Summary Report
October 2015

Whāia te iti kahurangi, ki te tuohu koe me maunga teitei
Pursue that which is precious, and do not be deterred by anything less than a lofty mountain
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This report summarises the full Interim Evaluation of the Sore Throat Management Component of the New Zealand Rheumatic Fever Prevention Programme, Quantitative Findings report (October 2015). For detailed information please refer to the full technical report.

The Otago University Human Research Ethics Committee (HD15/009) provided ethical approval for this interim evaluation.

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SUMMARY REPORT

Background to Acute Rheumatic Fever

Situation in New Zealand

Compared to other Organisation for Economic Co-operation and Development (OECD) countries, New Zealand (NZ) has strikingly high rates of acute rheumatic fever (ARF) and rheumatic heart disease (RHD)\(^1,2\). The distribution of ARF is markedly unequal (Figure 1), with this disease almost exclusively confined to Māori and Pacific Island children and young people aged 4-19 years living in lower socio-economic areas in the North Island\(^3,4\).

![Figure 1. First episode ARF hospitalisation rates 2005–2014 by ethnicity and level of deprivation](image)

Note: NZDep 2013 score is an area-based measure of deprivation combining 9 variables from the NZ Census reflecting eight areas of deprivation. Decile 1 or quintile 1 (decile 1 and 2) = least deprived; Decile 10 or quintile 5 (decile 9 and 10) = most deprived.

The 2012/13 hospitalisation rates for first episode ARF per 100,000 for all ages were 12.7 for Māori and 25.9 for Pacific Islanders compared to 4.0 for the total New Zealand (NZ) population\(^5\). The incidence rate for first episode ARF hospitalisations steadily increased in NZ from 2.8 in 2001 to 4.0 per 100,000 in 2011 with a corresponding increase in first episode ARF hospitalisations for Māori from 10.1 to 16.5 per 100,000 over the same time period. Using hospitalisation data the average incidence rates between 1993 and 2009 for children aged 5–14 years were 81.2 per 100,000 for Pacific, 40.2 per 100,000 for Māori and 2.1 per 100,000 for non-Māori non-Pacific children\(^6\). These disparities are similar in District Health Boards (DHBs) where ARF occurs.
Depending on the year analysed, the Pacific incidence rates for ARF are about 40 times higher and for Māori, about 20 times higher than non-Māori non-Pacific children\(^6\).

An estimated 42% to 60% of people diagnosed with ARF develop rheumatic heart disease (RHD) unless they are treated appropriately with monthly intramuscular antibiotics (penicillin injections)\(^7\). For NZ Māori and Pacific populations with RHD the mean age of death is (male/female) 56.4/58.4 years and 50.9/59.8 years respectively and is associated with considerable cost\(^8\). This compares to the current Māori life expectancy of 73/77.1 years; Pacific life expectancy of 74.5/78.7 years; and total NZ population life expectancy of 79.5/83.2 years\(^9\).

In response to rising rates of ARF, the Rheumatic Fever Prevention Programme (RFPP) was set up by the Ministry of Health (MoH) and rolled out initially to eight high incidence DHB areas in 2011. This was subsequently expanded to a further three DHB areas when the reduction of ARF became a Better Public Service (BPS) government target in 2012, aiming to reduce the incidence of ARF by two-thirds from a baseline of 4.0 per 100,000 in 2009/10–2011/12 to 1.4 per 100,000 by 2017.

The RFPP incorporates three main strategies to decrease ARF: primordial strategies addressing social and environmental factors such as household crowding; primary prevention strategies such as the school-based sore throat management service and rapid response clinics; and health promotion to families and health professionals on the importance of ARF, what causes it and how to prevent it.

The largest component of the RFPP is the school-based sore throat management service, and that is the main focus of this evaluation. A qualitative evaluation of the sore throat component is also being carried out and findings will be available later in 2015. The implementation of rapid response clinics has been much more recent, and therefore their full potential impact could not be assessed in this interim evaluation. The housing initiatives and health promotion strategies of the RFPP were outside the scope of this interim evaluation.

The RFPP school-based sore throat management service was based on recommendations from the NZ National Heart Foundation\(^10\), which in turn was based on the outcomes of a randomised controlled trial (RCT) of school-based sore throat management conducted in Auckland\(^11\) and subsequent meta-analysis of school-based and community sore throat management interventions\(^12\). The RCT was conducted from 1998 to 2001 where school-based sore throat management services were implemented in areas with high-risk children to reduce ARF. The Auckland trial found a 21–28% reduction in the incidence of ARF. This result was not statistically significant due to the lack of statistical power of the study. A subsequent meta-analysis, including the Auckland trial and other observational studies that were noted to be of poor quality, was conducted. The authors suggested that with ‘the best evidence available in an area with imperfect information’ ARF cases would reduce by about 60% using a school-based or community approach.
Why do some people get ARF?

Acute rheumatic fever is a complicated disease. Current understanding of the pathophysiology is that ARF is triggered by a sore throat infection with group A streptococcus (GAS) bacteria. A small proportion of untreated GAS pharyngitis (0.3% to 3%) activate an autoimmune reaction that results in ARF\(^{13,14}\). It is thought that repeated episodes of GAS sore throat may be needed to cause ARF\(^{15}\). About 30–45% of ARF cases have heart valves affected at the time of initial diagnosis\(^ {16}\) – some only minimally, but some more severe and persistent, leading to RHD. In most highly developed countries ARF has virtually disappeared as living conditions and access to good health care have improved. However, in some countries such as NZ and Australia, indigenous and Pacific populations continue to have high rates of ARF. The development of ARF is associated with environmental factors including poverty and household crowding.

How do we prevent GAS throat infections?

Preventing GAS throat infections and therefore ARF can be approached in three ways – primordial, primary and secondary prevention. **Primordial prevention** addresses environmental risk factors such as improving socio-economic and living conditions, and reducing household crowding that are known to be associated with ARF in high risk populations. **Primary prevention** is focused on preventing GAS infections and the spread of GAS infections between people through timely management of sore throats. Primary prevention should be focused on high risk populations and include early diagnosis through throat swabbing those with sore throats, appropriate antibiotic treatment for GAS positive sore throats and ensuring the full course of antibiotics are taken to eradicate the GAS bacteria from the throat. The RFPP incorporates primordial and primary prevention strategies to prevent the initial ARF episode. There are already systems in place in DHBs for **secondary prevention** i.e. preventing further GAS sore throat episodes for people with ARF through monthly penicillin injections, and therefore preventing any further damage to the heart.

Figure 2, provided by the MoH, explains the programme logic and interventions of the RFPP.
Figure 2. MOH programme logic for the RFPP

- **Poor environmental and economic conditions**
  - Reduce crowding in housing
  - Healthy communal living habits, especially in homes and schools

- **StrepA infection**
  - Throat infection with Group A Streptococcus bacteria
  - Targeted testing
  - Diagnosis and quick action & treatment through any contact with any health service
  - Inform people when to seek treatment

- **Rheumatic fever**
  - (180+ cases/yr)
  - Auto-immune response in 0.3-3% of untreated strepA infection
  - Ensure patients take preventative treatments including long acting penicillin
  - Better diagnosis & reporting
  - Preventative interventions for their families/whānau

- **Recurrence of rheumatic fever**
  - Prevent recurring RF
  - Guidance to health professionals about how to diagnosing and treating, including for the families
  - Active patient management systems
  - Targeted communications, incentives and remove barriers to encourage patients to take treatments
  - Use case histories to discover risk factors, early warning signs, and assess system performance

- **Rheumatic heart disease**

**Prevent transmission of Strep A (STOP IT)**
- Housing programmes where eligibility includes RF risk factors
- Guidance to professionals in contact with at-risk people about when and how to refer them to housing programmes
- Targeted communications telling people how to cough, sneeze, sleep

**Treat strep A quickly and effectively (TREAT IT)**
- Sore throat assessment and treatment in targeted schools and communities
- Guidance to health and social professionals who work with at-risk people about how to identify those at risk and what action to take
- Targeted communications telling people how to reduce their risks and when to seek treatment
- Remove barriers to accessing testing & treatment in community and primary care

**Prevent recurring RF**
Sore Throat Management Component of the New Zealand Rheumatic Fever Prevention Programme

The RFPP was launched in 2011 by the MoH in DHB areas with populations at high risk of developing ARF (‘priority populations’) i.e. Māori and Pacific children and young people aged 4–19 years living in more deprived areas in the North Island. The school-based sore throat management service was based on recommendations from the National Heart Foundation10 as noted earlier.

Funding was allocated to providers to set up sore throat management services in primary and intermediate schools (Year 1–8), initially within eight high incidence DHBs areas based on cluster analysis of ARF incidence for children aged 5–14 years. These initial eight DHBs were: Northland, Counties Manukau, Waikato, Bay of Plenty, Lakes, Tairāwhiti, Hawke’s Bay, and Capital & Coast. When the reduction of ARF became a BPS government target in 2012, the RFPP was expanded to a further three high-risk DHB areas namely, Auckland, Waitemata, and Hutt Valley (although Hutt Valley did not implement the school-based sore throat management service). High incidence DHBs were defined as those with three-year average baseline (2009/10–2011/12) incidence rates higher than 1.5 first episode ARF hospitalisations per 100,000 total population, and a three-year average of four or more cases per annum. The RFPP therefore covered 11 of NZ’s 20 DHBs - all North Island DHBs, except for Taranaki, Whanganui, Mid Central, and Wairarapa. It did not include any of the five South Island DHBs.

The DHBs selected which schools would implement a sore throat management service. Most DHBs followed the NZ Heart Foundation Rheumatic Fever Guidelines that recommended that if an area had an age specific rate for children aged 5–14 years for the incidence of ARF of 50 per 100,000 age or higher, they should consider implementing a school-based sore throat service10.

Some DHBs, for example Counties Manukau (CMDHB), selected schools based on a school scoring system using four measures including: ARF rate in the census area unit (CAU) where the school was located; school case density; school decile; and proportion of the school roll that is Māori or Pacific. Waitemata and Auckland followed a similar system. Other DHBs selected schools based on low decile, and with a high proportion of children who were of Māori or Pacific ethnicity.

DHBs used data that was available at the time of planning the school-based service, with three DHBs already having initiated a school based sore throat service prior to the start of the RFPP. Northland began a school-based sore throat service in 2002, Bay of Plenty in 2009 and Hawkes Bay in 2010.

A variety of contracting approaches were used over time to implement the school-based sore throat management service including contracting with DHBs, who then subcontracted to service providers, or direct contracting between MoH and local service providers including Māori and Pacific health provider organisations. As specified in the contracts, the overall service objective for providers was to reduce the incidence of ARF hospitalisations by:
• providing throat swabbing and referral services in the school, home or other settings as appropriate for school children aged 5–14 years who present with sore throats in high-risk areas, and eligible whānau/family members living with these children;

• increasing awareness of rheumatic fever risk factors among children and their whānau/families in the key geographical areas;

• developing and maintaining relationships with other health and social service providers (including Whānau Ora providers) to facilitate referral and support, as appropriate.

The RFPP funding 2011–14 was to be used as ‘seed funding’ that DHBs or other local organisations could add to for related activities in preventing ARF. The cost of throat swabs and analysis was borne by the DHBs. DHBs also financially contributed considerably to the rolling out of the RFPP in their areas including investments in the school-based service and rapid response clinics. Some DHBs, such as Counties Manukau through Mana Kidz, took a broader approach and included the assessment and management of uncomplicated skin infections.

The implementation of the school based sore throat service was variable among the DHBs in terms of coverage of priority populations, frequency of throat swabbing, scope of services and model of delivery. For the school-based service there was an overall estimated average coverage of just over 50% for children aged 5–12 years attending a decile 1–3 school with a school-based service in 2012 and 2013. Two DHBs ceased implementing a school-based service in 2014 (Tairāwhiti and Lakes) leaving an overall coverage of 36% in 2014, or 46% coverage for the remaining eight DHBs still implementing the school-based service. Coverage of children aged 5–12 years attending decile 1–3 schools ranged from 20% in Waitemata to over 100% in Tairāwhiti (Figure 3). Note that Hutt Valley does not have a school-based service operating.

The school-based service reached its maximum coverage at the start of 2014, with 251 schools implementing the service covering an estimated 53,998 children. By June 2014, 58 schools had stopped the service, leaving 193 schools operating at least through to the end of 2014, covering an estimated 45,656 children.
Figure 3. Coverage (%) of children aged 5–12 years attending decile 1–3 schools with a school-based sore throat management service in the 10 implementing DHBs

Note: Due to denominator issues, possibly relating to the accuracy of school roll numbers, Tairāwhiti has a coverage of over 100%.

The frequency of sore throat swabbing services by the various providers during the school year ranged from “as requested”, to three to five days per week. The school-based service was not provided during weekends or school holidays. As noted, some providers such as Mana Kidz in Counties Manukau expanded the scope of services to include wider child health services with a focus on the management of skin infections in addition to swabbing sore throats.

Provider personnel ranged from trained nursing staff, such as public health nurses or other registered nurses, to trained non-nursing staff, collectively known as kaiāwhina (community support workers and whānau [family] support workers), or a mixture. At least earlier in the roll out of the school-based service, there were quality issues noted in the taking of throat swabs. The provision of antibiotics for children with a positive GAS throat swab was generally through the use of standing orders. Antibiotics (or prescriptions for antibiotics) were either collected by parents/caregivers or delivered to their home, in some places with an extra home visit or phone call to check and encourage antimicrobial understanding and adherence.

A large part of the multi-component RFPP is the school-based sore throat management service. Recognising that a coverage of around 36% for high risk children in 2014, and a service that only operated for 40 weeks in the year was unlikely to have a large enough impact in reducing ARF, the MoH expanded the sore throat management component, setting up rapid response sore throat management clinics. These rapid response clinics aim to offer easily accessible, free assessment

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* A standing order is a written instruction issued by a medical practitioner that authorises a specified person or class of people (e.g., registered nurses) who does not have prescribing rights to administer and/or supply specified medicines and some controlled drugs (Ministry of Health, 2012).
and care of sore throats, together with the school-based service, to about 80% of high-risk populations aged 4-19 years. These were started in several high incidence areas in Auckland in 2014, expanding to other high incidence DHB areas in 2015.

This interim evaluation of the sore throat management component mainly focuses on data to the end of 2014, and is therefore largely focused on the school-based service that reached its peak in early 2014. Overall first episode ARF hospitalisation rates, and probable and confirmed ARF notifications are also reported through to June 2015.
AIMS OF THE QUANTITATIVE INTERIM EVALUATION

- To assess the effect of the sore throat management component of the RFPP on reducing the incidence of ARF in priority children and young people populations.

- To assess the effect of the RFPP on the targeting of sore throat management to children at high risk of developing ARF (based on the rates and distribution of swabbing and GAS detection).

- To determine the extent to which ARF cases are successfully identified and swabbed, either in primary health care or through school sore throat management services, during the period of their sore throat.

- To evaluate the costs and cost effectiveness of the school-based sore throat management service in preventing ARF.

- To provide conclusions for future investment in sore throat management for priority populations.
KEY FINDINGS

- There was an overall decline in the national incidence of ARF by June 2015 compared to baseline years (2009–2011) using both first episode ARF hospitalisation data and notification data.

- To June 2015, there is evidence of a statistically significant reduction in ARF notified cases following the implementation of the RFPP and the school-based sore throat management service among high-risk populations. For 5–12 year old children there was a decline of 26% in ARF notifications to June 2015 compared to 2009–2011. However, a decline was also noted among young people aged 13–19 years who were largely not exposed to the school-based service.

- The reasons for the decline in ARF are uncertain, consequently it is difficult to attribute the decline in ARF cases to exposure to the school-based service of the RFPP. If this decline persists, then it would be useful to consider whether it can be linked to other aspects of the RFPP, such as the generally increasing emphasis on sore throat treatment in primary care or the emphasis on primordial (social and environmental e.g. improved housing) prevention.

- The analysis of the effectiveness of the school-based sore throat management service in the 10 DHBs implementing this service showed an overall 17% decline in ARF cases. For Counties Manukau the decline was about 31%. However, neither estimate was statistically significant.

- For an area such as Counties Manukau with an incidence of ARF of 87 per 100,000 at a cost of $200 per child per year and 30% effectiveness, the school-based service would not be cost effective by current PHARMAC standards, but would be cost effective, although not highly cost effective, using WHO criteria. If the cost per child was higher, the school-based service would not be cost effective. For other areas in the North Island with an incidence of ARF between 20–50 per 100,000 with a cost of $200 per child per year and 20% effectiveness, the school-based service would not be cost effective.

- The school-based service was successful in increasing the number of throat swabs taken from high-risk children with sore throats.

- Monitoring reports record almost all children with GAS positive throat swabs are treated, however, information on timely initiation of treatment with antibiotics and treatment adherence is limited.
KEY QUANTITATIVE FINDINGS OF THE INTERIM EVALUATION

1. Acute Rheumatic Fever trends

First episode hospitalisation rates from 2000 through to June 2015

Overall national rates of ARF as measured by first episode ARF hospitalisation through to June 2015 have declined significantly compared to baseline rates (Figure 4, Table 1).

Figure 4. New Zealand first episode ARF hospitalisation rates per 100,000 population per year

NB. This graph uses crude rates to be consistent with method used for specifying the ARF Better Public Services baseline and target rates.

Table 1 presents first episode ARF hospitalisation rates in NZ for all ages, children aged 5–12 years, and young people aged 13–19 years comparing baseline years (2009–2011) to subsequent years. For all ages, there was a 27% statistically significant reduction in ARF rates per 100,000 by mid 2015 compared to baseline years (2009–11); for children 5–12 years there was a 32% statistically significant reduction; and for young people 13–19 years there was a 19% reduction that was not statistically significant, in ARF rates per 100,000 by mid 2015 compared to baseline years (2009–11) as calculated from data.
Table 1. First episode ARF hospitalisation crude rates per 100,000 population for baseline years (2009–11) compared to 2012, 2013, 2014 and June 2015

<table>
<thead>
<tr>
<th>Year</th>
<th>All New Zealand cases</th>
<th>Cases 5–12 years</th>
<th>Cases 13–19 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cases</td>
<td>Population</td>
<td>Rate per 100,000</td>
</tr>
<tr>
<td>2009–11</td>
<td>162</td>
<td>4,345,767</td>
<td>3.72</td>
</tr>
<tr>
<td>2012</td>
<td>151</td>
<td>4,408,100</td>
<td>3.43</td>
</tr>
<tr>
<td>2013</td>
<td>191</td>
<td>4,442,100</td>
<td>4.30</td>
</tr>
<tr>
<td>2014</td>
<td>143</td>
<td>4,509,900</td>
<td>3.17</td>
</tr>
<tr>
<td>2015 to June +</td>
<td>125</td>
<td>4,596,700</td>
<td>2.72</td>
</tr>
</tbody>
</table>

P value: two tailed z-test for comparing rates; *significant at 0.01; ** significant at 0.05
+ Note number of cases has been seasonally adjusted for 2015 to calculate an annual rate

Cumulative ARF notifications from 2009 through to June 2015

Please note that due to variability in the completeness of ARF notification data over time, particularly earlier in this time period, these findings are not directly comparable with temporal trends using ARF first episode hospitalisation data and should be treated with caution. The annual cumulative number of ARF probable and confirmed notifications by disease onset date in the 10 DHBs where the school-based sore throat management service is being implemented for children and young people aged 4–19 years shows a statistically significant 29% decline by June 2015 relative to the baseline period (Figure 5).

Figure 5. Cumulative ARF notifications in 4–19 year olds for the 10 DHBs with a school-based service, 2009–2015
To further review this recent trend we produced similar cumulative graphs for ARF notifications in children aged 5–12 years in the 10 DHBs where the school-based service was being implemented (Figure 6).

**Figure 6. Cumulative ARF notifications in 5–12 year olds for the 10 DHBs with a school-based service, 2009–2015**

The above graph show that for all 5–12 year old children there was a 26% decline in ARF notifications from baseline years 2009–11 compared to June 2015. This decline could be partly due to the school-based service which targets this age group although it may also be due to a background decline in the incidence of ARF, for example due to other additional components of the RFPP, or for other unknown reasons. Furthermore, for young people aged 13–19 years who are largely not targeted by the school-based service there was a decline of 40% by June 2015 compared to baseline years (Figure 7). Additional months and years of data will be needed to confirm trends.

**Figure 7. Cumulative ARF notifications in 13–19 year olds for the 10 DHBs with a school-based service, 2009–2015**
2. Has the overall Rheumatic Fever Prevention Programme (RFPP), including the sore throat management component been effective in reducing the incidence of ARF in primary and intermediate school-aged children?

Although the effectiveness analysis in this interim evaluation has primarily assessed the impact of the school-based sore throat management services on primary and intermediate-aged children, other components of the overall RFPP may also have impacted on the results. These include targeted communication strategies (‘awareness raising’) informing people how to reduce their risks and when to seek treatment for sore throats, and guidance to health professionals about diagnosing and treating sore throats that has been carried out alongside the school-based services.

The effectiveness analysis was largely a before and after analysis based on ARF cases for children aged 5–12 years attending a decile 1–3 school that implemented school-based sore throat management service through to the end of 2014. ARF cases not exposed to the school-based service were compared to cases exposed to the service during 2012–2014 (Table 2).

- Overall in the 10 DHBs where a school-based service was implemented there was a 17% reduction (non-statistically significant) in ARF cases (95% confidence interval (CI): -17–42%).
- In the Counties Manukau DHB (CMDHB) there was a 31% reduction (non-statistically significant) in ARF cases (95% CI: -13–58%)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Number of cases exposed/ person-days exposed</th>
<th>Number of cases not-exposed/ person-days not exposed</th>
<th>ARF decline (proportion) (%)</th>
<th>Lower confidence limit (%)</th>
<th>Upper confidence limit (%)</th>
<th>Statistical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schools with a sore throat service</td>
<td>79/34,798,158</td>
<td>52/18,960,113</td>
<td>17</td>
<td>-17</td>
<td>42</td>
<td>No</td>
</tr>
<tr>
<td>Schools in CMDHB with a sore throat service</td>
<td>33/15,273,980</td>
<td>31/9,945,963</td>
<td>31</td>
<td>-13</td>
<td>58</td>
<td>No</td>
</tr>
</tbody>
</table>

These results must be interpreted with caution, as although there was a decline, it was not statistically significant, so it is also consistent with the service having no effect on the incidence of ARF to the end of 2014. This analysis does not account for any changes in background incidence that may be seen in children attending a school without a school-based service. It is possible, that another year of data may strengthen findings.
Our analysis was suitably powered (85%) to detect a true effect size of 50% effectiveness on three years of data (approximately 18 months exposed to the service and 18 months not-exposed to the service).

For similar power with a true effect size of 30%, we estimate approximately eight years of data would be required (2008 to June 2016). For 85% power with a true effect size of 15%, we estimate approximately 32 years of data would be required. Power could be increased by having more schools providing the service, or by using individual level data if available.

ARF is an uncommon disease with a small number of cases each year. Few rapid response clinics were fully operating by the end of 2014 so this analysis largely reflects the effect of the school-based sore throat management service. We were not able to separate out and attribute any specific effects on the incidence of ARF due to the rapid response clinics, or due to usual primary care.

3. Economic analysis

The economic assessment is a ‘what if’ analysis noting that the effectiveness of the school-based sore throat service of the RFPP to date is modest and not statistically significant. For CMDHB with a high incidence of ARF, good service coverage, at a cost of $200 per child per year and an assumed effectiveness of 30%, the school-based service would not be considered cost effective by current PHARMAC criteria at a cost per QALY of $90,043 or 11.1 QALYs gained per million dollars expenditure. However, it is cost effective by WHO criteria (between one and three times GDP), although not highly cost effective (less than one times GDP) (see Figure 8). For other areas with a lower incidence of ARF, lower coverage of high risk children and more modest effectiveness the school-based service is not cost effective. However, a high cost may be acceptable in ongoing attempts to reduce marked ethnic and socioeconomic disparities in ARF.

Table 3 gives the estimated costs per ARF and RHD case averted and the cost per QALY gained for a range of effectiveness and cost per child of the school-based service. The base case is highlighted in red with a cost of $200 per child per year and a 30% effectiveness of the school-based service.
### Table 3. Estimated additional cost per case averted, per RHD death averted and per QALY gained by the school-based sore throat management service in CMDHB, over a range of annual cost per student and service effectiveness values

<table>
<thead>
<tr>
<th>Annual cost per child</th>
<th>Effectiveness of school-based service</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Cost per case averted</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td><strong>Cost per RHD death averted</strong></td>
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<td></td>
<td><strong>Cost per QALY gained</strong></td>
<td></td>
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<td></td>
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</tr>
<tr>
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</table>

ARF incidence rate estimated at 87.1 per 100,000 for high-risk children in CMDHB. Pink shading indicates less than one GDP per capita (‘very cost effective’ by WHO standards); bold red font is the base case; GDP per capita = $52,735 in Financial Year (FY) 2013/14. QALY = quality adjusted life year.

The school-based intervention in CMDHB, covering around 25,000 children at a cost of $5m per year, is estimated to prevent about six first episode cases of ARF in one year and avert one premature death from RHD over the lifetime of the cohort. Accordingly, it would provide a lifetime gain (discounted to present value) of 26.5 QALYs for that cohort of children.

Figure 8 displays the range of cost per QALY by varying incidence rates of ARF, with dotted lines indicating cost effectiveness according to WHO criteria as described above.
4. Did the sore throat management service in schools target the high-risk populations?

Analysis of laboratory data generated by throat swabbing practices in both primary care and school-based services clearly demonstrates a marked increase in the rate of throat swabbing before and after the implementation of the sore throat management service. Importantly, the swabbing rates were highest in the high-risk populations, namely Māori or Pacific children living in areas of high socioeconomic deprivation. In this regard, the sore throat management service did provide effective targeting of throat swabbing to relevant populations. School-based service monitoring data show that almost all children with a GAS-positive throat swab were treated with appropriate antibiotics, however, timely initiation of treatment with antibiotics may be a problem. The monitoring data were not verified and may be of variable quality.

5. Has the school-based sore throat management approach reduced ARF?

It is difficult to attribute the decline in ARF cases to exposure to the school-based service of the RFPP as it appears that overall ARF cases have declined in 2015 regardless of exposure to the school-based service. To June 2015, there is evidence of a statistically significant reduction in ARF cases following the implementation of the RFPP and the school-based sore throat management service among high-risk populations. For all 5–12 year old children in the 10 implementing DHBs there was a decline in ARF notifications of 26% to June 2015 compared to baseline years 2009–
2011. There was also a decline of 40% in young people aged 13–19 years who are largely not exposed to the school-based service over this same period, with the decline starting in 2015.

Consequently, it is difficult to attribute the decline in ARF cases solely to exposure to the school-based service of the RFPP. If this decline persists, then it would be useful to consider whether it can be linked to other aspects of the RFPP, such as the generally increasing emphasis on sore throat treatment in primary care or the emphasis on primordial (social and environmental e.g. improved housing) prevention, awareness raising, or for other unknown reasons.

Following the sore throat component programme logic, the detection and appropriate treatment of sore throats infected with the GAS bacteria, and preventing GAS transmission within households are a key components in preventing ARF. However, there are some shortcomings in this approach that need to be understood. More than one third of ARF cases do not recall a sore throat in the four weeks prior to admission or diagnosis (and therefore would not seek care or be treated to prevent ARF). Distinguishing the much more common viral sore throat from sore throats infected by the GAS bacteria is difficult. Some people have a viral sore throat infection, but have the GAS bacteria detected in their throat (GAS carriage). They may therefore be treated as if they had a GAS infection, when in fact they did not.

Under real life conditions such as the current school-based sore throat management service, there are several elements that could be strengthened. The detailed analysis of ARF cases in the last six months of 2014 when the school-based sore throat service reached its peak coverage found that the service was well targeted to priority populations. However, only half of the recent primary and intermediate aged ARF cases attended a school with a sore throat service, meaning that the coverage of the sore throat management school-based services did not reach all those at risk; and of those reporting a sore throat, not all were swabbed, and not all received the correct antibiotic treatment in a timeframe to prevent ARF or completed a full course.

Our finding of a 17% reduction in the incidence of ARF hospitalisations for priority population children in the areas where the school-based sore throat management service was implemented is consistent with the 21%-28% effectiveness reported from the Auckland randomised controlled trial of the same intervention conducted under research conditions\textsuperscript{11}. Our lower effectiveness may reflect real life programme implementation under ‘field conditions’. Overall our findings support the non-significant reduction in ARF hospitalisations as found by Lennon et al. in their group randomised trial of a sore throat management of GAS services in schools\textsuperscript{11}.

In order for New Zealand to be able to meet the BPS target of reducing the incidence of ARF hospitalisations by two-thirds (67%) by 2017, the school-based service alone will not be adequate. This situation is well recognised by the MoH and, as such, the RFPP incorporates wider interventions including messaging on seeking appropriate sore throat care and completion of a full course of appropriate antibiotics for GAS positive sore throats. The RFPP is also addressing wider
determinants of ARF through supporting the assessment of priority populations for improved housing to decrease close-contact transmission of GAS and other infectious diseases.

DHBs have generally targeted and provided the school-based sore throat service for children in primary and intermediate schools in more deprived areas with the highest incidence of ARF although coverage of high-risk children in some DHBs remains low. Gaps remain in the implementation of the school-based service with not all children with a sore throat being swabbed, and then not all children who had a GAS positive throat swab taking the full course of antibiotics. It is too early to determine the effectiveness of the rapid-response sore throat clinics that have been progressively rolled out since 2014.
CONCLUSIONS

- This interim evaluation was conducted just over half-way through a planned six year programme of work that aims to decrease the incidence of ARF by two-thirds by 2017.

- National rates of ARF, as measured by first episode hospitalisations, show a statistically significant decline following implementation of the RFPP by June 2015 compared to baseline years (2009–2011).

- The cumulative number of ARF notifications in children and young people aged 4–19 years also show a statistically significant decline for children and young people through to June 2015 compared to 2009–2011 overall (28%), and in the 10 DHBs implementing a school-based service (29%). Notification data suggest that the incidence of ARF began to decline sometime between August 2014 (in CMDHB but not other Auckland DHBs) and November 2014 (other North Island DHBs) and continued during the first six months of 2015.

- In the 10 DHBs that implemented a school-based service, for 5–12 year old children regardless of exposure to the school-based programme there was a decline in ARF notifications of 26% to June 2015 compared to 2009–2011. There was also a decline of 40% in young people aged 13–19 years who are largely not covered by the school-based service. Consequently, it is difficult to attribute this decline solely to exposure to the school based service of the RFPP. If this decline persists, then it would be useful to consider whether it can be linked to other aspects of the RFPP, such as the generally increasing emphasis on sore throat treatment in primary care or the emphasis on primordial (social and environmental e.g. improved housing) prevention, or for other unknown reasons.

- The effectiveness analysis shows that to the end of 2014, attending a school with a school-based sore throat management service was associated with a modest but non-statistically significant decline in ARF notifications (17%). There was a larger decrease in ARF notifications associated with the school-based sore throat management service in CMDHB (31%) but again this was not statistically significant. It is possible, that an additional year of data may help determine if these recent downward trends are sustained and become statistically significant.

- In order for New Zealand to be able to meet the BPS target of reducing the incidence of ARF hospitalisations by two-thirds (67%) by 2017, the school-based service alone will not be adequate.

- The school-based sore throat management service of the RFPP appears effective at targeting throat swabbing to high-risk populations attending schools with a school-based service, with a marked increase in the rate of throat swabbing after the implementation of the RFPP. There was also a smaller increase in throat swabbing in high-risk and low-risk children in primary care.
• The overall coverage of the school-based service for high-risk children is relatively low in several DHBs.

• The economic assessment is a ‘what if’ analysis noting that the effectiveness of the school-based sore throat service of the RFPP to date is modest and not statistically significant. For CMDHB with a high incidence of ARF, good service coverage, at a cost of $200 per child per year and an assumed effectiveness of 30%, the school based service would not be considered cost effective by current PHARMAC criteria. However it is cost effective by WHO criteria, although not highly cost effective. For other areas with a lower incidence of ARF, lower coverage of high risk children and more modest effectiveness the school-based service would not be considered cost effective. However, a high cost may be acceptable in ongoing attempts to reduce marked ethnic and socioeconomic disparities in ARF.

• It was not possible, using existing data, to separate out the effectiveness of school-based service from rapid response clinics, or rapid response clinics from routine primary care management of sore throats.

• Several aspects of the school-based sore throat management service could be strengthened including encouraging all children attending a school with a sore throat service with sore throats to have a throat swab taken, timely initiation of antimicrobial treatment, and supporting antimicrobial adherence. However, there is insufficient information to know if these changes would in fact improve the effectiveness of the school-based service.

• The school-based service of the RFPP was not adequately designed to be systematically and comprehensively evaluated. A further evaluation, incorporating at least an additional year of data, and/or using individual level data, could be considered to provide more certainty around the conclusions contained in this report. However, it is important to note that three years of data used in the effectiveness analysis would have had adequate power to determine a 50% reduction in ARF incidence, had that been seen (noting that the NZ National Heart Foundation guidelines expected an effectiveness of 60% for such a school-based or community approach). More modest reductions would require many years of data with the service fully implemented to gain sufficient power to demonstrate statistical significance.

• Further assessment of the RFPP could be strengthened by the inclusion of additional data which were not available for this interim evaluation. For example:
  • establishing a laboratory administrative marker for throat swabs and a record of who attends rapid response clinics with National Health Index numbers (NHIs) may allow contribution to any effect to be differentiated between the school-based service, rapid response clinics and usual primary care;
• recording NHIs of all children consenting to be part of school-based service would allow more robust individual-level analysis to be conducted. Tracking would need to document important details such as the timing of participation;

• good quality monitoring data for both school-based and rapid response clinics including: children and young people swabbed, repeated swabs on the same child or young person, prescriptions or antibiotics given, family members swabbed, and referral to housing initiatives from RFPP programmes would allow a better assessment of implementation issues;

• consistent reporting of RFPP costs could support a more extensive economic analysis of the programme;

• as noted, a more complete assessment of the RFPP would include potential co-benefits from operating school-based health services as well as the potential harms of increased antibiotic use on resistance;

• investigate the ability to track antibiotic dispensing at an individual level, linked to NHI, in order to monitor the safe and judicious use of antibiotics;

• assessment of alternative methods of delivery including the current quality of and access to sore throat management in primary care for high-risk populations;

• establishing a national ARF register to allow for improved national monitoring of ARF incidence throughout New Zealand.
METHODS OF THE INTERIM QUANTITATIVE EVALUATION


We used first episode ARF hospitalisation data covering the 15-year period from 2000 to June 2015 to determine trends in ARF hospitalisations. In general, the three-year period 2009–2011 provides a pre-RFPP baseline and 2012–June 2015 represents the intervention period of the RFPP.

We also produced cumulative incidence graphs from 2009 through to June 2015 using the most recent ARF notification data available.

Determining how well delivering sore throat management services in schools works

We used a cohort study design to assess the association between exposure to the school-based sore throat management service and the risk of ARF using ARF notification data. Eligible children were all children aged 5–12 years attending decile 1–3 schools in the 10 DHBs with a school-based sore throat management service operating under the RFPP from 2012 to 2014. We calculated person-days-exposed for those attending a school with a school-based service operating and those who did not (person-days—not-exposed). We used probable and confirmed cases of initial episodes of ARF reported to ESR with an onset date between January 2012 and December 2014. We determined service effectiveness (SE) as SE = 1-relative risk. As few rapid response clinics were fully operating by the end of 2014, we were unable to determine their effectiveness.

Figure 9. Cohort design effectiveness analysis

Eligible cohort: all children 5–12 years in decile 1–3 schools with a sore throat management service operating during 2012–2014.
Estimating the cost effectiveness of sore throat management services

We estimated the cost effectiveness of the school-based sore throat management intervention using a lifetime semi-Markov model. This was a ‘what if’ analysis incorporating ARF incidence rates, estimated service effectiveness, hospital admissions, costs and mortality. We estimated cost effectiveness in one DHB (CMDHB) that was selected as a best-case base scenario due to high coverage of a well-functioning school-based service, a high incidence of ARF, and cost data availability. The analysis was adapted from a previous model of a school sore throat service that was reported to the MoH in 2011, but using updated inputs and more accurate costs.

Determining if high-risk children are accessing the sore throat management services in schools

We reviewed who had a swab taken for their sore throat through the school-based service and in primary care. We also linked the throat swab data with ARF hospitalisations. For throat swab sample data, the number of swabs (rates) and percentage that were GAS positive (GAS positivity) were initially stratified according to socio-demographic factors (source of swab, NZDep quintile, ethnicity, and DHB) to determine if high-risk populations were indeed accessing sore throat management services in schools and primary care.

Determining why some children are still getting ARF

Using detailed information from ARF notified cases between July and December 2014, we reviewed possible reasons for failure to prevent ARF (root cause analysis). These included not accessing an available school-based service, not having a throat swab taken and not being given or completing a course of antibiotics if GAS was detected in the throat swab. The information was not verified and was only available over a short time period with small numbers so may not fully reflect measures for all children aged 5–19 years. In addition, monitoring data suggest that antibiotic treatment may not have been given in a timely manner.
STRENGTHS

This quantitative interim evaluation has several important strengths:

- Despite the limitations of ARF surveillance, New Zealand does have two long established national sources of ARF surveillance data: hospitalisations and notifications. After considerable work, these data sources are showing a high level of concordance, particularly over the last five years (2010–2014).

- Laboratory data provide a complete and fairly unambiguous measure of the extent and results of throat swab testing across populations.

- The unique patient identifier (NHI) allows additional data quality improvements and, in particular, linking of multiple surveillance data sources, notably laboratory and cases data.

- Surveillance systems have been refined to provide additional insights, notably school attended (which allows us to identify if a child was attending a school which is providing the sore throat management service). Also, the more recent addition of root cause analysis data collection to the ARF notification system allows a comprehensive analysis of modifiable factors contributing to the ARF cases occurring.

- The timing of this evaluation seems particularly useful as the RFPP is still operating, providing opportunities for the MoH to act on the findings in terms of decisions to continue and/or modify this sore throat management component. This is the earliest that such an evaluation could be conducted. The school-based sore throat management service has operated at maximum intensity for an entire year (2014). The rationale for the sore throat management component of the RFPP is that by detecting and treating presumed GAS pharyngitis, the development of ARF will be prevented. We would therefore expect to see a rapid reduction in ARF rates in those populations exposed to the sore throat management component of the RFPP, if such a programme was effective and delivered effectively. There is no reason why the effectiveness should necessarily increase further with time, unless this occurs through some other completely different mechanism (such as a reduction in circulating GAS caused by the widespread use of antibiotics in the programme, although supporting evidence for this theory is extremely limited).
LIMITATIONS

This interim quantitative evaluation has several important limitations:

- The major outcome, ARF, can be difficult to diagnose in some cases. Diagnostic behaviour may have changed over time, particularly with increasing awareness and interest in this disease. Additionally, there is no established national ARF register, so it was necessary to use hospitalisation or notification data to track this disease over time. Even with an agreed set of decision rules for analysing these data, there are inevitably some errors in using these data sources in measuring the incidence of ARF.

- ARF is an uncommon disease so a change in incidence (new cases) will need to be large to be statistically significant.

- Monitoring of the sore throat component of the RFPP was not standardised and reporting on deliverables and indicators was very limited until recently. Children consenting to participate in the school-based sore throat service did not have NHIs routinely recorded. Therefore evaluating the sore throat component of the RFPP has been challenging: the preferred and more robust approach of undertaking individual level analysis has not been possible. Throat swabs taken from the school-based service are clearly identified in laboratory data, however throat swabs taken in rapid response clinics are not currently able to be identified. Consequently, the contribution of rapid response clinics as differentiated from usual primary care has not been possible.

- The sore throat management approach in the primary prevention of ARF has shortcomings, notably that more than a third of ARF cases do not report having a sore throat prior to diagnosis.

- This interim evaluation has shown that the nature of the intervention also varies considerably across DHB regions in terms of coverage of the throat swabbing and management in priority populations, frequency of throat swabbing offered, and support for completing antibiotic treatment.

- Some of the surveillance data used here require careful interpretation. It is important to note that root cause analysis, by definition, is only applied to intervention failures i.e. those who have developed ARF despite the RFPP. It was based only on six months of data with small numbers. Findings cannot therefore be generalised to estimate these measures for the entire population of children aged 5–19 years.

- Obtaining complete, consistent data on the costs of the RFPP has been difficult and the data used in the current model are likely to be questioned by some users of this report. As with the RFPP itself, there is considerable regional diversity in the costs of the school-based service.
Partly for this reason, the economic analysis has focused on a single DHB, considered to be a best performer and thus most likely to show any benefit if there was one.

- This interim evaluation focused on quantitative effectiveness and cost-effectiveness of the school-based sore throat management service of the RFPP to the end of 2014. The qualitative component on parent/whanau service users and suppliers is being carried out separately and the findings will be available later in 2015.

- Some potential benefits are not being measured, such as additional health benefits from operating school-based health services, particularly for deprived populations who may have poor access to primary care services. Some potential harms are also not being measured by this evaluation, notably the potential negative impact of increased antibiotic use on resistance, although this question is currently being assessed separately.

- This interim evaluation was conducted over a very short time period and largely relied on existing routine data sources, the quality of which can vary across time and region. This may have limited the ability of this interim evaluation to assess the true effectiveness and cost-effectiveness of the sore throat management services. More time would have allowed the researchers the opportunity to check and validate some of these data more fully.

- Rapid response clinics and services aimed at reducing household crowding were being implemented during 2014 with increasing coverage in 2015. Findings from this interim evaluation therefore largely do not reflect any significant impact from those interventions.
REFERENCES
