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Bacterial skin infections

An observational study

Background
We aimed to determine the feasibility of measuring resolution rates of bacterial skin infections in general practice.

Methods
Fifteen general practitioners recruited patients from March 2005 to October 2007 and collected clinical and sociodemographic data at baseline. Patients were followed up at 2 and 6 weeks to assess lesion resolution.

Results
Of 93 recruited participants, 60 (65%) were followed up at 2 and 6 weeks: 50% (30) had boils, 37% (22) had impetigo, 83% (50) were prescribed antibiotics, and active follow up was suggested for 47% (28). Thirty percent (18) and 15% (9) of participants had nonhealed lesions at 2 and 6 weeks respectively. No associations between nonhealing and any modifiable factors investigated were identified. However, indigenous patients were more likely to have nonhealed lesions at 2 weeks and new lesions at 6 weeks.

Discussion
Clinicians need to be aware that nonhealing is not infrequent, particularly in indigenous people.

Bacterial skin infections such as impetigo and boils are common, contagious, often painful, and have the potential to recur. They are caused by *Staphylococcus aureus* and occasionally by *Streptococcus pyogenes*, and are transmitted by skin-to-skin contact, fomite contact or contact with nasal carriers.[1] In the United Kingdom, incidence of skin infections in children in 2005 was approximately 75 per 100 000.[2] Skin infection rates are likely to be higher in warmer climates. The only Australian data we found were for one Northern Territory Aboriginal Medical Service (Danila Dilba), which recorded 7.5 per 100 consultations for localised skin infections.[3]

Suggested risk factors for impetigo include: household crowding, inadequate access to water, heat and humidity, lack of education, and inadequate implementation of adequate personal hygiene.[4] Young children are predominantly affected and the potential for epidemics is highest in the warmer months of summer and autumn.[5,6]

However, despite bacterial skin infections being common presentations, little is known about their course after the primary care consultation. Furthermore, there is little evidence for recommended treatment options which include simple hygienic measures, topical disinfectants, topical antibiotics and oral antibiotics.[7] We aimed to investigate the feasibility of measuring the resolution rates and development of new skin infections in general practice, factors influencing these rates, and describing general practitioners' current investigation and management practices of these bacterial skin infections.

Methods

The study was a pilot prospective observational study in the primary care setting. General practitioners from the South East Queensland Research Network (SEQRN) were invited to participate. General practitioners opportunistically recruited and enrolled patients of any age with purulent skin infections including boils, impetigo, furunculosis and paronychia from March 2005 until October 2007. It was assumed that the GPs were able to identify purulent skin

infections and no additional training was provided. Patients with skin infections due to a fungal, parasitic or viral causes were excluded, as were secondary bacterial infections such as infected eczema, secondarily infected scabies or infected surgical or traumatic wounds.

General practitioners obtained informed consent and recorded diagnosis and site of infection, investigations conducted, treatments prescribed or advised if nonpharmaceutical, and relevant medical history. The GP faxed the enrolment forms and preliminary data to a research assistant who telephoned participants within a week of receipt of the enrolment details to complete preliminary data collection. The research assistant contacted patients again at 2 and 6 weeks to assess lesion resolution, development of new lesions in the patient or other household members, time taken off school or work, and any subsequent attendances to the GP.

Analysis

Our primary outcome variable was resolution of the skin infection at 2 weeks. Secondary outcome variables included development of new skin infections, development of skin infections in other household members, and patterns of care provided by the GPs. Data were analysed using Kruskal-Wallis rank tests, Chi-squared goodness of fit tests and Fisher's exact tests as appropriate. All statistical comparisons were undertaken using Stata version 10.0 software program, and α=0.05 was used to define significance.

The University of Queensland's Behavioural and Social Science Ethical Research Committee approved the study.

Results

Of the 20 SEQRN GPs, 15 (75%) enrolled 93 participants into the study over 32 months. Of these, 71 (69%) were contactable by the research assistant. Seven patients (8%) withdrew when contacted by the research assistant and four more were lost to follow up, leaving 60 patients (65%) who were followed up at 2 and 6 weeks and included in the analysis. Demographic data were not available for the 29 participants enrolled but not included in the analysis. The median age of participants was 19 years (range 2 months to 91 years), and 38% (23) were male. Half of participants had boils (30/60), 37% (22) had impetigo and just over half (31) had more than one lesion (*Table 1*). Skin infections predominantly affected the head, lower limbs, buttock and groin and there were relatively few lesions on the trunk and arms. There was no relationship found between lesion resolution at 2 weeks and the type or number of lesions, other household members having a skin infection at the time of diagnosis, patient past history of skin infections (*Table 1*), body site, age, gender, level of education, smoking status, diabetes (10% of total), and number of people in the household.

No investigations were done in 72% (43/60) of cases, although oral antibiotics were prescribed for 83% (50/60) of participants (*Table 2*), most commonly cephalexin (70%, 35/50). Patients were most likely to have tried antiseptic preparations (20%, 12/60) or antibacterial creams (7%, 4/60) before consulting the GP, with a few trying salt baths, pawpaw cream, magnoplasm and aloe vera. Neither patient nor GP initiated treatments, nor GP investigations, were significantly associated with lesion resolution at 2 or 6 weeks.

General practitioners advised some form of family treatment for 15 participants (25%). Of the 15 participants who reported household members with the same problem, seven (47%) received family treatment. Active follow up was suggested for 28 (47%) participants.

Indigenous participants were more likely than nonindigenous participants to have developed new lesions at 6 weeks (p=0.002). They were also more likely to have nonhealed lesions at 2 weeks (p=0.05) (*Table 3*), past skin infections (p=0.04), and to have a household member with a current skin infection (p=0.03). However,

Table 1. Type, number, history, and prevalence of skin infections among household members at baseline compared between participants with healed and nonhealed infections at 2 weeks

	Healed at 2 weeks		Not healed at 2 weeks		*p* value*
	n	(%)	n	(%)	
Type of infection					p=0.8
Boil(s) (n=30)	20	(67)	10	(33)	
Impetigo (n=22)	17	(77)	5	(23)	
Furunculosis (n=2)	1	(50)	1	(50)	
Other (n=6)	4	(67)	2	(33)	
Number of infective lesions					p=0.5
1 lesion (n=29)	22	(76)	7	(24)	
2–3 lesions (n=11)	8	(73)	3	(27)	
>3 lesions (n=20)	12	(60)	8	(40)	
Previous skin infections (n=24)	14	(58)	10	(42)	p=0.1
Other household members with current skin infection(s) at baseline (n=15)	11	(73)	4	(27)	p=0.8

* *p* value derived using Fisher's exact test to compare healed and nonhealed skin infections at 2 weeks

Table 2. Investigations done and treatment initiated at initial bacterial skin infection consultation with the GP, by infection type

	Boils (n=30)		Impetigo (n=22)		Other (n=8)		Total (n=60)	
	n	(%)^	n	(%)^	n	(%)^	n	(%)^
Investigations conducted*								
None	19	(63)	20	(91)	4	(50)	43	(72)
Swab	8	(27)	2	(9)	2	(25)	12	(20)
Full blood count	3	(10)	1	(5)	1	(13)	5	(8)
Electrolyte/liver function tests	4	(13)	1	(5)	1	(13)	6	(10)
Finger prick blood glucose	0	(0)	0	(0)	1	(13)	1	(2)
Ultrasound	0	(0)	0	(0)	1	(13)	1	(2)
Treatment initiated at presentation*								
None	0	(0)	0	(0)	1	(13)	1	(2)
Advice to clean lesion	9	(30)	11	(50)	4	(50)	24	(40)
Advice to cover lesion	15	(50)	13	(59)	4	(50)	32	(53)
Antibacterial wash	8	(27)	13	(59)	2	(25)	23	(38)
Nasal antibacterial cream	9	(30)	10	(45)	1	(13)	20	(33)
Topical antibacterial therapy	7	(23)	17	(77)	4	(50)	28	(47)
Oral antibiotics	28	(93)	16	(73)	6	(75)	50	(83)
Analgesia	6	(20)	1	(5)	0	(0)	7	(12)
Incision and drainage	6	(20)	0	(0)	1	(13)	7	(12)
Exclude from school/work	3	(10)	3	(14)	0	(0)	6	(10)
Hygiene advice for all household members	5	(17)	9	(41)	1	(13)	15	(25)
Follow up arranged	15	(50)	9	(41)	4	(50)	28	(47)

* For each type of skin lesion more than one investigation or treatment may have been reported

^ Percentages are calculated by dividing the number for each investigation/management strategy by the number for that type of skin lesion

these variables were not associated with nonresolution of the lesion at 2 weeks (*Table 3*). All these data need to be treated with caution owing to the small numbers contributing to statistical tests.

Resolution rates and development of new lesions for boils, impetigo and all lesions at 2 and 6 weeks are presented in *Table 4* with 95% confidence intervals. Seven (12%) patients needed a median of 2 days off either school or work.

Discussion

About one-third of bacterial skin infections seen in this study had not healed 2 weeks after the initial GP visit, with 10% of participants developing new lesions during the study follow up period. However, less than half of the participants had follow up arranged by their GP and few GPs recommended treating family members even when they had the same infection.

Our study had some strengths and weaknesses. The major strength was the collection of a comprehensive data set detailing normal practice of the participating GPs in managing bacterial skin infections. However, the small study size limits the generalisability of these results. Patient selection bias by GPs may have influenced the results of this study through recruitment of less complex cases. Patients had to self diagnose lesion resolution and presence of new lesions, which is unlikely to be as accurate as a clinical review. Finally, no microbiological evaluation was undertaken. Patient recruitment was slow, and continued over an extended period of time. Patient follow up was also difficult. Nearly one-third of potential participants who had initially consented to their GP were no longer willing to participate when contacted by the research assistant or were uncontactable and were therefore excluded from the study. These results suggest that feasibility of observational studies of this nature relies on an adequate number of actively participating GPs, a condition that is common enough to ensure sufficient numbers of patients can be recruited, and adequate resources to support the GPs and the study over an extended period of time.

Although this study was underpowered to determine the effect of patient and social factors on nonhealing and development of new lesions, we did find that indigenous patients with skin infections are less likely to heal at 2 weeks and more likely to develop new lesions at 6 weeks. Bacterial factors such as increased nasal carriage of community acquired methicillin

Table 3. History and prevalence of skin infections among household members at baseline, and resolution of infections/new lesions at 2 and 6 week follow up of indigenous and nonindigenous participants

	Indigenous participants N=17		Nonindigenous participants N=43		*p* value*
	n/N	(%)	n/N	(%)	
Baseline characteristics					
Previous skin infections	10/17	(59)	14/43	(33)	*p*=0.04
Other household members with current skin infections	7/17	(41)	7/43	(16)	*p*=0.03
2 week follow up					
Resolution of skin infection	9/17	(53)	34/43	(79)	*p*=0.05
New lesions developed	3/17	(18)	3/43	(7)	*p*=0.2
6 week follow up					
Resolution of skin infections	13/17	(76)	38/43	(88)	*p*=0.3
New lesions developed	5/17	(29)	1/43	(2)	*p*=0.002

* *p* value derived by comparing the indigenous and nonindigenous participants using Fisher's exact test

Table 4. Proportion of bacterial skin lesions healed at 2 and 6 week follow up

	Impetigo (n=22)	Boils (n=30)	Total (n=60)*
2 weeks			
Resolution	77% (95% CI: 59–96)	67% (95% CI: 49–84)	70% (95% CI: 58–82)
New lesions	9% (95% CI: 0–22)	7% (95% CI: 0–16)	8% (95% CI: 1–16)
6 weeks			
Resolution	91% (95% CI: 78–100)	77% (95% CI: 62–93)	85% (95% CI: 76–94)
New lesions	0%	10% (95% CI: 0–21)	8% (95% CI: 1–16)

* Eight lesions were classified by recruiting GPs as furunculosis, paronychia or other skin infections meeting inclusion criteria according to the GPs' clinical judgment

resistant *S. aureus* (MRSA) in a southeast Queensland Aboriginal community may also play a role.[8] Indigenous participants in this study were more likely to have had a skin infection in the past and have another household member with an infection. Although there was no difference in the median number of household members of indigenous and nonindigenous participants, the median number of household members for study participants was higher than the Brisbane median (four vs. two),[9] suggesting that overcrowding may contribute to skin infections.

The GPs in our study used oral antibiotics, particularly cephalexin, in the majority of skin infections. This is at odds with antibiotic guidelines recommending di/flucloxacillin first line and only first generation cephalosporins if the patient has penicillin hypersensitivity.[10] However, this is in line with the Pharmaceutical Benefits Scheme (PBS) which restricts di/flucloxacillin for use in serious staphylococcal infections such as endocarditis and sepsis. The reduced toxicity and adequate efficacy of first generation cephalosporins in mild staphylococcal skin infections makes them a reasonable choice for GPs.[11] Additionally, cephalexin may be used under the PBS for any staphylococcal infection without restriction. Antibiotic guidelines also recommend incision and drainage for boils, reserving additional oral antibiotics for large lesions, where there is spreading cellulitis and/or systemic symptoms.[10] The low rates of incision and drainage for boils along with high rates of antibiotic prescribing seen in our study are surprising. While topical therapy for impetigo has been studied,[7] other common interventions such as antisepsis and covering lesions lack an evidence base. Isolated pieces of the research puzzle exist to support hand washing,[12] hygiene measures,[12] individual towels,[13] and nasal bactroban[14] to reduce the high rates of skin infection recurrence which were a feature of our study.

Conclusion

General practitioners faced with a bacterial skin infection generally prescribe oral antibiotics though not always in accordance with antibiotic guidelines. General practitioners need to be aware of high nonhealing and recurrence rates. Appropriate safety netting and follow up are particularly important for indigenous people. Identification and treatment of family members may reduce recurrence. Further research is required to clarify the relative importance of bacterial factors, overcrowding and household infection in the development of new skin lesions. Interventions to prevent recurrence such as nasal mupirocin have not been studied in the community.

Conflict of interest: none declared.

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References

1. Miller LG, Diep BA. Clinical practice: colonization, fomites, and virulence: rethinking the pathogenesis of community-associated methicillin-resistant Staphylococcus aureus infection. Clin Infect Dis 2008;46:752–60.
2. Fleming DM, Elliot AJ, Kendall H. Skin infections and antibiotic prescribing: a comparison of surveillance and prescribing data. Br J Gen Pract 2007;57:569–73.
3. Thomas DP, Heller RF, Hunt JM. Clinical consultations in an aboriginal community-controlled health service: A comparison with general practice. Aust N Z J Public Health 1998;22:86–91.
4. Currie BJ, Carapetis JR. Skin infections and infestations in Aboriginal communities in northern Australia. Australas J Dermatol 2000;41:139–43.
5. Rortveit S, Rortveit G. Impetigo in epidemic and nonepidemic phases: an incidence study over 4(1/2) years in a general population. Br J Dermatol 2007;157:100–5.
6. Koning S, Mohammedamin RS, van der Wouden JC, van Suijlekom-Smit LW, Schellevis FG, Thomas S. Impetigo: incidence and treatment in Dutch general practice in 1987 and 2001 – results from two national surveys. Br J Dermatol 2006;154:239–43.
7. Koning S, Verhagen AP, van Suijlekom-Smit LW, Morris A, Butler CC, van der Wouden JC. Interventions for impetigo. Cochrane Database Syst Rev 2004(2):CD003261.
8. Vlack S, Cox L, Peleg AY, Canuto C, Stewart C, Conlon A, et al. Carriage of methicillin-resistant Staphylococcus aureus in a Queensland Indigenous community. Med J Aust 2006;184:556–9.
9. Australian Bureau of Statistics. Household composition by number of persons usually resident, Brisbane, urban locality. Census, Cat. no. 2068.0. Canberra: Commonwealth of Australia, 2006.
10. Antibiotic Expert Group. Therapeutic guidelines: Antibiotic. Version 13. Melbourne: Therapeutic Guidelines Limited, 2006.
11. Rayner C, Munckhof WJ. Antibiotics currently used in the treatment of infections caused by Staphylococcus aureus. Intern Med J 2005;35:S3–16.
12. Luby SP, Agboatwalla M, Feikin DR, et al. Effect of handwashing on child health: a randomised controlled trial. Lancet 2005;366:225–33.
13. Nguyen DM, Mascola L, Brancoft E. Recurring methicillin-resistant Staphylococcus aureus infections in a football team. Emerg Infect Dis 2005;11:526–32.
14. Laupland KB, Conly JM. Treatment of Staphylococcusaureus colonization and prophylaxis for infection with topical intranasal mupirocin: An evidence-based review. Clin Infect Dis 2003;37:933–8.

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