Clinic factors associated with better delivery of secondary prophylaxis in acute rheumatic fever management

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Background and objective
Acute rheumatic fever (ARF) is a complication of infection with group A streptococcus. ARF is treated with a long-term regimen of antibiotic secondary prophylaxis. Recent data have shown that only 36% of clients receive >80% of their regimen. The aim of this study was to determine clinic-level factors independently associated with the performance of primary healthcare clinics in delivering secondary prophylaxis to patients with ARF.

Methods
Cross-sectional de-identified data from clinics agreeing to data retention through the Audit and Best Practice for Chronic Disease National Research Partnership were accessed to calculate secondary prophylaxis performance scores and clinic-level factors associated with secondary prophylaxis performance using regression analysis.

Results
Thirty-six clinics and 496 client records met eligibility criteria for analysis. Clinic secondary prophylaxis performance was significantly associated with 'systematic processes of follow-up'. Every one unit increase in 'systematic approach to follow-up' increased the median level of secondary prophylaxis performance by 30% (95% confidence interval: 2, 66). Clinic accreditation status, location or workforce were not associated with secondary prophylaxis performance.

Discussion
General practitioners as clinical leaders are well placed to support managers to critically review follow-up and electronic reminder systems for secondary prophylaxis delivery at clinic level.

ACUTE RHEUMATIC FEVER (ARF) is an immune-mediated complication of infection from the highly contagious group A streptococcus (GAS).[1] Prior infection with GAS generally manifests as either pharyngitis or impetigo.[2,3] While age-standardised ARF incidence rates vary globally,[4] Aboriginal and Torres Strait Islander people in Australia have some of the highest rates (85 per 100,000 population).[5] Recurrent episodes of ARF can result in permanent damage known as rheumatic heart disease (RHD).[6] Both ARF and RHD are viewed as diseases arising from conditions of colonisation, marginalisation and poverty.[7]

After an initial episode of ARF, an individualised clinical management plan is required, including a long-term regimen of antibiotic secondary prophylaxis commonly using benzathine penicillin G (BPG) to reduce the risk of recurrent ARF in the context of continuing GAS exposure.[6] Because serum penicillin levels wane immediately following administration, both dosage and timing of an individual's secondary prophylaxis injections are critical.[8] Four-weekly BPG (every 28 days) is currently the regimen of choice.[6] These national guidelines also state, however, that, 'Some health services prefer to administer BPG on the same day every month, rather than every 4 weeks'. A calendar month rather than a four-weekly regimen of BPG is considered 'an acceptable alternative'.[6] Decisions about the appropriate regimen rest with the responsible specialist clinician to whom the patient has been referred by the primary healthcare team, usually a paediatrician or paediatric cardiologist who can refer to national guidelines.[6] Delivery of the nominated secondary prophylaxis regimen then rests with the multidisciplinary primary healthcare (PHC) team including general practitioners (GPs) serving the community in which the patient resides.

With the establishment of Australia's Rheumatic Fever Strategy (RFS) in 2009, efforts to improve secondary prophylaxis through registers in Northern Territory, Western Australia, Queensland and South Australia have received unprecedented attention. Each state and territory participating in the RFS National Partnership Agreement must report the percentage of patients registered in their jurisdiction receiving >80% of their secondary prophylaxis regimen.[9] Secondary prophylaxis performance remains highly variable.[10,11] From 2008 to

2014, the proportion of patients receiving >80% of their scheduled secondary prophylaxis regimen did not improve.[12] Two recent interventional studies using well-designed continuous quality improvement (CQI) methods did not show improvements in primary outcomes of secondary prophylaxis provision.[13,14]

There has been little standardisation in measuring individual secondary prophylaxis adherence.[15] Even less attention has been given to the development of a measure of secondary prophylaxis performance at the clinic level. Measuring and improving clinic performance would provide GPs and their PHC colleagues with useful insights about the care provided from their service to the population. In response, these researchers obtained access to a national PHC database to develop a measure of secondary prophylaxis performance and, importantly, identify factors at an organisational level that were associated with better secondary prophylaxis performance.

Methods

Data sources

As described elsewhere,[16] the Audit and Best Practice for Chronic Disease (ABCD) project began in 2002 to investigate and improve PHC, initially for clinic management of Aboriginal and Torres Strait Islander people with chronic disease. Later topics for CQI modules included ARF/RHD. PHC clinics chose their own CQI focus and could elect to participate only once or repeatedly in the same or different CQI modules. From 2005 until 2014, PHC sites participating in this CQI project were also asked to agree to share their de-identified CQI data with the ABCD National Research Partnership (NRP).[16] Approximately two-thirds of participating PHCs did so. When participating in their elected modules, each PHC submitted a community profile, known as the Health Care and Community Survey (HCCS). Clinic staff also used standardised audit tools to submit de-identified clinical information about the clinical topic retrieved from at least 30 randomly selected clinical records (for smaller communities, PHCs were asked to audit all available records). A participatory Systems Assessment Tool (SAT) was also completed to identify strengths and weaknesses onsite. As resources produced through this CQI program referred to people attending PHC services as 'clients' rather than 'patients', this term is used throughout this article. The term 'clinic' encompasses all PHC types.

In 2018, these researchers received ABCD NRP clinic and client data from 2008 to 2014 for clinics completing at least one ARF/RHD CQI module. Clinics were excluded if they had not concurrently completed their HCCS and SAT in the same year as the clinical ARF/RHD audit. If a clinic had completed more than one ARF/RHD audit cycle, their most recent cycle was used. With respect to client audit data, clinics had been instructed to complete the clinical audit for clients who had a history of a recorded diagnosis of definite or suspected ARF/RHD and resident in the community for ≥6 months in the past 12 months. This study only included clients prescribed BPG intramuscular injections for ARF/RHD at least monthly for ≥12 months prior to the audit for analysis. For each client, receipt of their prescribed regimen was calculated as a percentage.

Clinic secondary prophylaxis performance measure and potential explanatory variables

Until very recently,[17] there had been little evidence quantifying the accrued benefit in risk reduction of ARF recurrence for individuals prescribed secondary prophylaxis from increasing percentiles of regimen adherence. de Dassel et al showed that patients receiving <40% of their scheduled secondary prophylaxis regimen gained no protection against ARF recurrence.[17] Receiving >80% of prescribed secondary prophylaxis was clearly superior, while the risk reduction for patients receiving between 40% and 80% of their secondary prophylaxis regimen exhibited a linear dose–response relationship.[17] These finding were used in the current study to weight and allocate points to calculate a salient measure of each clinic's secondary prophylaxis performance. Accordingly, the points system assigned no points to any secondary prophylaxis provision by the clinic for a client receiving less than 40% of their scheduled secondary prophylaxis. After assigning points on the basis of each client's receipt of scheduled secondary prophylaxis regimen (Table 1), clinic performance was further weighted to reward secondary prophylaxis ≥80% to derive a value for the clinic's secondary prophylaxis performance from 0 to 60. To confirm the conceptualisation of the approach, two GPs, a clinical pharmacist, a public health nurse with RHD policy experience and a public health physician were provided with a copy of the seminal article[17] and the proposed points allocation system for feedback. For analyses, the researchers selected the median point score from the total number of points per clinic as the continuous secondary prophylaxis performance outcome measure.

The dataset contained a profile of the community that the clinic served (ie HCCS); this included data on the jurisdiction, governance of the clinic (community controlled or government managed), location (major city/regional versus remote/other), accreditation status and estimated Aboriginal community size served by the clinic (<500, 500–1000, >1000 people). The researchers also received 20 SAT scores assigned by clinical teams as continuous variables using a scale of values ranging from 0–11: 'limited or no support' (0–2), 'basic support' (3–5), 'good support' (6–8) and 'fully developed

Table 1. Assignment of points to produce a clinic-level secondary prophylaxis performance measure

Client adherence to secondary prophylaxis (%)	Points allocation at clinic level
<40	0
40–49	5
50–59	10
60–69	15
70–79	20
80–99	40
100	60

support' (9–11; Appendix 1, available online only). These were used as study variables given the range of barriers and enablers to optimal secondary prophylaxis performance sourced from expert opinion.[12]

Statistical analyses

Univariate analyses were first conducted to assess the median level of clinic-level points (continuous variable) across categorical clinic variables using either the Wilcoxon test or Kruskal–Wallis test as appropriate. For continuous explanatory variables, univariate linear regression analyses were performed to assess the association between the 20 SAT items scores and clinic-level points. Any univariate associations significant at the $P \leq 0.25$ level were entered into a multiple regression base model and refined using backwards elimination. This statistical approach enabled determination of independent factors associated with secondary prophylaxis performance at the clinic level (accounting for all other potential covariates). In building the base multiple regression model, a P value cut-off of 0.25 was set to minimise the risk of missing an influential explanatory variable. In the final multivariate regression model, a 0.05 alpha level was adopted for statistical significance. As the weighting procedure for calculating the clinic-level points outcome variable was a non-linear transformation, a natural logarithmic transformation was applied to this outcome when modelling the clinic-level points variable. This allowed for valid modelling of a linear relationship between clinic-level points and all covariates. Analyses were undertaken using SAS Enterprise Guide version 7.1 and R version 3.5.1.

Ethical approval

Ethics approval was obtained for use of NRP data for secondary analyses.[16]

Results

The final sample comprised data from 36 clinics (Table 2), representing more than half of all clinics participating in this CQI initiative, completing the ARF/RHD clinical audit module and consenting to NRP data retention (n = 60).[12] There was a median of 11 ARF/RHD clients per clinic (range 1–42). Table 3 shows key demographics of clients whose data met eligibility criteria. As also shown in Table 3, the proportion of clients on four-weekly regimens receiving >80% of their prescribed secondary prophylaxis was identical to that of clients on monthly regimens (both 27%).

Using the weighted measure – clinic-level points – it was determined that there was a median value of 15 clinic-level points across all 36 clinics (interquartile range: 10.00–23.75 points). Two (5%) clinics obtained the maximum possible 60 points. No categorical clinic variables were associated with secondary prophylaxis performance at the $P \leq 0.05$ level (Table 4). Univariate analyses of the continuous SAT items and the log-transformed clinic-level outcome variable initially found two covariates significantly associated at $P \leq 0.05$ level (Table 5). After controlling for 'systematic approach to follow-up', no additional covariates were significantly associated with the outcome in a multivariable model. The calculation of the continuous secondary prophylaxis performance variable was transformed via the natural logarithm, and so beta coefficients reported in Table 5 must first be back-transformed to be readily interpretable. Specifically, beta coefficients are exponentiated (with base e)

Table 2. Characteristics of clinics included in the study (n = 36)

Characteristic	n (%)
State or territory	
Northern Territory	13 (36)
Queensland	21 (58)
South Australia and Western Australia	2 (6)
Governance	
Community controlled or other*	6 (17)
State/territory managed	30 (83)
Location	
Major city/regional	3 (8)
Remote community/other†	33 (92)
Accreditation	
Accredited (AGPAL or QIC)	22 (61)
Not accredited/other‡	14 (39)
Estimated Aboriginal service population§	
<500	8 (22)
500–1000	14 (39)
>1000	14 (39)

*'Other' for the governance variable includes clinics funded from government and community controlled sources.
†'Other' for the location variable includes clinics reported as primary health clinic.
‡'Other' for the accreditation variable includes those clinics classified as other in the audit module, or reported as accreditation status in progress for the next 12 months.
§As provided by the clinic in audit documentation
AGPAL, Australian General Practice Accreditation Limited; QIC, The QIC Health and Community Services Standards

in order to obtain a percentage change in clinic-level points with a one-unit increase in the covariate. Recalling that scores for each of the SAT variables ranged from one to 11, a one-unit increase in score in 'systematic approach to follow-up' was associated with a 30% relative increase in the median clinic-level points (95% confidence interval [CI]: 2, 66).

Table 3. Characteristics of clients whose de-identified data were contained in the dataset after applying eligibility criteria (n = 496)

Characteristic	n (%)*	Number (%) receiving ≥80% of their regimen
Sex		
Female	174 (35)	44 (25)
Male	322 (65)	90 (28)
Age group (years)		
<18	249 (50)	46 (18)
18–35	63 (13)	19 (30)
36–50	165 (33)	60 (36)
>50	19 (4)	9 (47)
Indigenous status		
Aboriginal or Torres Strait Islander	477 (96)	131(27)
Non-Indigenous/not stated	19 (3)	3 (16)
ARF/RHD classification		
Priority severe RHD†	118 (24)	41 (35)
Priority moderate RHD†	97 (20)	26 (27)
Priority ARF/mild RHD†	221 (45)	55 (25)
Unable to determine	1 (<1)	0 (0)
Not recorded	59 (12)	12 (20)
Documented management plan in place		
Yes	414 (83)	114 (28)
No	82 (17)	20 (24)
Prescribed benzathine penicillin G injection regimen		
Monthly	266 (54)	72 (27)
Four-weekly	229 (46)	62 (27)
Other	1 (<1)	0 (0)

**Because of rounding to one decimal place, the percentages in the table above may not add up exactly to 100.*
†Recorded diagnosis as per national guidelines[6] in the clinical record system
ARF, acute rheumatic fever; RHD, rheumatic heart disease

Discussion

This unique study first conceptualised a contemporary quantitative measure of clinic performance in the provision of secondary prophylaxis to Aboriginal people with ARF under their care for whom the consequence of inadequate secondary prophylaxis is early death from RHD. This clinic-based secondary prophylaxis performance measure was weighted to reflect objective benefits that accrue for individual clients[17] but aggregated at the clinic-level to provide a system-level performance measure useful for managers and quality improvement activity. Despite the modest sample (n = 36 centres), it was sufficient in size to provide relevant insights about the importance of clinic-based systems to achieve higher rates of clinic secondary prophylaxis performance. Specifically, high functionality in the clinic's 'systematic processes of follow-up' was associated significantly with the clinic's objective secondary prophylaxis performance. Every one-unit increase in 'systematic approach to follow-up' increased the median value of clinic secondary prophylaxis performance by 30% (95% CI: 2, 66). System-level change, while complex[18] and sometimes hard to measure,[19] has been shown to be effective at improving the quality of some aspects of PHC for Aboriginal and Torres Strait Islander people.[20,21] GPs can provide the clinical leadership to support clinic managers to improve local reminder systems.

Nonetheless, it was disappointing to find no difference in the proportion of clients receiving ≥80% secondary prophylaxis whether they were assigned 28-day versus calendar month regimens. Given the imminent revision of the national guidelines[6] and meta-analyses of pharmacokinetic studies,[22] recommendations for GPs about the timing of the secondary prophylaxis regimen needs urgent reconsideration. Suggesting that clinics consider a regimen of 12 rather than 13 injections per year as a way to increase secondary prophylaxis adherence, while well-intended, appears to have little objective basis. As the majority (73%) of clients did not receive levels of secondary prophylaxis known to offer best protection from ARF recurrence (ie ≥80%), GPs are well placed to act on these findings by providing supportive clinical leadership to focus on system-level changes within primary healthcare.

Conclusion

Clinic managers are encouraged to critically review and improve their follow-up and

Table 4. Characteristics of clinics and their association with performance of delivering secondary prophylaxis for their eligible clients

Clinic characteristic	Clinic level points	
State or territory	**Median (interquartile range)**	***P* value**
Northern Territory	15.0 (10.0–20.0)	0.26*
Queensland	10.0 (7.5–17.5)	
South and Western Australia	27.5 (15.0–40.0)	
Governance		
Community controlled or other†	10.0 (10.0–15.0)	0.62‡
State/territory managed	15.0 (10.0–30.0)	
Location		
Major city/regional	10.0 (5.0–40.0)	0.71‡
Remote community/other§	15.0 (10.0–20.0)	
Accreditation		
Accredited (AGPAL or QIC)	10.0 (10.0–40.0)	1.0‡
Not accredited/other‖	15.0 (10.0–20.0)	
Estimated service population#		
<500	10.0 (10.0–15.0)	0.47*
500–1000	17.5 (10.0–35.0)	
>1000	15.0 (10.0–20.0)	

**Two-sided Kruskal–Wallis test*
†'Other' for the governance variable includes clinics funded from government and community controlled sources.
‡Two-sided Wilcoxon rank sum test
§'Other' for the location variable includes clinics reported as primary health clinic.
‖'Other' for the accreditation variable includes those clinics classified as other in the audit module, or reported as accreditation status in progress for the next 12 months.
#As provided by the clinic in audit documentation
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electronic reminder systems, as these are strongly associated with benefits for their clients that require secondary prophylaxis for ARF from the clinic and are within their control as health leaders to improve.

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Table 5. Univariate linear associations between clinic Systems Assessment Tool item scores and performance of secondary prophylaxis at clinic level

		Clinic level points	
Systems Assessment Tool (SAT) item	**Median SAT (IQR)**	**B-coefficient (95% CI)**	***P* value**
Team structure and function	6.50 (5.00–8.00)	0.293 (0.013, 0.572)	0.04†
Clinical leadership	7.00 (5.00–8.50)	0.162 (–0.167, 0.490)	0.32
Appointments and scheduling	6.50 (5.00–8.00)	0.204 (–0.057, 0.465)	0.12*
Care planning	7.00 (6.00–9.00)	0.101 (–0.218, 0.421)	0.52
Systematic approach to follow-up	8.00 (6.00–9.00)	0.265 (0.022, 0.508)	0.03†
Continuity of care	6.00 (5.00–8.00)	0.208 (–0.059, 0.476)	0.12*
Client access and cultural competence	9.00 (6.00–9.00)	0.074 (–0.175, 0.323)	0.55
Physical infrastructure, supplies and equipment	7.00 (5.00–8.00)	0.207 (–0.060, 0.474)	0.12*
Electronic client list	8.00 (6.00–9.00)	0.142 (–0.125, 0.408)	0.28
Evidence-based guidelines	8.00 (7.00–9.00)	0.222 (–0.129, 0.572)	0.21*
Specialist–generalist collaborations	6.50 (4.50–8.00)	0.115 (–0.106, 0.336)	0.30
Assessment and documentation	7.00 (5.00–8.50)	0.051 (–0.205, 0.307)	0.69
Self-management education and support	6.50 (5.00–7.50)	0.104 (–0.165, 0.372)	0.44
Communication and cooperation with governance and operations	6.00 (3.50–7.00)	0.161 (–0.072, 0.394)	0.17*
Linking with other health services	6.00 (4.00–8.00)	0.172 (–0.064, 0.408)	0.15*
Working out in the community	6.00 (4.00–8.00)	0.192 (–0.026, 0.410)	0.08*
Communication and cooperation on regional health planning	4.00 (1.50–7.00)	0.044 (–0.165, 0.252)	0.68
Organisational commitment	5.50 (4.00–7.00)	0.108 (–0.160, 0.376)	0.41
Quality improvement strategies	8.00 (6.00–9.00)	0.067 (–0.181, 0.314)	0.59
Integration and health system components	6.00 (4.50–8.00)	0.044 (–0.196, 0.285)	0.71

**Significant at P <0.25*
†Significant at P <0.05
CI, confidence interval; IQR, interquartile range

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