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Skin infections in children in a New Zealand primary care setting: exploring beneath the tip of the iceberg

Cathryn O'Sullivan, Michael G Baker

Abstract

Aim Over the past two decades there has been a documented steady rise in the incidence of hospitalised serious skin infections in New Zealand children. However there are few surveillance data from the primary care setting, where the majority of children with skin infections initially present. We aimed to describe the epidemiology of childhood skin infections presenting to primary care in a region of New Zealand with a particularly high burden of infection and compare this to hospitalised cases during the same period.

Methods A sample of general practitioners in the Tairawhiti (Gisborne) region recorded all cases of skin infections in 0–14 year old children diagnosed over a 10-week period in 2008. Observed case rates were directly standardised by age and ethnicity to the Tairawhiti population to give estimated rates for the whole region. Demographic data from primary care cases were compared to similar data from hospitalised cases during the same period.

Results There were 110 incident cases of skin infections seen by the nine participating general practitioners during the study period, equivalent to an annual incidence rate of 106.7 (95%CI: 85.2–127.2) cases per 1000 children in the region. For every one hospitalisation there were an estimated 14 primary care cases. Three quarters of skin infections in both primary care and hospital settings occurred in Māori children. There was no gender predominance in either setting, however hospitalised cases of serious skin infections were more likely to occur in the preschool age group whereas children aged 5–9 years predominated at the primary care level.

Conclusion Skin infections are a common childhood complaint in primary care in the Tairawhiti region, with hospital-based surveillance using coded discharge data only capturing a small proportion of the overall community disease burden. Previously observed ethnic disparities in hospitalisation rates for serious skin infections reflect similar disparities in skin infection rates in primary care. The establishment of a sentinel surveillance system in the New Zealand primary care setting would facilitate further research and monitoring of this and other important conditions.

Skin infections are a common complaint in primary care and are usually considered benign. However, in both New Zealand (NZ) and international settings, these infections are becoming an increasingly significant source of childhood morbidity, with the rate of skin infections requiring hospitalisation (termed 'serious skin infections') steadily increasing during the last two decades.[1–7]

In NZ, the rate of serious skin infections, doubled between 1990 and 2007.[4] In 2004, a report by Hunt found the national rate of cellulitis in children was twice that of Australia and the United States of America.[8]

Recent analyses have found that serious skin infections contribute heavily to health inequalities with the greatest hospitalisation rates observed in Māori and Pacific children.[4,5,8–11] These trends are hypothesised to reflect corresponding patterns of disease in the community,[8] however there are no published studies examining skin infections in the NZ primary care setting, where many patients initially present and the major burden of illness is managed. This deficit is likely due to the lack of routine primary care level surveillance for most health conditions in NZ.

Hospital admissions for serious skin infections represent the 'tip of the iceberg' in relation to the wider community burden of disease.[4,8] We aimed to estimate the incidence of skin infection cases in primary care in children in the Tairawhiti (Gisborne) region, describe the basic epidemiology of these infections, and compare these characteristics with serious skin infections hospitalised in the region during the same period.

Methods

We conducted a prospective observational analysis of skin infection cases in children seen by a cohort of general practitioners (GPs) in the Tairawhiti region.

Study location—The Tairawhiti region is a relatively isolated area of 45,000 people on the East Coast of NZ's North Island. The region is unique for its large Māori population (47.3% of the total population and 58.4% of the 0–14 year old population), young age distribution (26.2% of people are aged less than 15 years),[12] and high levels of deprivation (the Gisborne region has the highest proportion of the most deprived residents in the country).[13]

In Tairawhiti, childhood skin infections present a major challenge to both primary and secondary health services. The region's serious skin infection incidence is not only the highest in NZ,[4] research presented in companion articles in this issue of the *New Zealand Medical Journal* has shown it is considerably greater than that expected, even after standardising for the high-risk age, ethnicity and deprivation population composition.

General practitioner recruitment and data collection—The raw data for this study were collected by prospective consultation coding by a group of Tairawhiti GPs. All GPs within the region were approached and their voluntary participation in this study sought. Out of the usual local GP population of approximately 20 full-time equivalent practitioners working in six primary practices, nine GPs from three different practices agreed to participate. During the study period, 4627 of the 18,456 (25.1%) 0–14 year olds usually resident population of the Tairawhiti region were registered in the practice populations of these GPs.

Over the 10-week period, 19 May 2008 to 28 July 2008, GPs coded all incident cases of skin infection in children using the READ code system. Similar to International Classification of Disease (ICD) codes used in hospitals, READ codes are a standardised and hierarchically-arranged clinical terminology system widely used in primary care practices for coding diagnoses as well as a range of patient demographic and clinical data.[14]

All skin infections were included regardless of whether they were the primary reason for presentation or a secondary diagnosis. Repeat visits for the same episode of infection were not coded. All visits were during routine office hours of 8am to 5pm, Monday to Friday. A minimum level code of 'M0.00' (Skin/subcutaneous tissue infections) was recorded in the computerised clinical records of appropriate patients using MedTech32®, the electronic patient management system used in all participating practices.

Email reminders were sent to GPs every 3–4 weeks during the data collection phase. At the end of this period, the Query Builder® function of MedTech32® was used to design and run a standardised data query. An arbitrary and anonymous unique identifier was assigned to each case and raw data variables including READ code and free-text diagnosis description, date of birth, gender and ethnicity (Māori vs. non-Māori) were extracted and collated centrally.

Case definition—Cases of skin infection were diagnosed clinically based on the experience of participating GPs, however a written case definition was provided to standardise inclusion criteria:

> "Any child aged 0–14 years old, seen by a participating GP during the study period, with clinical evidence of a new episode of active bacterial infection of the skin or subcutaneous tissue including any of the following diagnoses: cellulitis, erysipelas, impetigo, subcutaneous abscess, furuncle, carbuncle, acute lymphadenitis, any pyoderma including bacterial super-infection of eczema/scabies/chickenpox/insect bites, and any other infection of the skin or subcutaneous tissue."

Hospital cases—We used anonymised hospitalisation data provided by the New Zealand Ministry of Health to identify all cases of serious skin infection in children aged 0–14 years admitted to Gisborne Hospital over the same 10-week period specified above. The case definition of hospitalised serious skin infection utilised in this study was developed in earlier work by the authors and has been described in detail elsewhere.[15] Cases were assigned an arbitrary and anonymous unique identifier and the same basic demographic variables as those collated for GP cases were extracted.

Data analysis—Age and ethnicity-specific skin infection rates from participating GP registers were directly standardised to the regional population to give an estimate of the total number and rate of skin infection cases seen in children in primary care in the Tairawhiti region. Confidence intervals (CIs) were constructed using the methods of Clayton and Hills.[16]

Denominators in rate calculations were based on usually resident population counts from the 2006 Census.

Annual infection rates were calculated from extrapolations of observed data. Seasonal adjustment was not made as recent work has shown there is very little seasonality in hospitalisation rates for skin infections in the Tairawhiti region compared to NZ (see companion articles in this issue of the *New Zealand Medical Journal)* and it is unknown whether rates of skin infections in primary care exhibit seasonal trends.

The ethnicity and gender distribution of children in general practice and in the hospital setting were compared using the Fisher's exact test. Age distributions were compared using the Mann Whitney U test. A two-tailed p-value of less than 0.05 was considered statistically significant.

Regional Ethics Committee approval was obtained for this study.

Results

Incidence and characteristics of skin infection cases in primary care—Over the 10-week data collection period, 110 incident cases of skin infections in 107 children were recorded by the nine participating GPs. Table 1 summarises the observed number and rate of cases in each age and ethnicity group.

Based on age and ethnicity standardisation of observed rates, there were an estimated 378.6 (95%CI: 312.4–458.9) cases of skin infections seen in primary care, equivalent to a rate of 20.5 cases (95%CI: 16.9 to 24.9) per 1000 0–14-year-old children in the Tairawhiti region during the 10-week study period (see Table 1).

Extrapolating these data longitudinally, without taking seasonal adjustment into account, there were an estimated 1968.7 (95%CI: 1624.5–2386.3) cases of skin infections in children in the Tairawhiti region primary care setting during 2008. This frequency is equivalent to an annual incidence rate of 106.7 (95%CI: 85.2–127.2) per 1000 children in the region, or 10.7% of the population if there were no repeat infections in the same individuals.

In Māori children, there was a trend towards reducing case incidence with increasing age. This trend was less apparent in non-Māori children. Annual infection rates ranged from 29.0 per 1000 for non-Māori children aged 10–14 years, up to 245.5 per 1000 for Māori children aged 0–4 years.

Table 1. Skin infection incidence observed in the study population, and estimated for the Tairawhiti region, 0–14 year old children, May–July 2008

Ethnicity/age group	Observed case rate per 1000† (no. of cases/no. at risk)	Tairawhiti region population‡	Estimated no. of primary care cases in Tairawhiti region§	Estimated annual rate of primary care cases in Tairawhiti region#
Māori				
0–4 years	47.2 (34/720)	2163	102.1	245.5
5–9 years	42.6 (33/774)	2241	95.4	221.4
10–14 years	24.0 (18/751)	2403	57.6	124.6
Non-Māori				
0–4 years	11.9 (8/671)	3651	43.5	62.0
5–9 years	14.8 (12/813)	3852	56.9	76.8
10–14 years	5.6 (5/898)	4146	23.1	29.0
Total	**20.5** (95%CI: 16.9–24.9)	**18,456**	**378.6** (95%CI: 312.4–458.9)	**106.7** (95%CI: 85.2–127.2)

95% CI: 95% confidence interval; No.: number.

† Ethnicity and age-specific rates of skin infections observed in participating primary care practices during 10-week study period.

‡ Based on usually resident population data in 2006 Census.

§ Estimated number of primary care cases of skin infection in children in the Tairawhiti region during the 10-week study period, based on multiplying the age and ethnicity specific rates observed in participating GP practices by the Tairawhiti region population for that age/ethnicity group.

Estimated annual rate per 1000 of primary care cases of skin infection in the Tairawhiti region, based on annualising the 10-week rate (without seasonal adjustment).

Comparing skin infection cases seen in primary care and hospital settings— During the same 10-week data collection period, 27 cases of serious skin infection in 27 children were admitted to Gisborne Hospital. Based on the estimated 378.6 primary care skin infection cases in the region over this period, there were 14 primary care cases for every one hospitalised serious skin infection.

Table 2 and Figure 1 summarise and compare the basic demographic characteristics of primary care and hospital cases seen over the same period in 2008. Most primary care cases were coded only to the minimum code level of 'M0.00', so information on subtypes of skin infection and free-text diagnosis description was not available.

There was a significant difference in the age distribution of skin infection cases between the two settings (p=0.0041). Preschool-aged children accounted for two-thirds (67%) of hospitalised cases of serious skin infection but only 38% of infections in primary care. While just 15% of hospitalised cases were in children aged 5–9 years, this group made up the largest proportion of cases in primary care (41%). The 10–14 year old age group accounted for the smallest proportion of cases overall.

Slightly more boys were admitted to hospital with a serious skin infection than girls, 56% and 44% respectively, but this difference did not reach statistical significance. There was no gender predominance in primary care cases with equal numbers of male and female children suffering skin infections. The difference between settings was not significant (p=0.67).

Just over three-quarters (77%) of skin infection cases in the primary care setting were in Māori children. Hospitalised cases of serious skin infections exhibited a similar ethnic distribution, with 78% occurring in Māori children (p 1.00).

Table 2. Comparison of the demographic characteristics of children with skin infections seen in primary care and hospital settings in the Tairawhiti region, May–July 2008

Variable	Primary care cases		Hospital cases		Difference	
	No.	P_P (95% CI)	No.	P_H (95% CI)	$P_P - P_H$	p
Age (yrs)						
0–4	42	0.38(0.30–0.48)	18	0.67(0.48–0.81)	- 0.29	
5–9	45	0.41(0.32–0.50)	4	0.15(0.05–0.33)	+0.26	0.004
10–14	23	0.21(0.14–0.29)	5	0.18(0.08–0.37)	+0.03	
Gender						
Male	55	0.50(0.41–0.59)	15	0.56(0.37–0.72)	- 0.06	0.67
Female	55	0.50(0.41–0.59)	12	0.44(0.28–0.63)	+0.06	
Ethnicity						
Māori	85	0.77(0.69–0.84)	21	0.78(0.59–0.90)	- 0.01	1.00
Non-Māori	25	0.23(0.16–0.31)	6	0.22(0.10–0.41)	+0.01	

No.: Number of cases.

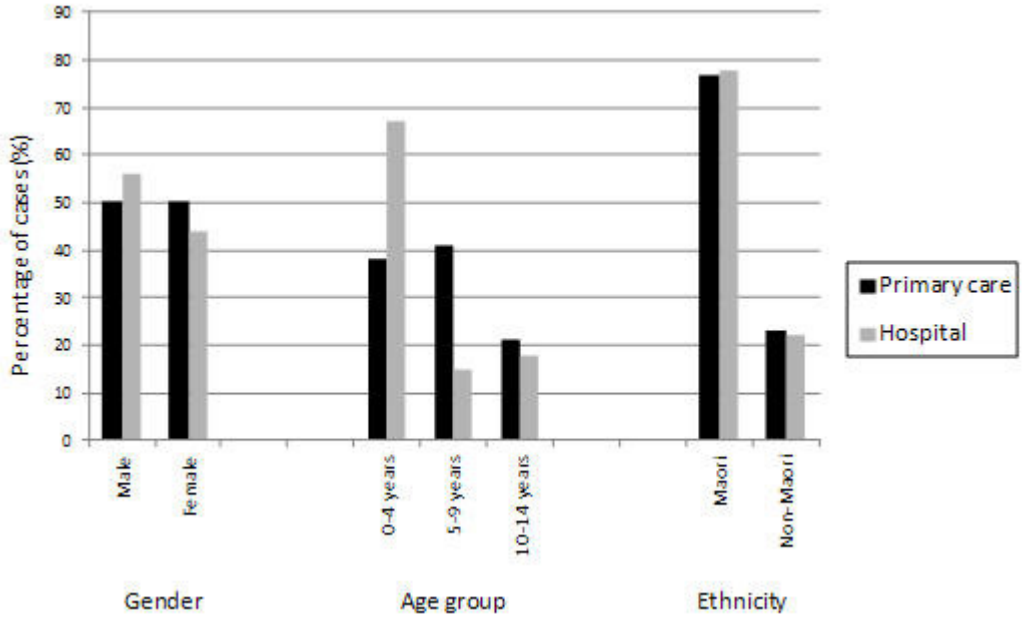
P_P: Proportion of primary care cases.

P_H: Proportion of hospital cases.

$P_P - P_H$: Difference between the primary care and hospital proportions.

p: Two tailed p-value (>0.05 considered statistically significant).

Figure 1. Gender, age and ethnicity distribution (%) of children with skin infections seen in primary care and hospital settings in the Tairawhiti region, May–July 2008



Discussion

Skin infections are a common childhood illness in NZ. Results of this study suggest that 10.7% of children in the Tairawhiti region consulted their GP with this complaint during 2008. The majority of infections are adequately treated in the primary care setting, avoiding hospitalisation. Population groups with the highest rates of infection were Māori children and those in both the 0–4 and 5–9 year old age groups, with no difference between male and female children.

We found that the epidemiology of skin infections in primary care reflected that of hospitalised serious skin infections, except for the age distribution of cases where there was a relatively higher proportion of 5–9 year olds presenting to primary care, whereas preschool-aged children were more dominant among those hospitalised. (see articles entitled *The epidemiology of serious skin infections in New Zealand children: comparing the Tairawhiti region with national trends*, and *Serious skin infections in children a review of admissions to Gisborne Hospital (2006-2007)* in this issue of the *New Zealand Medical Journal*).

This study provides the first NZ estimate of the rate of skin infection in children at the primary care level. Findings indicate that during a 10-week period in 2008, there were 378.6 cases (95%CI: 312.4–458.9) of skin infections seen in primary care in the Tairawhiti region, equivalent to an annual incidence rate of 106.7 cases per 1000 children or one in every nine children in the region consulting their GP for a skin infection during the 2008 year. This figure does not take into account repeat presentations for the same episode of infection.

Over three-quarters of skin infections in primary care occurred in Māori children with an almost identical proportion seen in hospitalised cases. This similarity in ethnic distribution between the two settings is important; it indicates that the high rates of serious skin infections in Māori children reported in previous analyses of NZ hospitalisation data[4,5,8–11] are a reflection of a similarly high burden of disease at the primary care level, rather than ethnic disparities in hospital admission thresholds.

Māori experience higher rates of infectious diseases in general.[17] The reasons for this difference are complex and multifactorial; they include household crowding, barriers to accessing primary healthcare such as cost and longer travel distances, and a range of socioeconomic factors.[17–22]

The relatively even spread of primary care skin infection cases across the 0–4 and 5–9 year old age groups was unexpected. Previous analyses have found hospitalisation rates for serious skin infections are highest in preschool-aged children,[4,5,8,9,23–26] and this distribution has been thought to directly reflect community trends in infection incidence. This finding could be an aberration due to our small sample size, but alternative hypotheses could include lower admission thresholds in young children or more severe disease requiring admission in a greater proportion of such cases.

This is the first published study we are aware of that has described the basic epidemiology of skin infections in children in a primary care setting and made comparisons to equivalent data from hospitalised serious skin infection cases over the same period. It is also the only study we know of that has attempted to quantify the

total primary care burden of childhood skin infections within a region in NZ. However several limitations must be considered in conjunction with its results.

Our analysis was based on a small number of primary care cases recorded over a short time interval. Regional infection rates were extrapolated from these observed data, and hence are subject to considerable sampling error, reflected in wide confidence intervals. However, in comparison to previous work estimating the primary care burden of skin infections, which have solely comprised workforce surveys,[8,27] this is an important step forward. The results are an indication of the magnitude of the problem beyond frequently measured hospitalisation data, and start to illuminate the area beneath the 'tip of the iceberg'.

The generalisability of the findings to populations outside the Tairawhiti region needs to be considered. If the ratio of 14 primary care cases for every one hospitalised case applied uniformly across NZ, then the 4,453 hospitalisations observed annually (2000–2007)[4] would correspond to 62,347 GP cases per year. However, further studies in other primary care populations are needed before relying on such extrapolations.

As involvement in this study was voluntary, it was not feasible to have a randomly selected sample of local GPs participating. Convenience sampling was therefore used. Potential clustering of practices limited our ability to analyse certain census area unit-based demographic variables, namely deprivation status. In addition, the analyses of the local primary care burden of disease assume that the group of participating GPs are a representative sample of all GPs in the Gisborne region and exhibited an average hospital admission threshold similar to the population mean.

While this objective would be best guaranteed by randomisation, we tried to minimise selection bias by including over one-quarter of the usually resident 0–14 year old population of the Tairawhiti region in the sample group, and ensuring participating GPs were recruited from a broad range of practice sizes, types and locations. We were unable to obtain data to compare the practice population demographics of GPs who participated and those who did not.

There was a large difference between the expected number of GP cases (based on GP-reported estimates made during preliminary discussions) and the actual number of recorded cases. The facility to code patient diagnoses exists within the computerised practice management systems used in almost all NZ general practices. However, most consultations are not routinely assigned a diagnostic code, so data collection in this study relied on participating GPs manually entering READ codes. Hence, it is likely that low coding compliance accounts for much of the discrepancy in expected and actual case numbers; despite good intentions, a minimal level code for simplicity, and regular email reminders, several participating GPs estimated their coding compliance was approximately 50%. This bias will result in an underestimation of the primary care burden of disease. However, it is also possible that some of the discrepancy was because anecdotal case numbers were initially overestimated.

GP cases were only recorded during routine office hours of 8am to 5pm, Monday to Friday. While there is an after-hours GP call-out service available in Gisborne, high costs and direct access to the local emergency department mean it is rarely utilised.

As such, all cases presenting overnight and during weekends were excluded from the dataset.

This study was not able to ascertain whether children admitted to hospital with a serious skin infection were referred immediately by their GP or after a failed trial of outpatient treatment. In addition, because this was not a longitudinal study, we could not determine if the marked rise in hospitalisation rates over the last two decades was due to comparative increases in primary care case rates over this same period.

Further research is warranted to explore childhood skin infections beneath the tip of the iceberg of serious hospitalised cases. While infections seen by primary care providers do not comprise the whole community burden of disease (infections may be self resolving or self treated), they do account for a significant proportion.

Further work is needed to investigate whether the high admission rates in NZ, compared to other developed countries, solely reflect greater community rates of disease, or whether a larger proportion of skin infections result in hospital admission.

Routine collection of primary care consultation data would facilitate this endeavour, and eliminate many of the limitations described in this study. One option would be to establish routine primary care surveillance of skin infection in NZ. Such primary care surveillance is arguably one of the largest gaps in NZ's infectious disease surveillance system.[28]

Many countries have well established general practice sentinel systems that NZ could emulate[29–33] and NZ has successfully piloted syndromic surveillance in the past for conditions including skin and subcutaneous tissue infection.[34]

Competing interests: None declared.

Author information: Cathryn O'Sullivan, Masters of Medical Sciences Student; Michael G Baker, Associate Professor; Department of Public Health, University of Otago, Wellington

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Correspondence: Associate Professor Michael Baker, Department of Public Health, University of Otago, Wellington. PO Box 7343, Wellington South, New Zealand. Fax: +64 (0)4 3895319; email: michael.baker@otago.ac.nz

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