complications of RHD and its management such as heart failure, stroke and infective endocarditis.

In addition to providing primary prevention of Strep A infection, a vaccine administered to people with pre-existing ARF or RHD could provide effective secondary prevention of ARF. Other medical approaches to primary prevention such as antibiotic treatment for Strep throat and skin infections have not been able to achieve large and sustainable reductions in the subsequent development of ARF or RHD.[33]

In the longer term, reducing ARF and RHD through vaccination of high-risk populations will help eliminate the disease. In the short term, offering vaccination to those at risk will reduce the impact of ARF and RHD on individuals, families and communities. A successful vaccine will be an important part of ending RHD in Australia, eliminating RHD as a global public health problem, and would be a game-changer for control of all conditions associated with Strep A. Protection from a vaccine would likely be long-lasting, and certainly much longer than the protection provided from a single dose of BPG.

Development of a Strep A vaccine is the most attractive opportunity for a single medical intervention to substantially reduce the global burden of RHD. Science has identified many vaccine targets (antigens) on the Strep A bacteria with promising results in laboratory and animal studies.[34,35] Unfortunately, there have been scientific, regulatory and commercial obstacles which have delayed the progress of a vaccine, and almost a century later there is no safe and reliable human Strep A vaccine available.[36,37] However, there has been an upsurge in interest from the World Health Organization (WHO) and other major international public health bodies and funders, vaccine developers, and regulators discussing and planning ways to overcome obstacles.[38] Strep A vaccine development was promoted in the WHO's 2018 Resolution on Rheumatic Fever and Rheumatic Heart Disease.[39]

In early 2019, the WHO published a GAS (Strep A) Vaccine Research and Development Technology Roadmap and Preferred Product Characteristics for GAS vaccines.[40-42] Through the Australian and New Zealand government-funded Coalition to Advance Vaccines Against Group A Streptococcus (CANVAS)[43] and other initiatives, Australian leadership has been crucial to promoting development of a vaccine, achieving global consensus on the way forward, and building new models to test vaccines. This includes an Australian-based controlled human infection ('human challenge') model of Strep A pharyngitis to test the ability of vaccines to protect healthy adult volunteers before starting large clinical field trials.[23,38,44]

In 2019 the Australian Federal Government, through the Medical Research Future Fund, committed $35 million to the Australian Strep A Vaccine Initiative coordinated by Telethon Kids Institute and Murdoch Children's Research Institute (MCRI), with the goal of fast-tracking Strep A vaccine development towards large field trials.[45,46] A surge of invasive Strep A infections since 2022 has further highlighted the urgent need for a Strep A vaccine. Many candidates are steadily moving along the pathway from laboratory experiments to animal studies, towards human trials.[47, 48] Australian leadership in Strep A vaccine development will help ensure that the benefits of a vaccine ultimately reach Australian populations at highest risk of ARF and RHD.[49]

BIOMARKERS FOR DIAGNOSIS OF ARF

There is no specific laboratory test for the diagnosis of ARF. The modified Jones criteria include recommendations for measuring general markers of inflammation such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), together with streptococcal serology (ASO and anti-DNase B). Streptococcal serology provides evidence of a preceding Strep A infection but is not a measurable indicator (biomarker) for ARF risk.[46,50] The identification of disease markers that are specific for ARF could aid in making a diagnosis, classifying the case and monitoring disease progression.[51]

Research to identify biomarkers for ARF has been gaining momentum, including the application of 'omics' technology.[52] There are reports of proteomics being used to map the proteins associated with mitral stenosis in RHD[53,54] and molecular library approaches to identify potential autoantigens in ARF sera.[55] A 2018 study of ARF blood samples collected from First Nations children made use of cytokine arrays, flow cytometry and transcriptomics.[56] This broad profiling approach led to the identification of a dysregulated cytokine axis (IL-β and GM-CSF) in these patients. Collectively, these studies demonstrate that it is feasible to apply 'omics' approaches to ARF and, despite being limited in sample size, suggest it will be possible to identify biomarkers that can distinguish ARF from non-ARF cases.

The START study (**S**earching for a **T**echnology-Driven **A**cute **R**heumatic Fever **T**est) is a larger scale trans-Tasman study aiming to identify ARF biomarkers.[57] If a panel of ARF specific biomarkers can be identified, these would need to be converted into assays suitable for use in clinical diagnostic laboratories. Technology platforms that enable multiplex testing, such as bead-based immunoassays, are a possible future approach. Feasibility for bead-based multiplex testing in ARF has been demonstrated for streptococcal serology.[58] Expanded multiplex assays incorporating ARF specific biomarkers have the potential to dramatically improve the efficiency and accuracy of ARF diagnosis.

REFERENCES

1 Broderick MP, Hansen CJ, Russell KL, et al. Serum penicillin G levels are lower than expected in adults within two weeks of administration of 1.2 million units. PLOS One. 2011;6:e25308.

2 Hand RM, Salman S, Newall N, et al. A population pharmacokinetic study of benzathine benzylpenicillin G administration in children and adolescents with rheumatic heart disease: new insights for improved secondary prophylaxis strategies. Journal of Antimicrobial Chemotherapy. 2019;74(7):1984-1991.

3 International Rheumatic Fever Study Group, Allergic reactions to long-term benzathine penicillin prophylaxis for rheumatic fever. Lancet. 1991;337(8753):308-310.

4 Shulman ST, Bisno AL, Clegg HW, et al. Clinical Practice Guideline for the Diagnosis and Management of Group A Streptococcal Pharyngitis: 2012 Update by the Infectious Diseases Society of America. Clinical Infectious Diseases. 2012;55:e86-e102.

5 Manyemba J, Mayosi BM. Penicillin for secondary prevention of rheumatic fever. Cochrane Database of Systematic Reviews. 2002;(3):CD002227.

6 Littauer P, Caugant DA, Sangvik M, et al. Macrolide-Resistant Streptococcus pyogenes in Norway: Population Structure and Resistance Determinants. Antimicrobial Agents and Chemotherapy. 2006;50(5):1896-1899.

7 Walker MJ, Barnett TC, McArthur JD, et al. Disease Manifestations and Pathogenic Mechanisms of Group A Streptococcus. Clinical Microbiology Reviews. 2014;27(2):264-301.

8 Wyber R, Johnson TD, Patel B. Supply of benzathine penicillin G: the 20-year experience in Australia. Australian and New Zealand Journal of Public Health. 2015;39(6):506-508.

9 Russell K, Nicholson R, Naidu R. Reducing the pain of intramuscular benzathine penicillin injections in the rheumatic fever population of Counties Manukau District Health Board. Journal of Paediatrics and Child Health. 2014;50:112-117.

10 Amir J, Ginat S, Choen YH, et al. Lidocaine as a diluent for administration of benzathine penicillin G. The Pediatric Infectious Disease Journal. 1998;17(10):890-893.

11 Wyber R, Johnson T, Carapetis J. Global Status of BPG Report: The benzathine penicillin G Report. 2017.

12 Carapetis JR, McDonald M, Wilson NJ. Acute rheumatic fever. Lancet. 2005;366(9480):155-168.

13 Stollerman GH, Rusoff JH. Prophylaxis against group A streptococcal infections in rheumatic fever patients; use of new repository penicillin preparation. Journal of the American Medical Association. 1952;150:1571-1575.

14 Kassem AS, Zaher SR, Abou Shleib H, et al. Rheumatic fever prophylaxis using benzathine penicillin G (BPG): two-week versus four-week regimens: comparison of two brands of BPG. Pediatrics. 1996;97(6):992-995.

15 Montagnat OD, Webster GR, Bulitta JB, et al. Lessons learned in the development of sustained release penicillin drug delivery systems for the prophylactic treatment of rheumatic heart disease (RHD). Drug Delivery and Translational Research. 2018;8:729-739.

16 Santos-Magalhaes N, Pontes A, Pereira V. Colloidal carriers for benzathine penicillin G: Nanoemulsions and nanocapsules. International Journal of Pharmaceutics. 2000;208:71-80.

17 Barr RK, Barber BW, Tait JR, et al. Development of a sustained release implant of benzathine penicillin G for secondary prophylaxis of rheumatic heart disease. Eur J Pharm Biopharm. 2023;189:240-250.

18 Kado J, Salman S, Hla T, et al. Subcutaneous Infusions of High-Dose Benzathine Penicillin G (SCIP) is Safe, Tolerable and Potentially Suitable for Less Frequent Dosing for Rheumatic Heart Disease Secondary Prophylaxis. Heart, Lung and Circulation. 2022;31(3):S301.

19 Enkel SL, Kado J, Hla TK, et al. Qualitative assessment of healthy volunteer experience receiving subcutaneous infusions of high-dose benzathine penicillin G (SCIP) provides insights into design of late phase clinical studies. PLoS One. 2023;18(4):e0285037

20 Cooper J, Enkel SL, Moodley D, et al. "Hurts less, lasts longer" experiences of young people receiving high-dose subcutaneous infusions of benzathine penicillin G to prevent rheumatic heart disease. MedRXiv. 2023.

21 de Dassel JL, Malik H, Ralph AP, et al. Four-weekly benzathine penicillin G provides inadequate protection against acute rheumatic fever for some children (in Australia's Northern Territory). American Journal of Tropical Medicine and Hygiene. 2019;100(5):1118-1120.

22 Parnaby MG, Carapetis JR. Rheumatic fever in Indigenous Australian Children. Journal of Paediatrics and Child Health. 2010;46(9):527-533.

23 Osowicki J, Azzopardi KI, Baker C, et al. Controlled human infection for vaccination against Streptococcus pyogenes (CHIVAS): Establishing a group A Streptococcus pharyngitis human infection study. Vaccine. 2019;37(26):3485-3494.

24 Hla TK, Osowicki J, Salman S, et al. Study protocol for controlled human infection for penicillin G against Streptococcus pyogenes: a double-blinded, placebo-controlled, randomised trial to determine the minimum concentration required to prevent experimental pharyngitis (the CHIPS trial). BMJ Open. 2022;12(12):e064022.

25 Trotter CL, McVernon J, Ramsay ME, et al. Optimising the use of conjugate vaccines to prevent disease caused by Haemophilus influenzae type b, Neisseria meningitidis and Streptococcus pneumoniae. Vaccine. 2008;26:4434-4445 .

26 Steer AC. Historical aspects of rheumatic fever. Journal of Paediatrics and Child Health. 2015;51(1):21-27.

27 Sheel M, Moreland NJ, Fraser JD, Carapetis J. Development of Group A streptococcal vaccines: an unmet global health need. Expert Review of Vaccines. 2016;15(2):227-238.

28 Steer AC, Carapetis JR, Dale JB, et al. Status of research and development of vaccines for Streptococcus pyogenes. Vaccine. 2016;34(26):2953-2958.

29 Excler JL, Kim JH. Accelerating the development of a group A Streptococcus vaccine: an urgent public health need. Clinical and Experimental Vaccine Research. 2016;5(2):101-107.

30 Colquhoun SM, Condon JR, Steer AC, Li S Q, Guthridge S, Carapetis JR. Disparity in Mortality from Rheumatic Heart Disease in Indigenous Australians. Journal of the American Heart Association. 2015;4(7):e001282.

31 Steer AC, Carapetis JR. Acute rheumatic fever and rheumatic heart disease in indigenous populations. Pediatr. Clin. North Am. 2009;56:1401-1419.

32 Marshall CS, Cheng AC, Markey PG, et al. Acute post-streptococcal glomerulonephritis in the Northern Territory of Australia: a review of 16 years data and comparison with the literature. American Journal of Tropical Medicine and Hygiene. 2011;85(4):3-10.

33 Jack SJ, Williamson DA, Galloway Y, et al. Primary prevention of rheumatic fever in the 21st century: evaluation of a national programme. International Journal of Epidemiology. 2018;47(5):1585-1593.

34 Dale JB, Batzloff MR, Cleary PP, et al. Current Approaches to Group A Streptococcal Vaccine Development. In: Streptococcus pyogenes: Basic Biology to Clinical Manifestations. Oklahoma City: University of Oklahoma Health Sciences. Center; 2016.

35 Watson ME Jr, Neely MN, Caparon MG. Animal Models of Streptococcus pyogenes Infection. In: Streptococcus pyogenes: Basic Biology to Clinical Manifestations. Oklahoma City: University of Oklahoma Health Sciences Centre. 2016.

36 Steer A, Batzloff MR, Mulholland K, Carapetis JR. Group A streptococcal vaccines: Facts versus fantasy. Current Opinion in Infectious Diseases. 2009;22(6):544-552.

37 SAVAC. Strep A Vaccine Industry Forum: Catalyzing Industry Investment in Strep A Vaccine R&D. Forum Report. May 2024.

38 Osowicki J, Vekemans J, Kaslow DC, et al. WHO/IVI global stakeholder consultation on group A Streptococcus vaccine development: Report from a meeting held on 12-13 December 2016. Vaccine. 2018;36:3397-3405.

39 World Health Organization. Rheumatic fever and rheumatic heart disease. (Report by the Director-General). World Health Organization, 2018.

40 Vekemans J, Gouvea-Reis F, Kim JH, et al. The path to group A Streptococcus vaccines: WHO research and development technology roadmap and preferred product characteristics. Clinical Infectious Diseases. 2019;69(5):877-883.

41 Group A Streptococcus Vaccine Development Technology Roadmap: Priority activities for development, testing, licensure and global availability of group A Streptococcus vaccines. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO.

42 World Health Organization. Preferred Product Characteristics for Group A Streptococcus Vaccines. Geneva: World Health Organization. 2018.

43 Moreland NJ, Waddington CS, Williamson DA, et al. Working towards a group A streptococcal vaccine: report of a collaborative Trans-Tasman workshop. Vaccine. 2014;32:3713-3720.

44 Schodel F, Moreland NJ, Wittes JT, et al. Clinical development strategy for a candidate group A streptococcal vaccine. Vaccine. 2017;35:2007-2014.

45 Telethon Kids Institute. $35 million to develop vaccine with potential to save half a million lives per year. 2019.

46 Murdoch Children's Research Institute. MCRI welcomes $35m Federal grant for Strep A vaccine research to prevent deadly heart disease. 2019.

45 International Vaccine Institute. New push to develop world's first vaccine against the deadly Strep A bacteria killing hundreds of thousands. 2019.

46 Steer AC, Smeesters PR, Curtis N. Streptococcal Serology: Secrets for the Specialist. The Pediatric Infectious Disease Journal. 2015;34:1250-1252.

47 Osowicki J, Azzopardi KI, Fabri L, et al. A controlled human infection model of Streptococcus pyogenes pharyngitis (CHIVAS-M75): an observational, dose-finding study. Lancet Microbe. 2021;2(7):e291-e299.

48 Walkinshaw DR, Wright MEE, Mullin AE, et al. The Streptococcus pyogenes vaccine landscape. NPJ Vaccines. 2023;8(1):16.

49 Meier-Stephenson V, Hawkes MT, Burton C, et al. A phase 1 randomized controlled trial of a peptide-based group A streptococcal vaccine in healthy volunteers. Trials. 2024;25(1):781.

50 Jack S, Moreland NJ, Meagher J, Fittock M, Galloway Y, Ralph AP. Streptococcal Serology in Acute Rheumatic Fever Patients: Findings From 2 High-income, High-burden Settings. The Pediatric Infectious Disease Journal. 2019;38(1):e1-e6.

51 Moreland NJ, Wilson NJ. Can soluble adhesion molecules accurately predict carditis in acute rheumatic Fever? Pediatric Cardiology. 2014;35:556-557.

52 Carapetis JR, Beaton A, Cunningham MW, et al. Acute rheumatic fever and rheumatic heart disease. Nature Reviews Disease Primers. 2016;1:1-24.

53 Mukherjee S, Jagadeeshaprasad MG, Banerjee T, et al. Proteomic analysis of human plasma in chronic rheumatic mitral stenosis reveals proteins involved in the complement and coagulation cascade. Clinical Proteomics. 2014;11(1):35.

54 Martins C de O, Santos KS, Ferreira FM, et al. Distinct mitral valve proteomic profiles in rheumatic heart disease and myxomatous degeneration. Clinical Medicine Insights Cardiology. 2014;8:79-86.

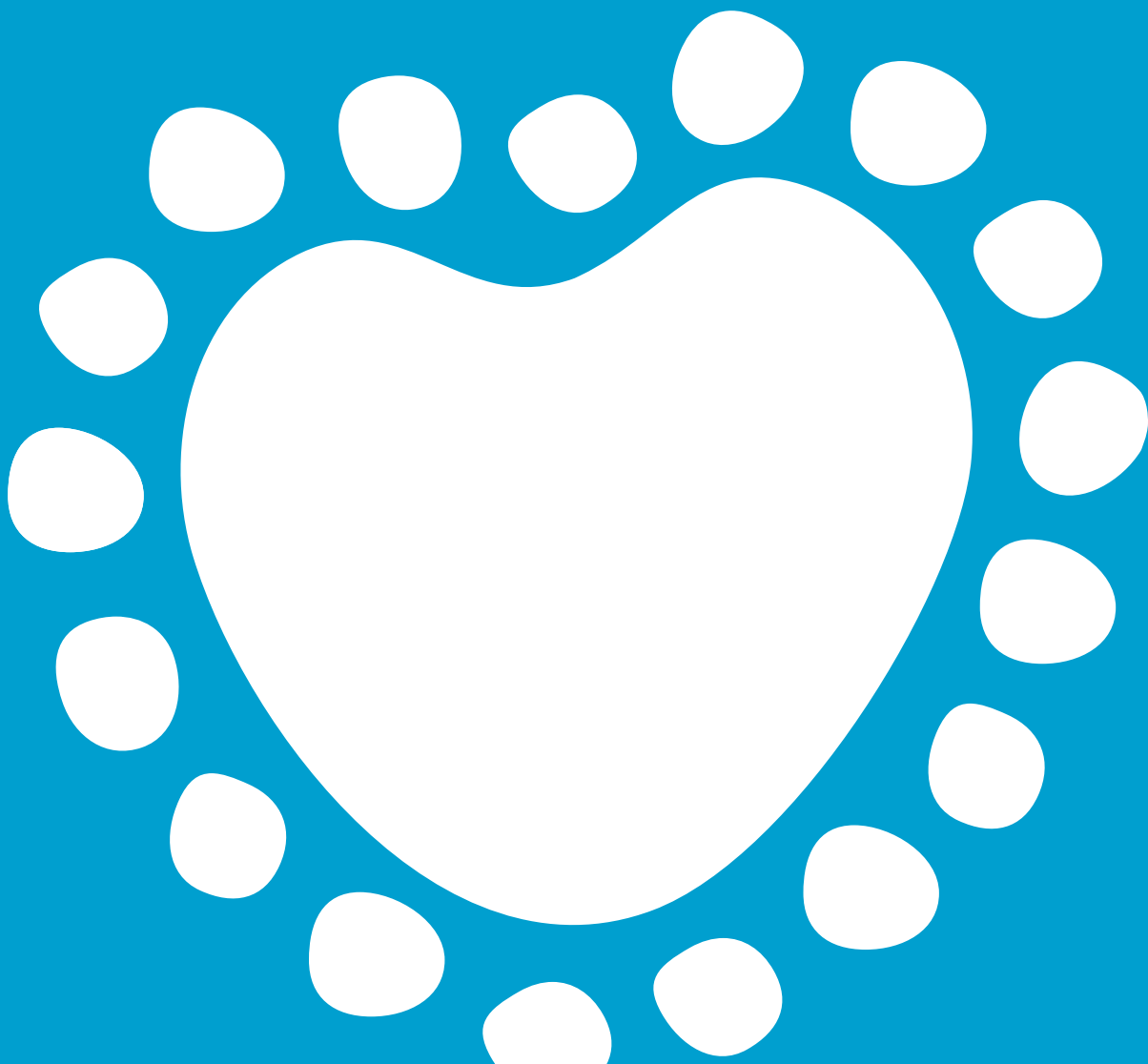
55 Towers RJ, Bolm M, Currie BJ, et al. Autoantigens identified by screening a human heart cDNA library with acute rheumatic fever sera. Annals of the New York Academy of Sciences. 2009;1173:83-91.

56 Kim ML, Martin WJ, Minigo G, et al. Dysregulated IL-1β-GM-CSF Axis in Acute Rheumatic Fever That Is Limited by Hydroxychloroquine. Circulation. 2018;138(23):2648-2661.

57 Ralph AP, Webb R, Moreland NJ, et al. Searching for a technology-driven acute rheumatic fever test: the START study protocol. BMJ Open. 2021;11:e053720.

58 Hanson-Manful P, Whitcombe AL, Young PG, et al. The novel Group A Streptococcus antigen SpnA combined with bead-based immunoassay technology improves streptococcal serology for the diagnosis of acute rheumatic fever. Journal of Infection. 2018;76(4):361-368.

Acronyms and abbreviations



Acronyms and abbreviations

2DE	Two-dimensional echocardiography
3DE	Three-dimensional echocardiography
ACE	Angiotensin-converting enzyme
ADB	Antideoxyribonuclease B / Anti-DNase B (titre)
AF	Atrial fibrillation
AHA	American Heart Association
AHP	Aboriginal Health Practitioner
AHW	Aboriginal Health Worker
AIHW	Australian Institute of Health and Welfare
AMB	Aboriginal Mothers and Babies (team)
AMS	Aboriginal Medical Service
AMVL	Anterior mitral valve leaflet
anti-CCP	Anti-cyclic citrullinated peptide
APSGN	Acute post-streptococcal glomerulonephritis
APSU	Australian Paediatric Surveillance Unit
APVU	Alert, verbal, pain, unresponsive (score)
AR	Aortic regurgitation
ARB	Angiotensin receptor blockers
ARF	Acute rheumatic fever
ARNI	Angiotensin receptor neprilysin inhibitor
AS	Aortic stenosis
ASO	Antistreptolysin O (titre)
AV	Atrioventricular
AVR	Aortic valve replacement
BAV	Balloon aortic valvuloplasty
BMI	Body mass index
BNP	B-type natriuretic peptide
BPG	Benzathine benzylpenicillin G
CANVAS	Coalition to Advance Vaccines Against Group A Streptococcus
CARPA	Central Australian Rural Practitioners Association
CDNA	Communicable Diseases Network Australia
CMV	Cytomegalovirus
COAG	Council of Australian Governments
CRE	Carbapenem-resistant enterobacteriaceae
CRP	C-reactive protein
CT	Computed tomography
CVD	Cardiovascular disease
CW	Continuous wave
DALY	Disability-adjusted life year
DRR	Death rate ratio

ECG	Electrocardiogram
EF	Ejection fraction
ERO	Effective regurgitant orifice
ESR	Erythrocyte sedimentation rate
EST	Exercise stress test
FBC	Full blood count
GAS	Group A streptococcus
GBD	Global burden of disease
GCS	Group C streptococcus
GGS	Group G streptococcus
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HBcAb	Hepatitis B core antibody
HBsAb	Hepatitis B surface antibody
HBsAg	Hepatitis B surface antigen
HFpEF	Heart failure with preserved election fraction
HFrEF	Heart failure with reduced ejection fraction
ICD	International Classification of Diseases
IE	Infective endocarditis
IMI	Intramuscular injection
INR	International normalised ratio
IU	International units
IUCD	Intra-uterine contraceptive device
IUGR	Intrauterine growth restriction
IVIg	Intravenous immunoglobulin
JVP	Jugular venous pressure
LA	Left atrium
LMWH	Low molecular weight heparin
LV	Left ventricular
LVEDD	Left ventricular end-diastolic diameter
LVEF	Left ventricular ejection fraction
LVESD	Left ventricular end-systolic diameter
LVOT	Left ventricular outflow tract
MR	Mitral regurgitation
MRA	Mineralocorticoid receptor antagonist
MRSA	Methicillin-resistant staphylococcus aureus
MS	Mitral stenosis
MVA	Mitral valve area
mWHO	Modified World Health Organization classification of maternal cardiovascular risk
NNDSS	National Notifiable Diseases Surveillance System
NOAC	Non-vitamin K antagonist oral anticoagulant

NSAID	Non-steroidal anti-inflammatory drugs
NYHA	New York Heart Association (Functional Classification)
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
PAH	Pulmonary arterial hypertension
PANDAS	Paediatric autoimmune neuropsychiatric disorder associated with streptococcal infection
PASP	Pulmonary artery systolic pressure
PBMV	Percutaneous balloon mitral valvuloplasty
PCR	Polymerase chain reaction
PG	Pressure gradient
PH	Pulmonary hypertension
PPI	Proton pump inhibitor
RADT	Rapid antigen detection tests
RHD	Rheumatic heart disease
RNA	Ribonucleic acid
RR	Relative risk
RV	Right ventricle
SLE	Systemic lupus erythematosus
SSSI	Skin and skin structure infection
Strep A	Group A streptococcus
TAVI	Transcatheter aortic valve implantation
TOE	Transoesophageal echocardiography
TOP	Termination of pregnancy
TR	Tricuspid regurgitation
TS	Tricuspid stenosis
TTE	Transthoracic echocardiography
U	Unit/s
UEC	Urea, electrolytes, creatinine
UFH	Unfractionated heparin
ULN	Upper limits of normal
VKA	Vitamin K antagonist
VRE	Vancomycin-resistant enterococci
WBC	White blood cell
WHO	World Health Organization
YLD	Years of life lost to disability
YLL	Years of life lost to death

Australian guideline for the prevention, diagnosis and management of acute rheumatic fever and rheumatic heart disease (Edition 3.4) October 2026

Email: rhdguidelines@menzies.edu.au

Website: www.rhdguidelines.org.au