The normalisation of scabies and impetigo: A cross-sectional comparative study of hospitalised children in northern Australia assessing clinical recognition and treatment of skin disease

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PRESENTATIONS, PUBLICATIONS AND PRIZES

- Australian Society for Infectious Diseases ASM (Launceston, Tas) – April 2016 (Poster)
- Telethon Early Mid-Career Researcher (EMCR) Poster Morning Tea (Perth, WA) - May 2016 (Poster – best poster)
- International Congress on Tropical Medicine and Malaria (Brisbane, QLD) - Sept 2016 (Oral presentation – selected from abstract)
- Wesfarmers Centre for Vaccine and Infectious Diseases Research: Inspired by Infectious Diseases Breakfast Presentation (Perth, WA) – Oct 2016
- Princess Margaret Hospital (PMH) Research Symposium Finalist (Perth, WA) – Nov 2016
- PMH Department of General Paediatrics Meeting (Perth, WA) – Feb 2017
- 5th Rural Dermatology Meeting (Broome, WA) – August 2017 (abstract submitted)
- Broome Hospital Journal Club – Aleisha Anderson (Broome, WA) – August 2016
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# AUTHORSHIP DECLARATION: CO-AUTHORED PUBLICATIONS

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ABSTRACT

Background:

Complications of scabies and impetigo such as glomerulonephritis and invasive bacterial infection in Australian Aboriginal children remain significant problems despite the availability of effective treatment. We hypothesised that one factor contributing to this high burden is that skin disease is under-recognised and hence under-treated, in settings where prevalence is high.

Methods:

We conducted a literature review to summarise the epidemiology of and current diagnostic and treatment strategies for scabies and impetigo. We subsequently conducted a prospective, cross-sectional study to assess the burden of scabies, impetigo, tinea and pediculosis in children admitted to two regional Australian hospitals from October 2015 to January 2016. A retrospective chart review of patients admitted in November 2014 (mid-point of the prospective data collection in the preceding year) was performed. Prevalence of documented skin disease was compared in the prospective and retrospective population to assess clinician recognition and treatment of skin infections.

Results:

One hundred and fifty-eight patients with median age 3.6 years, 74% Aboriginal, were prospectively recruited. 77 patient records were retrospectively reviewed. Scabies (8.2% vs 0.0%, OR N/A, p=0.006) and impetigo (49.4% vs 19.5%, OR 4.0 (95% confidence interval [2.1–7.7) were more prevalent in the prospective analysis. Skin examination was only documented in 45.5% of cases in the retrospective review. Patients in the prospective
analysis were more likely to be prescribed specific treatment for skin disease compared with those in the retrospective review (31.6% vs 5.2%, OR 8.5 (95% CI 2.9-24.4).

**Conclusions:**

Scabies and impetigo infections are under-recognised and hence under-treated by clinicians. Improving the recognition and treatment of skin infections by clinicians is a priority to reduce the high burden of skin infection and subsequent sequelae in paediatric populations where skin disease is endemic.
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Abbreviations: APSGN: Acute post streptococcal glomerulonephritis, ARF: acute rheumatic fever; ATSI: Aboriginal and Torres Strait Islander, GAS: Group A streptococcus; MSSA: methicillin-susceptible Staphylococcus aureus, MRSA: methicillin-resistant Staphylococcus aureus, SSTI: skin and soft tissue infection;
Impetigo and scabies are common infections with high prevalence in developing countries and amongst disadvantaged populations in developed nations (1, 2). Although often considered trivial or minor infections, both scabies and impetigo can lead to serious complications and the global burden of disease is considerable (3, 4). Specific to the Australian setting, the high incidence of invasive bacterial infection due to *Staphylococcus aureus* and *Streptococcus pyogenes*, and the prevalence of both chronic renal disease and rheumatic heart disease amongst our Aboriginal population speak to the significant local burden of complications of skin infection (5-12).

There are a number of effective treatment strategies for both scabies and impetigo, yet the burden of complications persists. In recent years, there have been a small number of comparative clinical trials demonstrating the efficacy of novel strategies for the treatment of impetigo and scabies respectively (13, 14). Moreover, the translation of these findings and those from previous trials relies in part on the accurate and timely diagnosis by medical staff in the clinical setting. Indeed, there are some observational data to suggest that clinicians can fail to diagnose impetigo and scabies (15-17).

Clinician recognition of skin infection has not been assessed in paediatric populations or in the Australian setting previously.

The first paper of this thesis seeks to summarise the current disease burden, diagnostic strategies and treatment options for scabies and impetigo. The second paper outlines a novel study designed to test the hypothesis that clinician under-recognition and ‘normalisation’ of scabies and impetigo contribute to perpetuating the burden of complications in endemic settings.
LITERATURE REVIEW

Impetigo and scabies – Disease burden and modern treatment strategies

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Introduction

Both scabies and impetigo are common infections of the skin with a large global burden (1, 2). In the industrialised world, significant complications from scabies and impetigo are rare whilst in resource-poor settings and certain marginalised communities, their collective impact is much greater. There are several effective options for the treatment of both scabies and impetigo. Despite this, challenges remain in addressing the burden of disease on a community level in regions where infection is endemic. The under-recognition of skin diseases in the health care setting may contribute to this. It is likely that health professionals normalise skin disease in endemic settings, and as such fail to recommend treatment unless specifically requested.

Impetigo

Background

Impetigo is a common superficial skin infection which predominantly affects young children (18, 19). It is estimated that more than 162 million children are suffering from impetigo at any one time (1). The burden of disease is highest in low-income countries and within marginalised populations in developed nations (1). Infection is caused by invasion of the epidermis by bacteria colonising the skin following minor trauma. Autoinoculation is common and the infection is highly transmissible. Hot and humid climatic conditions, poor access to water and possibly overcrowding are factors which play a role in frequent impetigo transmission in endemic areas (19).

There is limited data of the prevalence of skin disease in the paediatric population in rural and remote Western Australia. A study of the effect of swimming pools on the skin health of
children in 2 remote aboriginal communities in the Pilbara estimated the prevalence of impetigo at 62-70% (20). Studies from primary health care centres in the Northern Territory and Far North Queensland give a similar picture of a high burden of disease (21-23). Estimates of the prevalence of impetigo from colleagues working in the Kimberley region range from 20-40%.

The bacterial aetiology of impetigo varies according to region and continues to change over time. In tropical climates *Streptococcus pyogenes* (Group A Streptococcus or GAS) remains the major pathogen (18, 19) and co-infection with *Staphylococcus aureus* is common (24). In temperate climates *S. aureus* has largely replaced *S. pyogenes* as the predominant pathogen in impetigo (25) and community acquired methicillin resistant *S. aureus* (CA-MRSA) is of increasing importance worldwide (25-27).

**Clinical Manifestations, Complications and Diagnosis**

Impetigo can present as bullous lesions or non-bullous, papular lesions that go on to form a crust. Bullous impetigo is caused by *S. aureus* whilst non-bullous lesions are associated with both *S. pyogenes* and *S. aureus* as described above. Ecthyma is a deep form of impetigo in which ulceration extends into the dermis. In the developed world impetigo is a common reason for presentations to primary health care providers but it is generally a self-limiting condition in this setting (28). In resource-limited settings severe disease and complications of impetigo remain problematic (14, 18, 19)

Invasive infections such as erysipelas (involving the dermis and lymphatics), cellulitis (involving subcutaneous tissue), osteomyelitis, septic arthritis and bacteraemia can all complicate impetigo. *S. pyogenes* bacteraemia and streptococcal toxic shock syndrome are commonly preceded by skin and soft tissue infection (6). *S. aureus* bacteraemia carries a high
mortality and skin infection is an important risk factor in settings where impetigo is common (5, 27).

Where *S. pyogenes* is the predominant pathogen, impetigo can also lead to significant immune-mediated complications. In endemic settings most cases of acute poststreptococcal glomerulonephritis (APSGN) are preceded by impetigo (7, 10). Individuals with a history of APSGN in childhood are at increased risk of developing ongoing albuminuria and chronic kidney disease in later life (8, 9). There is also a plausible link between *S. pyogenes* skin infection and acute rheumatic fever (11). This hypothesis is supported by the presence of endemic rates of rheumatic fever and rheumatic heart disease in aboriginal populations in Australia wherein impetigo is pervasive and *S. pyogenes* throat infection is uncommon (12).

The diagnosis of impetigo is generally made clinically. The use of clinical algorithms may aid in the identification and treatment of impetigo in resource-limited settings. For example, the WHO Integrated Management of Childhood Illness (IMCI) skin algorithm has been assessed in Fiji and demonstrated improvement in the clinical recognition of impetigo (17). Elsewhere, flipcharts using high quality photographs and clinical descriptions are used to train health care workers in diagnosing impetigo (29). Gram stain and culture of skin swabs to confirm the aetiological agent are often recommended (30) but adequate laboratory resources are not always available in resource-limited settings. Nonetheless, in the current milieu of increasing antimicrobial resistance (25), regional data on causative bacteriological agents and their antibiotic sensitivity profiles remains vital (19).

There is limited data assessing clinical recognition of impetigo by health professionals.

Although the persistence of high-rates of impetigo in Northern Australia and other endemic
settings is clearly due to a number of factors, it is likely that the recognition and treatment of skin sores in the health care setting is an area where improvements could be made. As will be discussed later with regards to scabies diagnosis, there is evidence to suggest that skin infections are neglected by both patients and health professionals in communities where they are common(15).

**Treatment**

When determining impetigo treatment, there are several important factors including the extent of disease, community wide prevalence, likely adherence to treatment and known antimicrobial resistance. Most of the trials for impetigo treatment relate to limited or uncomplicated impetigo defined as fewer than 5 lesions. Where, impetigo is extensive (greater than 5 lesions) or community prevalence is high, refer to the treatment section on extensive impetigo.

**Limited OR Uncomplicated impetigo**

Topical antibiotics are the most effective treatment for limited impetigo(31). In this systematic review which included 68 randomised control trials representing 5578 participants(31), mupirocin, fusidic acid and retapamulin were all shown to be superior to placebo and there was no difference demonstrated between the most commonly studied topical agents: mupirocin and fusidic acid. In addition, there was no significant difference found in 7-day cure rates between topical and oral antibiotics (excluding erythromycin which is inferior to topical mupirocin) and topical antibiotic use was associated with fewer adverse events(31). The review also cited a lack of supportive evidence for the use of disinfectant solutions in the treatment of impetigo(31).
There are several factors to consider when selecting a topical antibiotic. Resistance to mupirocin and fusidic acid is increasing in association with increased use of these agents (25, 32). Although retapamulin has demonstrated good *in vitro* activity against methicillin resistant *S. aureus* (MRSA), its efficacy in clinical trials against MRSA infections has been variable (33, 34) and it is not approved for the treatment of MRSA infections. Moreover, *S. aureus* isolates with elevated minimum inhibitory concentrations (MICs) to retapamulin have been described although the clinical significance of this is uncertain (35). There are calls to restrict the use of topical fusidic acid in order to preserve the oral formulation as a useful agent (used in combination with rifampicin) for difficult-to-treat MRSA infections (32).

Topical fusidic acid is not available for use in the USA and this is reflected in the Infectious Diseases Society of America (IDSA) guidelines for skin and soft tissue infection which recommend topical retapamulin or mupirocin for uncomplicated impetigo (30).

**Extensive impetigo**

Determining the optimal treatment of extensive impetigo, particularly in resource-limited settings where the burden of disease is highest, remains a challenge (19). It is generally accepted that the use of systemic antibiotics for extensive disease is practical and appropriate, yet there is limited data comparing therapies for this indication (19) and this is a clear limitation of the systematic review on treatment of impetigo (31). Furthermore the demonstrated frequency of co-infection of *S. pyogenes* with *S. aureus* and the emergence of CA-MRSA present additional challenges in selecting appropriate therapy (24, 25). Individual antibiotic treatment leads to resolution of impetigo lesions which likely reduce transmission. Studies to date have not explored the effect of antibiotics on rarer endpoints such as invasive infection or APSGN due to the large sample size required. Further work is needed to understand the full benefits of treatment of extensive impetigo.
The available systemic treatment options for impetigo have respective limitations. Benzathine penicillin G (BPG) has been widely used however it is poorly tolerated due to its intramuscular (IM) route of administration and its efficacy has been questioned with the emergence of *S. aureus* as a pathogen in impetigo (19). Empiric therapy with *S. aureus* cover is recommended for extensive impetigo however oxacillins and first generation cephalosporins lack activity against MRSA and may not be appropriate in settings where methicillin-resistance is common (30). Amongst oral agents with activity against MRSA, tetracyclines are contraindicated for use in children and liquid formulations of lincosamides are unpalatable for this age group. Co-trimoxazole (TMP-SMX) is an attractive option in that it is cheap, licenced for use in children and is available in a palatable liquid formulation. Although the conventional wisdom is that TMP-SMX lacks activity against *S. pyogenes* there is both *in vitro* (25) and *in vivo* (8, + Miller et al NEJM 2015) data to challenge this perception (36).

A recent large clinical trial demonstrated non-inferiority of oral co-trimoxazole compared to IM BPG in the treatment of impetigo in indigenous children in Northern Australia (14). The majority of participants (72%) had extensive disease and *S. pyogenes* and *S. aureus* were isolated from 90% and 81% of participants respectively. Clearance of *S. pyogenes* (but not *S. aureus*) was associated with clinical resolution of sores highlighting the primary role of *S. pyogenes* in impetigo pathogenesis in this setting (14). The only other study that has clear findings for this context compared oral amoxicillin with oral erythromycin for treatment of impetigo. Treatment success was achieved in 89% of both groups, although microbiology was not available (37). Presumably the high success rate seen in this study was also due to the dominance of *S. pyogenes* in the microbiology of impetigo.

**Community treatment and Prevention**
Community based drug administration in certain scenarios may reduce the burden of disease associated with impetigo particularly in the setting of APSGN outbreaks and in communities where scabies infestation is widespread. A review of observational studies of such outbreaks in Northern Australia concluded that targeted treatment of children with skin sores and household contacts of cases using BPG was warranted. In communities where scabies is endemic targeted or mass community treatment of scabies has also been shown to reduce the prevalence of impetigo.

It is clear that the greatest burden of impetigo and its complications is borne by resource-limited populations and focus on disease prevention in these settings is key. There is ongoing work in the development of a vaccine against GAS which could offer a cost-effective and practical avenue for disease prevention. There are, however, barriers around vaccine safety and efficacy and so far the advent of a GAS vaccine is not imminent. In the interim, advocacy to improve access to health services, sanitation and housing and to reduce overcrowding in areas where impetigo is highly prevalent should be a major focus in disease prevention. There is some evidence that greater access to water in the form of swimming pools or a combination of hand-washing and daily bathing can reduce the burden of impetigo. On a broader scale, as evidenced in the industrialisation of Asian countries such as Singapore, complications such as APSGN can be virtually eliminated in the setting of improved socioeconomic status, housing and health services.

**Scabies**

**Background**
Scabies is an infection of the skin caused by the mite *Sarcoptes scabiei var hominis*. The adult mites burrow into the epidermis and reproduce. In the epidermis, the mites and their excreta produce a delayed hypersensitivity reaction which is responsible for the rash and pruritus associated with scabies infestation. Transmission is predominantly via prolonged skin-to-skin contact and most commonly occurs between members of a household(3). Unsurprisingly scabies infection is associated with overcrowding and socioeconomic disadvantage (3, 19, 45) and children carry the highest burden of disease(2). The prevalence of scabies was found to range from 0.2% to 71.4% in a recent systematic review of population based studies(2). The highest prevalence is seen in tropical regions, such as Central America, the Pacific islands and Northern Australia (2). In developed countries prevalence is generally low but outbreaks amongst populations in institutionalised care are well described (45). As with impetigo, there is limited data on the prevalence of scabies specific to Western Australia but studies involving indigenous populations in other parts of Northern Australia demonstrate a high burden of disease(21, 22).

**Clinical Manifestations, Complications and Diagnosis**

During primary infection, the appearance of symptoms is delayed until 4 weeks following initial contact (3). Patients present with a papular or vesicular eruption which is intensely pruritic, usually worse at night. The mites are most often found in web spaces of the fingers, on the wrists, in the axillae, around the umbilicus and in the groin or the popliteal fossa. Other family members may also have pruritus. The distribution of infestation is different in infants with involvement of the palms, soles and scalp(46).

Scabies infestation is associated with significant complications related to secondary infection with bacteria. Bacterial infection, particularly with *S. pyogenes* and *S. aureus*, is a well-recognised complication of scabies infestation(5, 19, 24, 47). The presence of scabies is
associated with complications of impetigo including invasive bacterial infection and post-
streptococcal glomerulonephritis (5-7). As discussed earlier, in endemic settings the
treatment of scabies at a community level has been shown to reduce the prevalence and
severity of skin sores (39) and haematuria (40).
Crusted Scabies is a severe form of scabies where the host immune system fails to control
the number of mites (48). It is characterised by crusted, hyperkeratotic lesions with mite
numbers reaching millions in some patients (48). Cases classically occur in
immunosuppressed patients and those in institutional care although, in particular
communities, patients with no underlying risk factors are also affected (48). Because of the
high mite burden, contacts of patients with crusted scabies are at high risk of infestation
themselves (49) and this may drive community outbreaks.
Diagnosis of scabies is predominantly based on the clinical findings of intense pruritus and a
typical distribution of papules. Skin scrapings occasionally reveal mites, ova or faeces,
however microscopy is time consuming, of low-yield and may be impractical in resource-
limited settings (3, 50). While dermatoscopy is a potentially useful diagnostic tool, the cost
of equipment and the reliance on appropriate training are limitations (50, 51). As with
impetigo, clinical algorithms designed for use in resource-limited settings have shown
promise in increasing case identification and warrant further evaluation (17). Certainly
comparison between studies examining prevalence and treatment outcomes is hindered by
the lack of consensus criteria for the diagnosis of scabies (2, 46). Further research in
designing simple and accurate diagnostic tests for scabies is ongoing.

There is evidence that scabies is under-recognised by health professionals in both resource-
limited (15) and industrialised (16) settings. In a cross-sectional study of a population
dwelling in a slum in Brazil only 28 of 54 patients with scabies sought specific treatment at the adjacent primary health care centre (15). Although the community prevalence of scabies was estimated at 8.8%, doctors at the health care centre failed to diagnose any cases of scabies amongst the 260 patients who presented for other reasons during the study period (15). These results suggest that scabies may be ‘normalised’ by both patients and health professionals in endemic settings. Hong et al demonstrated that time constraints and ED overcrowding were potential factors contributing to the missed diagnosis of scabies in patients admitted to a tertiary hospital in Taiwan where the diagnosis was missed by the ED physician in 65% (72 of 111) of cases (16).

Treatment

Individual treatment

There are various topical therapies utilised in the treatment of scabies. In a Cochrane review of randomised control trials comparing scabies therapies, permethrin was found to be the most effective topical therapy (superior to lindane and crotamiton) (46). Benzyl benzoate is another effective topical therapy that is preferred in some resource-limited settings due to the relatively high cost of permethrin (3, 52). The application of topical scabies therapies can result in skin reactions and tolerability may be poorer in humid tropical climates (46).

Ivermectin is an oral scabicide which was previously reserved for cases of scabies refractory to topical therapy but is increasingly seen as a useful agent in individual and community based treatment (53). As ivermectin is not ovicidal a second dose is recommended 8 to 15 days following the initial dose to prevent recrudescence (45). The efficacy of oral ivermectin is superior to placebo and topical lindane whilst trials comparing oral ivermectin to topical
benzyl benzoate have demonstrated mixed results (46, 52). In the Cochrane review of scabies therapies, topical permethrin was found to be superior to oral ivermectin although the length of follow up in included trials ranged from 1-2 weeks only (46).

Although ivermectin is an effective and well-tolerated agent in the treatment of scabies there remain some limitations to its use. Resistance is a potential concern particularly in endemic communities (54). Also, there is limited data demonstrating safety and tolerability of ivermectin in infants (55) and it is not yet licensed for the treatment of uncomplicated scabies in many regions.

**Community Treatment and Prevention**

The treatment of the close contacts of patients with scabies is recommended in order to prevent re-infection and further transmission although there is limited data supporting this strategy (53). Topical permethrin is considered first-line therapy (45), however poor compliance amongst contacts has been identified as a barrier to the efficacy of this approach (56). Oral ivermectin is an alternative agent for the treatment of contacts which may prove effective and more acceptable than topical therapies but this has yet to be assessed in comparative trials (3, 45). There is a clear need for further research in this area with a recent Cochrane review failing to identify any well-designed randomised trials assessing prophylactic measures to prevent the transmission of scabies (57).

Mass drug administration (MDA) may be an alternative approach to scabies control in settings where scabies is endemic (3, 53). This strategy has been explored as a control measure using permethrin (13, 58) and ivermectin (13, 40, 59) respectively with promising results. Notably, a recently published randomised trial assessing the effectiveness of scabies MDA in Fiji compared ivermectin MDA and permethrin MDA with standard care (i.e. permethrin treatment of cases and contacts) in three separate island communities (13).
There was a significant and sustained reduction in scabies and impetigo in all three groups with the most marked effect in the ivermectin group followed by the permethrin MDA group. A significant reduction in the community prevalence of scabies has previously been demonstrated following the implementation of an ivermectin MDA program for the treatment of lymphatic filariasis in Tanzania (60). This study highlights the potential for collaborative research in assessing the effects of MDA programmes on a number of neglected tropical diseases including scabies (61).

As with impetigo, the long-term control of scabies in endemic settings is greatly dependent on addressing the social determinants of health within these populations.

**Crusted Scabies Treatment**

It is recommended that patients with crusted scabies be treated with a combination of topical permethrin and oral ivermectin (45, 49). Keratolytic agents should also be applied to skin crusts to increase the efficacy of the topical scabicide (45, 49). As yet there are no randomised control trials comparing treatment regimens for patients with crusted scabies.

With regards to community control, active case identification and treatment of core transmitters with crusted scabies within a population is a potential adjuvant approach in endemic settings (49).

**Conclusions**

The significant impact of scabies and impetigo on the health of people in resource-limited settings has in the past been under-recognised. Promisingly, there is growing interest and advocacy concerning scabies and skin sores as demonstrated by the recent formation of the
International Alliance for the Control of Scabies (53) and the inclusion of scabies on the WHO list of neglected tropical diseases in 2013. There is advocacy for impetigo to be included on this list as well(1).

There are safe and efficacious treatments available for these common skin infections, yet in many areas where disease burden is highest, little has changed with regards to control. Ongoing research exploring risk factors and aetiology, improved methods for diagnosis and approaches to both individual and community based treatment is required. Addressing the environmental and socioeconomic factors which serve to perpetuate the high rates of skin disease in certain communities is of chief importance. In addition to this, particularly in regions where scabies and impetigo are endemic, improved recognition of these infections in the health care setting and the opportunistic implementation of appropriate therapy would contribute significantly to addressing the burden of disease.
SCAB HEAL STUDY

Are scabies and impetigo “normalised”? A cross-sectional comparative study of hospitalised children in northern Australia assessing clinical recognition and treatment of skin disease

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Introduction

Skin infections including scabies, impetigo, tinea and pediculosis are common in children, with high prevalence in developing countries and marginalised populations within developed countries (1, 2, 7, 62). Community based skin infection prevalence studies from Aboriginal populations in northern Australia demonstrate some of the highest prevalence rates in the world (21, 63).

The high burden of skin infections is challenging in the primary health care setting, whilst the serious sequelae of skin infections predominantly affect hospitalised patients. The burden of these sequelae of skin infections is greatest where the prevalence is high (4, 53, 64). Impetigo and secondarily infected scabies lesions may be complicated by invasive bacterial infections including cellulitis, skeletal infection and bacteraemia (6, 27, 65, 66).

Immune complications of impetigo are important in tropical regions where Streptococcus pyogenes (Group A Streptococcus or GAS) is the predominant pathogen (4, 7, 67). In endemic settings most cases of acute post streptococcal glomerulonephritis (APSGN) are preceded by impetigo (10) and scabies infestation has been shown to be associated with renal disease (40). There is also a plausible link between S. pyogenes skin infection and acute rheumatic fever (ARF) and rheumatic heart disease (11).

There are effective and relatively well tolerated treatments for skin infections, yet the burden of disease appears to be increasing or at least stable in endemic settings (14, 46, 68). Translation of these evidence-based treatments depends on the successful recognition and diagnosis of skin infection by clinicians.
We hypothesised that under-recognition due to the ‘normalisation’ of skin disease by clinicians contributes to under-treatment and the perpetuation of skin disease and subsequent sequelae in endemic settings. Normalisation is a term to describe that in contexts of high burden, but not life threatening disease clinicians may not specifically diagnose or treat scabies, impetigo, pediculosis or tinea when a patient presents to a health care provider for a reason other than skin infection. To test this hypothesis, we designed this study to prospectively assess prevalence of skin disease and to assess recognition by comparing this with the documented prevalence in a retrospective case note review.
Methods

Study Design

We performed a prospective, cross-sectional study to ascertain prevalence of skin disease and compared this with a retrospective, cross-sectional study to assess recognition of skin disease by health professionals. In the prospective arm, patients were opportunistically recruited from two regional hospitals during the period from October 2015 to January 2016. Data for the retrospective review were obtained from the medical records of all patients admitted to the two paediatric wards in November 2014 at both centers. The retrospective data collection was limited to a one-month period that was the mid-point in the prospective data collection period for feasibility. This retrospective data capture provided the same season and likely admission profile as the prospective study.

Study Population and Setting

All children and adolescents (aged <16 years) admitted to Broome Hospital (a 36 bed facility with 8 paediatric inpatient beds) and Hedland Health Campus (a 55 bed facility with 8 paediatric inpatient beds) during the study period were eligible for participation in the prospective study. These two hospitals provide the regional paediatric services for the Kimberley and Pilbara regions respectively, covering a total catchment of greater than 900,000 km² in the north of the state of Western Australia. In combination, these units admit around 1500 paediatric patients annually (69) servicing a total paediatric population of over 20,000 (70). The study was conducted during the tropical “wet season” when temperatures are on average 33-36°C respectively and rainfall and humidity are high (70). The population of the Kimberley region is 37,000 of whom 40% are Aboriginal (70). The population of the Pilbara is 62,000 of whom 12% are Aboriginal (70).
Patients were recruited by the site coordinator (DY, AA) at the two sites. An attempt to approach all admitted patients was made by the respective site coordinators and individuals were approached to participate regardless of the reason for admission, comorbidities, ethnicity, language spoken, address or gender. Individuals were excluded if the individual or the parent / carer did not assent or consent to participation or if there was no parent / carer available to provide consent.

Data Collection and Management

All participants in the prospective arm of the project underwent assessment including:

a) directed history including age, ethnicity, locality of residence, number of household members, primary reason for admission, past history of skin disease, treatment and complications

b) a full examination of the skin looking specifically for scabies (including secondarily infected lesions), impetigo (flat/dry, crusted or purulent lesions), tinea corporis, tinea capitis and pediculosis.

c) any treatment prescribed for skin disease was recorded and classified as either primarily for skin disease or for another indication but also covering skin disease (e.g. osteomyelitis, septic arthritis as the primary condition under treatment).

All purulent or crusted skin lesions were swabbed and sent for microscopy, culture and antibiotic susceptibility testing according to standardized methods. All samples were delivered to the local microbiology laboratory and subsequently sent to a tertiary laboratory (over 2500km away) for processing.
In the retrospective review of medical records age, ethnicity, locality of residence, number of household members, primary reason for admission, history of skin disease (including complications and comorbidities), documentation of skin disease on physical examination and treatment recommendations were recorded. Pathology records were reviewed for each patient and microbiology of skin lesions was recorded where applicable.

All data were initially recorded onto standard case report forms and subsequently entered onto a secure online database (REDCap Software – Version 6.10.12).

**Definitions**

Ethnicity was self-reported or as recorded in the medical record as Aboriginal and/or Torres Strait Islander (ATSI), Pacific Islander / Maori, Caucasian or other. Locality was assessed and classified for each participant as a local town (resident in Broome or Port Hedland), another regional town (within the region but outside of Broome and Port Hedland) or a remote Aboriginal community. By the Australian Standard Geographical Classification (ASGC) for remoteness, Broome, Port Hedland and Karratha are considered remote and the remainder of the Kimberley and Pilbara are considered very remote(71). Remote Aboriginal communities are defined areas inhabited by Aboriginal people with housing and infrastructure that is managed on a community basis(72). Whilst nearly all are connected to essential services disruptions are commonplace with 38%, 85% and 49% of communities reporting disruptions to water supply, electricity and sewage disposal respectively in 2001(72). Access to health services is often limited with 74% of communities 100km or
further from the nearest hospital and only 12% with a local doctor resident in the community (72).

Skin disease was defined as scabies, impetigo, tinea corporis, tinea capitis and/or pediculosis. A standard diagnostic guideline with clinical and photographic definitions of each condition was used as a reference tool in the prospective assessment of skin disease (73). Scabies, a parasitic infection of the skin was diagnosed in the presence of pruritic papules in a typical distribution; classically in the web spaces, hands, feet and other moist areas. Impetigo is a bacterial infection of the superficial skin. Clinical detection ranges from active purulent or crusted lesions to resolving flat, dry lesions. Tinea infections were diagnosed based on well-demarcated areas of scale with a raised edge and itch. Pediculosis was diagnosed if either the live lice or nits attached to strands of hair were visualized. Secondary bacterial infection of parasitic or fungal lesions was diagnosed in the presence of pus or a crust. Cellulitis and abscess were not included in this assessment. Each condition was diagnosed clinically by the site’s study coordinator (a paediatric clinician) and treatment was prescribed according to local guidelines (74).

Statistical Analysis

The primary objective was to compare the prevalence of skin disease in the prospective study with the documented prevalence in the retrospective review. The demographic details of patients and microbiology of impetigo lesions were reported for each group using descriptive statistics. Prevalence of each of the skin diseases (scabies, impetigo, tinea, and pediculosis) in the prospective and retrospective cohort was determined. Odds ratios comparing frequency of each skin disease and frequency of
treatment prescribed in the prospective and retrospective cohorts were calculated using logistic regression. Univariate analysis of associations between skin disease and age, admission reason, overcrowding and ethnicity respectively was performed using logistic regression. Comparison of categorical data was conducted using logistic regression, Pearson’s Chi-square test or Fisher’s exact test (where 0 events occurred in one or more groups). P-values of <0.05 were considered to indicate statistical significance. All statistical analysis was performed using SPSS statistics version 23.0.0.0 (Armonk, NY: IBM Corp.).

Consent and Ethics Approval

Participation in the study was voluntary and verbal and written informed consent was sought from each participant’s parent or appropriate guardian and where appropriate (i.e. in children >7yo) assent was obtained. Ethics approval was granted by the Western Australian Country Health Service Research Ethics Committee (project number 2015:11) and the Western Australian Aboriginal Health Ethics Committee (project number 635). The study protocol was finalised only after consultation with the Kimberley Aboriginal Health Planning Forum Environmental Health and Research subcommittees as well as local Aboriginal Medical Services.
Results

Study Population

One hundred and fifty-eight patients were included in the prospective assessment; 102 from Broome and 56 from Port Hedland. This was 43.8% of those admitted during the period. No patients who were approached to participate refused to consent. Seventy-seven patient records were reviewed in the retrospective arm; 46 from Broome and 31 from Port Hedland.

The demographic characteristics including age, gender, ethnicity and area of residence along with the primary reason for admission were similar between the prospective and retrospective cohorts (Table 1). In the prospectively assessed group median age was 3.6 years (interquartile range [IQR] 0.9-7.4), 74.1% were of Aboriginal ethnicity and 25.3% were from a remote Aboriginal community. The most common reason for admission was respiratory illness (34.2% prospective, 28.6% retrospective). Conditions that may complicate skin disease including APSGN, ARF, skeletal infections and soft-tissue infections accounted for almost one-quarter of admissions (24.1% prospective, 20.8% retrospective).

### Table 1 – Baseline Characteristics – prospective vs retrospective

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Prospective Cases (n=158)</th>
<th>Retrospective Review (n=77)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hospital:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broome n (%)</td>
<td>102 (64.6 %)</td>
<td>46 (59.7 %)</td>
<td>0.473</td>
</tr>
<tr>
<td>Port Hedland n (%)</td>
<td>56 (35.4 %)</td>
<td>31 (40.3 %)</td>
<td></td>
</tr>
<tr>
<td><strong>Age in years:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>median (IQR)</td>
<td>3.6 (0.9, 7.4)</td>
<td>4.1 (1.4, 9.5)</td>
<td>0.746</td>
</tr>
<tr>
<td><strong>Gender:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>86 (54.4 %)</td>
<td>43 (55.8 %)</td>
<td>0.838</td>
</tr>
<tr>
<td>Ethnicity:</td>
<td></td>
<td></td>
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<tr>
<td>-------------------</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
| Aboriginal / Torres Strait Islander (ATSI), n (%) | 117 (74.1%)^ | 50 (64.9%) | 0.148  
| Community of residence: |  
| local town, n (%) | 92 (58.2%) | 52 (67.5%) | 0.374  
| other town, n (%) | 26 (16.5%) | 9 (11.7%) |  
| remote community, n (%) | 40 (25.3%) | 16 (20.8%) |  
| Primary Admission Reason: |  
| APSGN, n (%) | 7 (4.4%) | 4 (5.2%) | 0.741  
| ARF, n (%) | 4 (2.5%) | 2 (2.6%) |  
| bone / joint infection, n (%) | 3 (1.9%) | 1 (1.3%) |  
| SSTI, n (%) | 24 (15.2%) | 9 (11.7%) |  
| Respiratory, n (%) | 54 (34.2%) | 22 (28.6%) |  
| Gastroenteritis, n (%) | 23 (14.6%) | 13 (16.9%) |  
| UTI/CNS, other infection, n (%) | 8 (5.1%) | 2 (2.6%) |  
| Injury / Immersion, n (%) | 9 (5.7%) | 6 (7.8%) |  
| Surgical / ENT / Dental, n (%) | 13 (8.2%) | 8 (10.4%) |  
| FTT, n (%) | 3 (1.9%) | 0 (0.0%) |  
| Other, n (%) | 10 (6.3%) | 10 (13.0%) |  

*Pearson’s Chi-square (unless otherwise specified)  
^compared with overall ATSI population 12% in Pilbara and 40% in Kimberley in 2011 (22)  

APSGN: Acute post streptococcal glomerulonephritis, ARF: acute rheumatic fever; SSTI: skin and soft tissue infection, ENT: ear nose or throat infection, UTI: urinary tract infection, CNS: central nervous system infection, FTT: failure to thrive  

Less than 20% of patients in the prospective analysis reported receiving specific treatment for skin disease in the twelve months prior to admission; 13.9 % of patients had received treatment for scabies, 18.4% for impetigo and 13.9% for pediculosis.  

Prevalence, Recognition and Treatment of Skin Disease
Prevalence of skin disease was high in the prospectively assessed group with 53.2% of patients diagnosed with one or more skin diseases. Scabies was diagnosed in 8.2% (95% CI 3.9–12.6). Impetigo was present in 49.4% (95% confidence interval [CI] 41.5–57.3%) of participants, with crusted or purulent lesions identified in 27.8% (95% CI 20.8–34.9%) tinea was identified in 8.2% (95% CI 3.9–12.6) and pediculosis in 14.6% (95% CI 9.0–20.1).

The recognition of skin disease was four-fold greater in the prospective assessment compared with the retrospective review; odds ratio (OR) 4.0 (95% CI 2.2–7.5) (Table 2). Skin disease was diagnosed in 22.1% of patients in the retrospective review and notably 54.5% did not have any skin examination findings documented anywhere in the case notes. The prevalence of scabies (8.2% vs 0.0%; OR N/A (p=0.006)), impetigo (49.4% vs 19.5%; OR 4.0 (2.1–7.7)) and pediculosis (14.6% vs 1.3%; OR 13.0(1.7–97.8)) respectively were significantly higher in the prospective assessment compared with the retrospective review. Prevalence of tinea was not significantly higher in the prospective assessment (8.2% vs 2.6%; OR 3.4 (0.7–15.3))

Table 2 – Prevalence of Skin Disease – prospective vs retrospective

<table>
<thead>
<tr>
<th>Skin Disease</th>
<th>Prospective Cases (n=156)</th>
<th>Retrospective Review (n=77)</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any skin lesions:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total n (%)</td>
<td>84 (53.2 %)</td>
<td>17 (22.1 %)</td>
<td>4.0 (2.2-7.5)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Scabies:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total n (%)</td>
<td>13 (8.2 %)</td>
<td>0 (0 %)</td>
<td>N/A</td>
<td>0.006**</td>
</tr>
<tr>
<td>Impetigo (total):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total n(%)</td>
<td>78 (49.4 %)</td>
<td>15 (19.5 %)</td>
<td>4.0 (2.1-7.7)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Impetigo (purulent/crusted):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total n (%)</td>
<td>44 (27.8 %)</td>
<td>12 (15.6 %)</td>
<td>2.1 (1.0-4.2)</td>
<td>0.041*</td>
</tr>
</tbody>
</table>
### Tinea Corporis / Capitis:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Prospective Cases (n=156)</th>
<th>Retrospective Review (n=77)</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total n (%)</td>
<td>13 (8.2%)</td>
<td>2 (2.6%)</td>
<td>3.4 (0.7-15.3)</td>
<td>0.117</td>
</tr>
</tbody>
</table>

### Pediculosis:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Prospective Cases (n=156)</th>
<th>Retrospective Review (n=77)</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total n (%)</td>
<td>23 (14.6%)</td>
<td>1 (1.3%)</td>
<td><strong>13.0 (1.7-97.8)</strong></td>
<td><strong>0.013</strong>*</td>
</tr>
</tbody>
</table>

*Fisher’s exact test (2-sided) used where 0 events in retrospective arm

Specific treatments for scabies, impetigo, tinea and/or pediculosis were prescribed eight times more frequently in the prospective assessment (31.6% vs 5.2%; OR 8.5 (95% CI 2.9-24.4)) (Table 3). Antibiotics were the most commonly prescribed treatment and significantly more patients in the prospective analysis received antibiotics for skin disease (27.8% vs 14.3%); OR 2.3 (1.1-4.8). No patients received treatment for scabies or tinea in the retrospective group while all patients diagnosed in the prospective assessment received treatment.

Environmental health measures were implemented in 8.2% of the prospective cases compared with none in the retrospective review (p=0.006). Although skin infection recognition was higher in the prospective arm, the communication of this finding was poor.

In a subsequent review, only 64.6% (31 of 48) of children who received treatment for skin disease in Broome in the prospective study had this documented in the discharge letter.

### Table 3 – Treatment of Skin Disease prospective vs retrospective

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Prospective (Cases n=156)</th>
<th>Retrospective Review (n=77)</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment recommended (specifically for skin)</strong>*: Total n (%)</td>
<td>50 (31.6%)</td>
<td>4 (5.2%)</td>
<td><strong>8.5 (2.9-24.4)</strong></td>
<td><strong>&lt;0.001</strong>*</td>
</tr>
<tr>
<td><strong>Treatment recommended (any covering skin disease)</strong>*: Total n (%)</td>
<td>62 (39.2%)</td>
<td>12 (15.6%)</td>
<td><strong>3.5 (1.8-7.0)</strong></td>
<td><strong>&lt;0.001</strong>*</td>
</tr>
<tr>
<td><strong>Treatment Type:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV antibiotics n (%)</td>
<td>21 (13.3%)</td>
<td>9 (11.7%)</td>
<td>1.2 (0.5-2.7)</td>
<td>0.730</td>
</tr>
<tr>
<td>IM antibiotics n (%)</td>
<td>6 (3.8%)</td>
<td>1 (1.3%)</td>
<td>3.0 (0.4-25.4)</td>
<td>0.313</td>
</tr>
<tr>
<td></td>
<td>Oral antibiotics n (%)</td>
<td>Any antibiotic n (%)</td>
<td>Oral scabicide n (%)</td>
<td>Topical scabicide n (%)</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------------------</td>
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<td>----------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td>24 (15.2 %)</td>
<td>44 (27.8 %)</td>
<td>1 (0.6 %)</td>
<td>14 (8.9 %)</td>
</tr>
<tr>
<td></td>
<td>6 (7.8 %)</td>
<td>11 (14.3 %)</td>
<td>0 (0 %)</td>
<td>0 (0 %)</td>
</tr>
<tr>
<td></td>
<td>2.1 (0.8-5.4)</td>
<td>2.3 (1.1-4.8)</td>
<td>0.8</td>
<td>4.8</td>
</tr>
<tr>
<td>**Environmental Health</td>
<td>recommended n (%)</td>
<td>13 (8.2 %)</td>
<td>0 (0 %)</td>
<td>N/A</td>
</tr>
<tr>
<td>measures**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

# treatment specifically for skin disease (not otherwise indicated)

^treatment for skin disease specifically or for another indication but also treating skin lesion

**environmental health measures – treatment of household contacts and education around cleaning household linen and clothing

* IV = intravenous, IM = intramuscular

Risk Factors and Associations

Household overcrowding, Aboriginal ethnicity, older age (>5yo) and residence in a remote community were all associated with an increased odds of skin disease in the prospectively assessed group (Table 4). Scabies, impetigo and pediculosis were all significantly associated with Aboriginal ethnicity and household overcrowding. Increased age was associated with increased prevalence of impetigo and pediculosis whilst prevalence of scabies and tinea was similar between age groups (Table 5). Children aged >5y were 3 times more likely to have a condition complicating skin disease (APSGN, ARF, bone and joint infection and soft tissue infection) as the primary admission diagnosis compared with those <5y age; OR 3.2 (95%CI 1.5-6.9).
Table 4 – Risk Factors for Skin Disease (Prospective only, univariate logistic analysis)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Any lesions: OR (95 % CI)</th>
<th>Scabies: OR (95 % CI)</th>
<th>Impetigo: OR (95 % CI)</th>
<th>Tinea: OR (95 % CI)</th>
<th>Pediculosis: OR (95 % CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-ATSI</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>ATSI</td>
<td>28.5 (8.3-98.4)</td>
<td>N/A * p=0.022</td>
<td>36.2 (8.3-157.4)</td>
<td>4.6 (0.6-36.3)</td>
<td>N/A ** p=0.001</td>
</tr>
<tr>
<td>Remoteness:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Town</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>Remote community</td>
<td>7.7 (3.0-19.8)</td>
<td>1.4 (0.4-4.6)</td>
<td>9.5 (3.7-24.5)</td>
<td>2.8 (0.9-8.9)</td>
<td>1.7 (0.9-5.5)</td>
</tr>
<tr>
<td>Household:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 or less</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>&gt;5 members</td>
<td>3.9 (1.9-7.9)</td>
<td>4.0 (1.2-14.0)</td>
<td>3.4 (1.7-6.8)</td>
<td>2.2 (0.7-7.0)</td>
<td>4.2 (1.7-10.8)</td>
</tr>
</tbody>
</table>

* no cases of scabies in non-Aboriginal patients (p-value 0.022) (Fisher’s)
** no cases of pediculosis in non-Aboriginal patients (p-value 0.001) (Fisher’s)

Table 5 – Prevalence by Age Group (Prospective)

<table>
<thead>
<tr>
<th>Age (n)</th>
<th>&lt;1mo (6)</th>
<th>1-5mo (18)</th>
<th>6-12mo (18)</th>
<th>1-4yo (52)</th>
<th>5-10yo (43)</th>
<th>&gt;10yo (21)</th>
<th>p-value^</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any skin lesions: prevalence</td>
<td>0 %</td>
<td>33.3 %</td>
<td>33.3 %</td>
<td>55.8 %</td>
<td>62.8 %</td>
<td>76.2 %</td>
<td>0.002*</td>
</tr>
<tr>
<td>Scabies: prevalence</td>
<td>0 %</td>
<td>11.1 %</td>
<td>11.1 %</td>
<td>5.8 %</td>
<td>9.3 %</td>
<td>9.5 %</td>
<td>0.917</td>
</tr>
<tr>
<td>Impetigo (total): prevalence</td>
<td>0 %</td>
<td>27.8 %</td>
<td>33.3 %</td>
<td>48.1 %</td>
<td>62.8 %</td>
<td>71.4 %</td>
<td>0.003*</td>
</tr>
<tr>
<td>Tinea: prevalence</td>
<td>0 %</td>
<td>5.6 %</td>
<td>5.6 %</td>
<td>9.6 %</td>
<td>9.3 %</td>
<td>9.5 %</td>
<td>0.952</td>
</tr>
<tr>
<td>Pediculosis: prevalence</td>
<td>0 %</td>
<td>0 %</td>
<td>5.6 %</td>
<td>9.6 %</td>
<td>32.6 %</td>
<td>14.3 %</td>
<td>0.004*</td>
</tr>
</tbody>
</table>

^ Pearson’s chi-square test
Where the reason for admission was a condition associated with or complicating skin disease the prevalence of impetigo was significantly higher compared with admission for other reasons (Table 6). Despite this difference, skin disease was still common amongst those admitted for reasons not directly associated with or complicating skin infection with 40.5% (95% CI 31.6–49.4) of these patients having any skin disease: scabies in 6.6% (95% CI 2.1–11.1), impetigo in 35.5% (95% CI 26.9–44.2), crusted/purulent impetigo in 13.2% (95% CI 7.1–19.4), tinea capitis / corporis in 5.8% (95% CI 1.6–10.0) and pediculosis in 9.9% (95% CI 4.5–15.3).

### Table 6 – Prevalence by Admission Reason (Prospective)

<table>
<thead>
<tr>
<th>Admission reason</th>
<th>SSTI / BJI / ARF / APSGN (37)</th>
<th>Other (121)</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any skin lesions:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prevalence</td>
<td>35 (94.6 %)</td>
<td>49 (40.5 %)</td>
<td>25.7</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Scabies:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prevalence</td>
<td>5 (13.5 %)</td>
<td>8 (6.6 %)</td>
<td>2.2</td>
<td>0.190</td>
</tr>
<tr>
<td>Impetigo (total):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prevalence</td>
<td>35 (94.6 %)</td>
<td>43 (35.5 %)</td>
<td>31.7</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Tinea:</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>prevalence</td>
<td>6 (16.2 %)</td>
<td>7 (5.8 %)</td>
<td>3.15</td>
<td>0.052</td>
</tr>
<tr>
<td>Pediculosis:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prevalence</td>
<td>11 (29.7 %)</td>
<td>12 (9.9 %)</td>
<td>3.8</td>
<td>0.004*</td>
</tr>
</tbody>
</table>

**Microbiology of Skin Diseases**

Bacterial swabs were collected from 41/44 (93.2%) participants with crusted and purulent impetigo lesions in the prospective assessment. An organism was isolated in 37/41 (91%). *Staphylococcus aureus* (30/37, 81% of swabs) and *Streptococcus pyogenes* (18/41, 44%) were the predominant pathogens and co-infection (15/41, 37%) was common (Figure 1). Of the *S. aureus* isolates 13 (39%) were methicillin resistant (MRSA). All *S. aureus* isolates were...
susceptible to co-trimoxazole (SXT). 90% of methicillin susceptible *S. aureus* (MSSA) and 77% of MRSA isolates were susceptible to clindamycin. All *S. pyogenes* were susceptible to penicillin. Susceptibility of *S. pyogenes* to SXT is not routinely tested in our laboratory.

**Figure 1 – Impetigo Microbiology**

![Pie chart showing the distribution of impetigo microbiology with 24.4% S. pyogenes (GAS), 19.5% MRSA, 12.2% MSSA, 9.8% MRSA & GAS, 7.3% MSSA & GAS, 2.4% other, and 24.4% no growth.]

Total 41 samples from prospectively assessed patients with crusted or purulent impetigo
Discussion

Our findings demonstrate that under-recognition of skin disease is clearly an important problem; consequentially specific treatment for skin disease is not offered by clinicians. Previous studies have confirmed that under-recognition of scabies occurs in industrialised (16) and resource limited settings (15) due to the absence of diagnostic tests. This is the first comparative study to demonstrate the under-recognition by clinicians of impetigo along with scabies and pediculosis in a region of high skin infection prevalence.

The implications of under-recognition of skin infection are manifold. The significant individual complications of scabies, pediculosis and impetigo are well documented(4, 7, 11, 53, 62, 64, 68). Scabies, impetigo and pediculosis are highly transmissible and the assessment and treatment of household members is recommended as important public health control measures to prevent onward transmission and re-infection(45, 75). In failing to treat children and their family members for skin infections during a hospital admission, clinicians may miss the opportunity to prevent serious individual complications, perpetuate the cycle of ongoing transmission within communities and possibly render other patients at risk by failing to implement appropriate infection control measures.

The prevalence of skin disease is high in this region as demonstrated in our prospective assessment with over half of all children having at least one form of skin infection. Limited data exists regarding prevalence of skin disease in the Kimberley and Pilbara region although other studies in regional Western and Northern Australia have found similarly high rates(20, 21, 63). This high prevalence in our study supports our hypothesis that the under-
recognition of skin infection is not a product of lack of familiarity with skin infection but rather that clinicians may ‘normalise’ skin infection because it is pervasive.

*S. aureus* was the most common pathogen in impetigo lesions in our study with *S. pyogenes* implicated in less than half of cases. In previous studies *S. pyogenes* has been demonstrated as the predominant pathogen in impetigo in tropical regions where co-infection with *S. aureus* is also common(67). The yield of *S. pyogenes* culture may have been reduced in our study due to the processing of samples which were sent to a tertiary laboratory over 2500km away for plating. *S. pyogenes* requires rigorous temperature and humidity controls to prevent deterioration(76). Our results also reflect the increasing importance of community acquired MRSA as a pathogen in the Australian setting with almost 50% of *S. aureus* demonstrating methicillin resistance, as has been apparent in recent times(27).

Clearly other broad factors including the social determinants of health and patient access to health services significantly contribute to the persistent high burden of skin disease and complications in this setting. Overcrowding, poor access to water and poverty have been associated with scabies and impetigo(1, 2, 53, 77), and indeed in our prospective analysis those patients from overcrowded households and remote Aboriginal communities had significantly increased odds of skin disease. As evidenced in the industrialisation of tropical countries such as Singapore, improvements in housing along with better access to quality healthcare can significantly impact on the burden of skin disease complications such as post-streptococcal glomerulonephritis(44).
It is reasonable to conceive that skin disease is also under-recognised outside of the hospital setting. This is compounded by the poor communication of diagnosis and treatment of skin infections documented by hospital staff on discharge back to primary care providers. Despite the high prevalence of skin disease in our population, few children had received specific treatment for impetigo in the preceding twelve months. This speaks to the likely 'normalisation' of skin sores amongst patients and families as well as under-treatment of skin disease in primary health care and community clinics. Strategies to improve recognition of and awareness of the complications of skin disease and the importance of treatment should consider primary health care workers, community workers, teachers, environmental health providers as well as children and their families.

This study has several limitations. Firstly, we were not able to recruit all of the eligible patients during the study period due to the availability of study staff and clinical commitments at other sites. Although recruitment was opportunistic, all children admitted to the ward were approached to participate when the study site doctor was present in order to achieve a representative sample. Secondly, in the prospective assessment, the diagnosis of skin disease was made clinically. In order to limit possible bias due to the reliance on clinical judgement, a diagnostic guide with clear clinical definitions was used as a reference tool in all cases. Finally, by virtue of the study design the assessment of clinician recognition of skin disease was performed retrospectively. Although it is plausible that clinicians did in fact recognise skin disease but did not document this, specific treatment for skin disease was prescribed far less frequently in the retrospective analysis supporting the finding of clinician under-recognition. Notwithstanding the limitations of this study the findings have significant implications for policy and future research.
As the diagnosis of skin infections in endemic settings remains predominantly clinical, training of health care providers is vital in improving recognition. Specific training of health workers has been shown to improve recognition and treatment of skin disease in resource-poor settings (78). The use of integrated algorithms for the management of skin disease in health clinics has also demonstrated promise as a strategy to improve diagnosis of skin disease (17, 79). Future policy in regions with high prevalence of skin infection should direct the training of clinicians in the recognition and treatment of skin disease as well as the implementation of local diagnostic and therapeutic guidelines. The use of mass drug administration to target scabies has shown promise in populations with endemic disease; this strategy may allow circumvention of some of the challenges around clinical under-recognition and normalisation of skin disease in selected settings (13).

Other factors outside of lack of skills and training likely contribute to the under-recognition of skin disease and warrant further investigation. Identifying barriers to clinician diagnosis and treatment of skin disease and exploring reasons for the ‘normalisation’ of skin disease through well-designed qualitative research is vital. Measuring potential under-recognition of skin disease at a patient and community level and exploring factors that contribute should be a focus of future studies. Moreover, ongoing efforts to address the social determinants which lead to the disproportionate load borne by people of Aboriginal ethnicity, particularly those living in remote communities, remain of great importance.
Conclusion

Skin infections are under-recognised by clinicians and this leads to suboptimal treatment and likely contributes to the significant ongoing burden of sequelae. There are many factors which contribute to the challenge of addressing the problem of skin disease and improving clinician recognition and treatment of skin disease is a priority.
GENERAL DISCUSSION

Scabies and impetigo remain highly prevalent in paediatric populations in the developing world as well as in Aboriginal populations in northern Australia. The complications of these skin infections contribute to a significant overall burden of disease. Despite the availability of tolerable and efficacious individual therapies, recognition of these conditions remains reliant predominantly on clinical diagnosis. Hence, the failure of clinicians to diagnose and subsequently prescribe appropriate therapy persists as a barrier to preventing complications in individual patients and onward transmission in the community setting. The under-recognition of scabies and impetigo by clinicians in an endemic setting, as demonstrated by this body of research, suggests that skin infections are normalised where they are common, that is to say in regions where appropriate treatment is most important.

The logical focus of research leading on from this data should include the identification of barriers to clinician recognition and treatment, the exploration of interventions to improve clinician diagnosis and the further evaluation of alternative strategies to individual case management such as mass-drug administration. Further qualitative evaluation of reasons for under-recognition of scabies and impetigo amongst hospital clinicians in northern Australia could marry with similar studies at regional and remote health centres to inform strategies to improve diagnosis and education of health workers in general. Assessing specific strategies to improve clinician recognition and treatment of skin infections such as educational resources, clinical algorithms and / or standing orders and standardized protocols in regional clinics will help inform policy on the best approach to optimising diagnosis and treatment. With the recent evidence of the efficacy of mass drug administration for the treatment of scabies, further assessment is warranted including exploring the applicability of this strategy in the Australian setting. It is feasible that impetigo could also be targeted by mass drug administration in communities where prevalence is very high although in any such trial monitoring of adverse events and the emergence of drug-resistance would be essential.
Significant challenges persist for policy makers in addressing the burden of scabies and impetigo in endemic settings. Clearly, efforts to educate clinicians at all levels of health care are vital to improve recognition and treatment of skin infection. Furthermore, focus to improve public and environmental health with access to basic amenities such as clean water and appropriate housing should have significant impacts on skin health. In addition, where access to health services or the number of trained health workers may be limited, particularly in areas where scabies is highly prevalent, mass drug administration should be considered as an option. Elsewhere, access to suitable health care facilities and community education and engagement remain vital in minimising the impact of skin disease on the health of communities.

Overall, there has been much recent progress in addressing scabies and impetigo with increasing recognition of the breadth of the problem, yet many challenges remain. Importantly, as diagnosis of these conditions remain largely dependent on clinician recognition, as demonstrated in this data, the under-recognition of skin disease by clinicians leads to under-treatment of skin infections in hospitalized children. There is potentially much to be gained by improving clinical recognition of scabies and impetigo in regions with high burden of disease such as Northern Australia and this should be a priority for researchers and policy-makers.
REFERENCES


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51. FitzGerald D, Grainger RJ, Reid A. Interventions for preventing the spread of infestation in close contacts of people with scabies. The Cochrane database of systematic reviews. 2014;2:Cd009943.


69. WACHS. Western Australian Country Health Service - Paediatric Activity Data 2014.


73. East Arnhem Regional Healthy Skin Project - Recognising and Treating Skin Conditions. Menzies School of Health Research.


Study Protocol – SCAB Heal Project

1. PROJECT DETAILS

1.1 Project Details.

<table>
<thead>
<tr>
<th>Protocol/Research Project Title:</th>
<th>Skin Care Assessment in Broome &amp; Port Hedland (SCAB Heal) Project</th>
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<tr>
<td>Amendment (Number and Date):</td>
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<tr>
<td>Project Start Date:</td>
<td>August 2015   Project Finish Date:</td>
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<tr>
<td>Coordinating Principal Investigator Name:</td>
<td>Dr Daniel Yeoh</td>
</tr>
<tr>
<td>Coordinating Principal Investigator Contact Details:</td>
<td>Princess Margaret Hospital Roberts Road, SUBIACO 6008 <a href="mailto:Daniel.yeoh@health.wa.gov.au">Daniel.yeoh@health.wa.gov.au</a> Phone: 0423520575</td>
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</tr>
<tr>
<td>Laboratory Name (if applicable):</td>
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1.2 Project Summary

A prospective cross-sectional study to assess the prevalence of skin sores, scabies and other skin diseases in children presenting to Broome & Port Hedland Hospitals requiring paediatric review / admission. A retrospective medical record review of a cohort of children previously presenting to Broome & Port Hedland hospitals to assess the recognition of skin disease in this population. The documentation of skin disease in the retrospective and prospective cohorts will be compared.

2. RATIONALE / BACKGROUND

In northern Australia the complications of skin disease continue to present a significant challenge. This is despite the availability of tolerable and effective therapies for impetigo, scabies and tinea[1]. It is clear that improvements need to be made in the recognition and treatment of these conditions by health professionals[1]. It is likely that health professionals normalise skin disease, and as such fail to recommend treatment unless specifically requested. This study seeks to understand, by comparing the documentation of skin disease in a retrospective cohort and a prospective cohort, whether this hypothesis is true.

*Streptococcus pyogenes* (GAS) is the key pathogen in most cases of impetigo in Northern Australia although co-infection with *Staphylococcus aureus* is common[2]. Skin infection with GAS is associated with a number of serious sequelae including acute rheumatic fever, rheumatic heart disease, glomerulonephritis and invasive GAS infection[3, 4]. GAS skin disease is strongly associated with infection with scabies and treatment of scabies is thought to decrease the risk of the complications associated with GAS[2, 5].

Over the last 24 months there has been an ongoing outbreak of post-streptococcal glomerulonephritis in the north west of Western Australia. This has put a significant strain on local health services faced with the challenge of managing individual cases and mounting a public health response. In addition to this, acute rheumatic fever and invasive bacterial infections are ongoing problems in this region. This all emphasises the need to continue to address skin disease both at the community level and in the health care setting. Greater recognition of the breadth of this problem along with the significant benefit to patients of better treatment of skin disease must begin with health care professionals.
There is limited data of the prevalence of skin disease in the paediatric population in rural and remote Western Australia. A study of the effect of swimming pools on the skin health of children in 2 remote aboriginal communities in the Pilbara estimated the prevalence of impetigo at 62-70%(6). Studies from primary health care centres in the Northern Territory and Far North Queensland give a similar picture of a high burden of disease (7, 8). Estimates of the prevalence of impetigo from colleagues working in the Kimberley region range from 20-40%. There is no local data assessing clinical recognition of skin sores/skin disease by health professionals.

By describing the prevalence of skin sores in children presenting to Broome & Port Hedland Hospitals and potentially demonstrating the under-recognition of skin sores clinically, we hope to draw further attention to the significant burden of skin disease in these regions. The flow on effect from this will be increased clinical awareness leading to improved treatment of skin sores in hospitals and primary health care clinics locally and also abroad.

### 3. PROJECT OBJECTIVES / HYPOTHESES

#### 3.1 Objectives:

To describe the prevalence of skin diseases in a population of paediatric patients presenting to Broome Hospital and Port Hedland Hospital.

To assess the clinical recognition of skin diseases in a population of paediatric patients by health professionals at Broome Hospital & Port Hedland Hospital.

To trial the SCAB proforma as a possible tool for data collection of skin diseases in paediatric populations.

#### 3.2 Hypotheses:

We hypothesise that the burden of skin disease is high in this population and that there is under-recognition of skin sores in the health care setting. This will be reflected in a higher prevalence of all skin diseases when documented prospectively as compared to the documentation of skin diseases in the retrospective chart review.

### 4. PROJECT DESIGN

*The scientific integrity of the project and the credibility of the project data depend substantially on the project design and methodology.*

#### 4.1 Project Type:

Quantitative Prospective Cross-Sectional Study (to ascertain prevalence of skin disease) and a Retrospective Cross-sectional Study (to assess recognition of skin disease by health professionals in this population).

#### 4.2 Study Population:

Participants will be opportunistically recruited from the population of all children and adolescents (aged <16 years) presenting to Broome hospital & Port Hedland hospital requiring paediatric review over a 3-4 month period in the latter half of 2015 with an aim to recruit 100 patients at each site. A retrospective review of case notes from patients admitted over a 4 week period prior to August 2015 will also be conducted.

#### 4.3 Inclusion Criteria:

All children presenting to Broome hospital & Port Hedland hospital requiring review by the paediatric team during the recruiting period will be eligible to participate.

#### 4.4 Exclusion Criteria:

Individuals will be excluded if the individual and/or the parent/carer do not give assent/consent.

#### 4.5 Participant Withdrawal:

Participants are free to withdraw from the trial voluntarily at any stage. The data collected in these participants prior to withdrawal will be destroyed.

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SCAB Heel Project Version 3 (17/08/15)
4.6 Measures taken to minimise/avoid bias: 
Individuals will be approached to participate regardless of the reason for admission / review, co-
morbidities, ethnicity, language spoken, address or gender. 
The retrospective review of cases will include all patients presenting to Broome Hospital & Port 
Hedland Hospital requiring paediatric review during the designated time period, and will record the 
frequency, severity and treatment of any skin diseases documented. 
This study design is necessary to assess for “normalisation” of skin health, as it is not ethical to 
provide a prospective data collection tool and then expect clinicians to fail to use this.

4.7 Communication with participants and families: 
In cases where cultural and linguistic diversity may be a barrier to effective communication, 
professional interpreters will be utilised. In cases where an on-site interpreter is not available 
professional telephone interpreters will be used (via the National Translator Interpreter Service/On 
Call Interpreters). Family members will not be used to translate to avoid breaches in confidentiality or 
inaccuracies due to misunderstanding of medical terminology.

4.8 Community and agency support: 
Advice and support for this project have been sought from the Kimberley Public Health Unit, 
Kimberley Aboriginal Medical Services Council the Port Hedland Hospital Paediatric Team and the 
Broome Hospital Paediatric Team.

4.9 Data Collection: 
All participants in the prospective arm of the project will undergo an assessment including: 
a) A directed history including past history of skin disease, treatment and complications 
b) A full examination of the skin looking specifically for impetigo (flat/dry, crusted or purulent 
lesions and total number of lesions), scabies (including infected lesions), tinea corporis, tinea 
capitis and tinea unguium, pediculosis and other skin diseases. 
c) A microbiological swab if any purulent or crusted lesions are present 
This information will be recorded on the Case Report Form (see Appendix A). 
The retrospective review of medical records will record the documented history of skin disease 
(including complications and comorbidities) and any skin diseases seen and documented on physical 
examination (see Appendix E). The retrospective review will be performed by the site’s primary 
investigator. Patient medical records of children presenting to Broome Hospital & Port Hedland 
Hospital requiring paediatric review in October 2014 will be re-called from the medical records 
department at respective hospitals in order to collect this data.

Data will be drawn from the prospective assessment to assess prevalence of skin disease in the study 
population. Comparison will be made with the proportion of patients with skin disease documented in 
their case records from the retrospective review.

“Data will be collected from the discharge summary of all patients with skin disease recruited at 
Broome Hospital to assess whether the findings and management plan were communicated to the 
appropriate primary health care provider”

4.10 Data Analysis: 
Descriptive statistics will be used to analyse the data using SPSS. Guidance will be provided by a 
PMH biostatistician as required. The prevalence of each of the skin diseases (impetigo, scabies, 
tinea, and pediculosis) in the prospective and retrospective cohort will be determined and 95% 
confidence intervals calculated, to determine if there is a difference in the documentation of skin 
diseases.

4.11 Project Duration: 
The expected duration of the data collection for this project is 3-4 months.

5. TREATMENT OF PARTICIPANTS

Protocol Version/Date: 
SCAB Heal Project Version 3 (17/08/15) 

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PRINCESS MARGARET HOSPITAL FOUNDATION

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This project does not include the assessment of treatment outcomes in participants. All skin diseases recognised during assessment will be treated according to local guidelines (see link below and appendix D). Participation in the study will have no bearing on treatment decisions. The principal site investigator will follow up any swab results and contact the family of the patient and implement any necessary changes in therapy’ http://resources.kamsc.org.au/downloads/oth_skin.pdf

6. ASSESSMENT OF EFFICACY

Not applicable

7. ASSESSMENT OF SAFETY

All three components of the assessment of participants in this study (history, physical examination and microbiological swabs of purulent/crusted lesions) are a part of the usual assessment of paediatric patients admitted to Broome Hospital. There is no additional risk of harm attributable to participation in this study.

Treatment recommendations are a part of the data collection however treatment decisions will not be affected by participation in the study. Treatment will be implemented according to local protocols in accordance with best clinical practice (Appendix D)

All information documented on research forms will be securely managed to ensure participant confidentiality is maintained throughout (as outlined below).

8. DATA MANAGEMENT AND RECORD KEEPING

Safeguards will be put in place to maintain patient confidentiality and anonymity of participants. All paper-based forms (including consent forms and CRFs) will be stored in a locked filing cabinet in the locked medical officer’s office at Broome & Port Hedland Hospitals. All electronic data documents will be password-protected and saved on the W-drive of the WA Health Information Network System. This system is secured by user names and passwords and protected from external access by firewalls. Only the research team will have access to the paper-based and electronic data.

Any patient medical records re-called for the retrospective arm of the study will be stored securely in a locked filing cabinet in the locked medical officer’s office at the two study sites. Once data has been collected, individual records will be returned to the medical records departments. Only the primary site investigator will have access to these medical records during the data collection.

All the data generated by this project will be retained for a minimum of 7 years following the date of publication, as per the National Health and Medical Research Council guidelines.

9. MONITORING / AUDIT

The project investigators will permit project-related monitoring, audits, and regulatory inspections, providing direct access to source data/documents. This may include, but not limited to, review by external sponsors, Human Research Ethics Committees and institutional governance review bodies.

10. QUALITY CONTROL AND QUALITY ASSURANCE

10.1 This project will be conducted in compliance with the protocol, Good Clinical Practice and the application regulatory requirements.

10.2 All assessments in the prospective and the retrospective arms of this study will be performed by the chief investigator. Cases of scabies, impetigo and tinea will be diagnosed based on clinical case definitions in concordance with available clinical resources (Appendix F).

11. ETHICS

Protocol Version/Date:
SCAB Heal Project Version 3 (17/08/15)
Informed Consent and Assent
Participation in this study will be entirely voluntary and verbal and written informed consent will be sought (Appendix C). As all participants will be under the age of 16, consent will be sought from a parent or appropriate guardian for the child to participate in the study. Where appropriate (ie in children >7yo) assent will also be sought from the child.
Information will be presented in a written format (Appendix B) and also offered verbally by the recruiting clinician. Where there may be linguistic barriers to adequate communication, an interpreter will be employed as outlined above.

12. FINANCING
All costs for this project will be covered through the salary of the chief investigator who is the recipient of a PMH Foundation Fellowship for the year 2015. This full time fellowship combines clinical duties (80% allowance) with allocated time for research activities (20%).

13. PUBLICATION
The results of this study will be disseminated through publication in peer-reviewed journals and through presentation at local and/or international conferences.

14. REFERENCES

15. APPENDICES
15.1 Appendix A – Case Report Form
15.2 Appendix B – Patient/Carer Information Form
15.3 Appendix C – Patient/Carer Consent Form
15.4 Appendix D – KAMSC Management of Skin Infections Protocol
15.5 Appendix E – Retrospective Case Review Form
15.6 Appendix F - East Arnhem Regional Healthy Skin Project - Recognising and Treating Skin Conditions

Protocol Version/Date:
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APPENDIX B – CASE REPORT FORM (PROSPECTIVE)

SCAB Heal (Skin Care Assessment in Broome & Port Hedland) Project - Case Report Form

1) Demographics

Postcode or Community: ___________ DOB: ___________ Gender: M □ □, F □ □
Ethnicity: Aboriginal □, TSI □, Caucasian □, Pacific Islander □, Other □, ___________
Unknown □ [More than one ethnicity is possible]
Number of people living in household: ___________
Number of bedrooms in household: ___________
Does your child attend school? YES □, NO □, UNKNOWN □
What year are they currently in at school? _______

2) Admission Details

Primary reason for admission: ______________________________
Comorbidities (list all):
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4) **Skin Assessment**

Count of total body Impetigo lesions (purulent and/or crusted)__________

Count of total body Impetigo lesions (flat, dry)__________

(Code: A.1.3 = 3 purulent impetigo lesions in 1 body area)

5) **Microbiology (any child with a crusted or purulent skin sore)**

Swab (from the most purulent or crusted lesion):

- **A – impetigo**
  - A.1 – purulent
  - A.2 – crusted
  - A.3 – flat and dry

- **B – scabies**
  - B.1 – not infected
  - B.2 – infected
  - B.3 – crusted

- **C – tinea**
  - C.1 - corporis
  - C.2 - capitis
  - C.3 – unguium

- **D - pediculosis**

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</table>

6) **Management**

Has treatment of skin lesions been recommended? YES ☐, NO ☐, UNKNOWN ☐

If so, list all recommended treatments for skin disease

Were any environmental health interventions recommended? YES ☐, NO ☐, UNKNOWN ☐

Were skin findings and management communicated in discharge letter YES ☐, NO ☐
APPENDIX C – CASE REPORT FORM (RETROSPECTIVE)

SCAB Heal (Skin Care Assessment in Broome & Port Hedland) Project –
Retrospective Case Report Form

1) Demographics

Postcode or Community: _______ DOB: __________ Gender: M[ ] F[ ]
Ethnicity: Aboriginal[ ] TSI[ ] Caucasian[ ] Pacific Islander[ ] Other[ ]
Number of people living in household: _______ Not recorded[ ]
Number of bedrooms in household: _______ Not recorded[ ]
Level of Education - Year at school: __________ Not recorded[ ]

2) Admission Details

Primary reason for admission: ____________________________________________
Comorbidities (list all):
____________________________________________________________________

3) Significant Past Medical History

Any history of:
ARF or Rheumatic Heart Disease…………… YES[ ] NO[ ] UNKNOWN[ ]
Post-streptococcal Glomerulonephritis………… YES[ ] NO[ ] UNKNOWN[ ]
Osteomyelitis/Septic Arthritis……………… YES[ ] NO[ ] UNKNOWN[ ]
Cellulitis (requiring hospital admission)………… YES[ ] NO[ ] UNKNOWN[ ]

4) Skin Assessment

Any documented physical examination findings of:
Impetigo………………………………………………………………………………………………………………………… YES[ ] NO[ ] UNKNOWN[ ]
If yes, were microbiological swabs collected? YES[ ] NO[ ] UNKNOWN[ ]
Scabies……………………………………………………………………………………………………………………………….. YES[ ] NO[ ] UNKNOWN[ ]
Tinea Corporis ……………………………………………………………………………………………………………………….. YES[ ] NO[ ]
Tinea Capitis ………………………………………………………………………………………………………………………….. YES[ ] NO[ ]
Tinea Unguim ………………………………………………………………………………………………………………………………… YES[ ] NO[ ]
Pediculosis …………………………………………………………………………………………………………………………… YES[ ] NO[ ]
Other (e.g. leprosy, eczema, vitiligo)…………… YES[ ] NO[ ]
--specify ____________________________________________________________________________________________

5) Microbiology (if available from skin swabs collected)

Site(s) taken from _____________________________________________________________________________________
Group A streptococcus…………… YES[ ] NO[ ] UNKNOWN[ ]
MSSA………………………………………………………………………………………………………………………………. YES[ ] NO[ ] UNKNOWN[ ]
MRSA………………………………………………………………………………………………………………………………. YES[ ] NO[ ] UNKNOWN[ ]
Other………………………………………………………………………………………………………………………………….. YES[ ] NO[ ] UNKNOWN[ ]

6) Management

Has treatment of skin lesions been recommended? YES[ ] NO[ ] UNKNOWN[ ]
If so, list all recommended treatments for skin disease ____________________________
Were any environmental health interventions recommended? YES[ ] NO[ ] UNKNOWN[ ]
SCAB Heal (Skin Care Assessment in Broome Port Hedland) Project Consent Form

Signing this form means that you agree to take part in the study.
You do not have to join the study and can say No.
If you have any complaints please contact the WACHS HREC mobile 0417 068 594

Patient/Carer Consent

I __________________ consent for __________________ to participate in this project.

(parent/carer’s name) (child’s name)

I __________________ aged___ assent to participate in this project (if older than 7)

(child’s name)

I have received and read a copy of the carer & patient information sheet. I understand all of
the information provided and have had any questions about this information answered.

I consent to:

- answering questions ....................................... YES ☐ NO ☐
- recording skin problems .................................. YES ☐ NO ☐
- skin swabs ..................................................... YES ☐ NO ☐

Parent/Carer Signature: __________________________________________

Child’s Signature: _________________________________________________

Clinician’s Signature ___________________________ Initials:____________

Date: ______________

Interpreter’s Name / Job Number (if required): ______________________
APPENDIX E – PATIENT / CARER INFORMATION SHEET

SCAB Heal (Skin Care Assessment in Broome & Port Hedland) Project - Patient & Parent Information

Background
This project includes children less than 16 years of age seen by the paediatric teams at Broome and Port Hedland Hospitals for any reason to look at how common skin infections are in these children.

We think that skin problems are not recognised and treated as often as they should be. We are doing this study to find out if this is true.

We know that early treatment of skin problems can prevent later complications.

Complications of untreated skin infections include kidney and heart disease.

If we find skin infections that need to be treated, your child will receive treatment while they are at the hospital.

What does participating in the study involve?
The study has three parts:
- We will ask a few questions about your child
- We will look at your child’s skin and record any skin infections
- We will swab any skin sores that have pus or a crust

We will record this information on a research form as well as in the medical record.

Do I have to participate in the study?
Being a part of the study is entirely up to you. Participation is voluntary. You do not have to sign up. Not signing up will not have any effect on your (or your child’s) hospital care.

What are the benefits to participating in the study?
By participating in the study you will be helping us to better understand how common skin problems are in kids. With this information we hope to improve awareness of skin health and improve the management of skin problems in kids in Western Australia and beyond.

What will happen to my information once it is collected?
All of your child’s information will be kept confidential and there will be no information on the form to identify your child. A separate, secure spreadsheet including the unit record number will allow us to follow up swab results later on in the week.

All information collected will be stored securely in a locked cabinet and all electronic databases will be password protected. Data sheets and databases will be stored for a minimum of 7 years in keeping with the National Health and Medical Research Council guidelines.

Once we have enough patients in the study we will compare our results with what has happened in the past to see how we are doing with the recognition of skin problems in children.

Any significant findings will be shared with other health professionals through local meetings/conferences and also through publication in medical journals.
Who do I contact if I have any questions or would like to withdraw from the study?

If you have any questions or would like to withdraw from the study please contact me:

Dr Daniel Yeoh
Email: daniel.yeoh@health.wa.gov.au
Phone: 9340 8222 / 9194 2222

If you have any complaints about this study please contact:

WACHS Research Ethics Committee
Email: Research.ethicscommittee@health.wa.gov.au
Phone: 9223 8500 / 0417 068 594
17 September 2015

Dr Daniel Yeo
Princess Margaret Hospital
Roberts Road
SUBLACO WA 6008

Email: Daniel.yeo@health.wa.gov.au

Dear Dr Yeo

Project Title: Skin Care Assessment in Broome and Port Hedland (SCAB Heal) project

WACHS HREC Reference: 2015:11

The ethics application together with your response for further information and clarification for the project referenced above was reviewed by the WA Country Health Service Research Ethics Committee and I am pleased to have that the project has been approved. The following documents have been approved for use in this project.

<table>
<thead>
<tr>
<th>Document</th>
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<tbody>
<tr>
<td>• SCAB Heal Project (Carer &amp; Patient information)_v4</td>
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<tr>
<td>• SCAB Heal Project (Case Report Form)_v4</td>
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<td>• SCAB Heal Project (Consent)_v4</td>
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<td>• SCAB Heal Project (Retrospective Case Report Form)_v4</td>
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<td>• SCAB Heal Project (Protocol)_v3</td>
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<td>• SAMSC Skin Infection Management Pamphlet</td>
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<td>• Recognising and Treating Skin Conditions – 2009 Edition</td>
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</table>

Approval of this project from the WA Country Health Service Board Research Ethics Committee EC00261 is valid from 3 August 2015 to 30 June 2016 (12 months).

The nominated participating sites in this project are:

• WACHS - Kimberley
• WACHS - Pilbara

[Note: If additional sites are recruited prior to the commencement of, or during the research project, the Coordinating Principal Investigator is required to notify the HREC. Notification of withdrawn sites should also be provided to the HREC in a timely fashion.]

Our Values: Community | Compassion | Quality | Integrity | Justice
A copy of this ethical approval letter must be submitted by all site Principal Investigators to the Research Governance Office or equivalent body or individual at each participating institution in a timely manner to enable the institution to authorise the commencement of the project at its site/s.

This letter constitutes ethical approval only. This project cannot proceed at any site until separate site authorisation has been obtained from the CE, or delegate, of the site under whose auspices the research will be conducted at that site. See Site Specific Assessment Forms at the WACHS website: http://www.wacountry.health.wa.gov.au/index.php?id=researchethicscommittee

The WA Country Health Service Board Research Ethics Committee is registered with the Australian Health Ethics Committee and operates according to the NHMRC National Statement on Ethical Conduct in Human Research and International Conference on Harmonisation – Good Clinical Practice.

Should you have any queries about the HREC’s consideration of your project, please contact the Ethics Executive Officer of the WA Country Health Service Board Research Ethics Committee on research.ethicscommittee@health.wa.gov.au or mobile ph 0417 068 594.


Yours sincerely

Rod Kroon
Acting Chairperson
WA Country Health Service Human Research Ethics Committee
Western Australian Aboriginal Health Ethics Committee

17th September, 2015

Dear Daniel,

HREC Reference number: 635
Title: SCAB Heal (Skin Care Assessment in Broome) Project

Thank you for submitting the above research project which was considered by the WAAHEC at its meeting held on 10th September, 2015. I am pleased to advise that the WAAHEC has granted approval of this research project from date of the meeting held, pending your agreement of the following conditions:

1. Conditions
   - The WAAHEC will be notified, giving reasons, if the project is discontinued before the expected date of completion.
   - The coordinating Investigator will provide a Progress Report every 30th June each year in the specified format. This form can be found on the AHCWA website (www.ahcwa.org).
   - The approval for studies is for three years and the research should be commenced and completed within that period of time. Projects must be resubmitted if an extension of time is required.
   - Publications that arise from this research are to be provided to the WAAHEC for review prior to submission for dissemination.
   - That the Aboriginal and Torres Strait Islander community are formally acknowledged for their contribution to this research project.

2. Amendments

If there is an event requiring amendments to be submitted you should immediately contact ethics@ahcwa.org for advice.

Should you have any queries about the WAAHEC’s consideration of your project please contact ethics@ahcwa.org.

The WAAHEC wishes you every success in your research.

Kind regards

Tara Pierson
Western Australian Aboriginal Health Ethics Committee

For
Vicki O’Donnell
Chair, WAAHEC

This HREC is constituted and operates in accordance with the National Health and Medical Research Council’s (NHMRC) National Statement on Ethical Conduct in Human Research (2007), NHMRC and Universities Australia Australian Code for the Responsible Conduct of Research (2007) and the CPMP/ICH Note for Guidance on Good Clinical Practice. The process this HREC uses to review multi-centre research proposals has been certified by the NHMRC.
Impetigo and scabies — Disease burden and modern treatment strategies

Daniel K. Yeoh, Asha C. Bowen, Jonathan R. Carapetis

Princess Margaret Hospital for Children, Perth, Western Australia, Australia
Telethon Kids Institute, University of Western Australia, Perth, Western Australia, Australia

Available online www.elsevier.com/locate/jinf

KEYWORDS
Scabies;
Skin sores;
Impetigo;
Pyoderma;
Children;
Pediatrics

Summary Impetigo and scabies both present different challenges in resource-limited compared with industrialised settings. Severe complications of these skin infections are common in resource-limited settings, where the burden of disease is highest. The microbiology, risk factors for disease, diagnostic approaches and availability and suitability of therapies also vary according to setting. Taking this into account we aim to summarise recent data on the epidemiology of impetigo and scabies and describe the current evidence around approaches to individual and community based treatment.

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Introduction

Both impetigo and scabies are common infections of the skin with a large global burden.1,2 In the industrialised world, significant complications from impetigo and scabies are rare whilst in resource-poor settings and certain marginalised communities, their collective impact is much greater. There are several effective options for the treatment of both impetigo and scabies. Despite this, challenges remain in addressing the burden of disease on a community level in regions where infection is endemic.

Impetigo

Background

Impetigo is a common superficial skin infection which predominantly affects young children.1,3 It is estimated that more than 162 million children are suffering from impetigo at any one time.1 The burden of disease is highest in low-income countries and within marginalised populations in developed nations.3 Infection is caused by invasion of the epidermis by bacteria colonising the skin following
minor trauma. Autoinoculation is common and the infection is highly transmissible. Hot and humid climatic conditions, poor access to water and possibly overcrowding are factors which play a role in frequent impetigo transmission in endemic areas.1,2

In temperate climates Streptococcus pyogenes (Group A Streptococcus or GAS) remains the major pathogen1,2,13 and coinfection with Staphylococcus aureus is common.10 In temperate climates S. aureus has largely replaced S. pyogenes as the predominant pathogen in impetigo10 and community-acquired meticillin-resistant S. aureus (CA-MRSA) is of increasing importance worldwide.12,18

Clinical manifestations, complications and diagnosis

Impetigo can present as bullous lesions or non-bullous, papular lesions that go on to form a crust. Bullous impetigo is caused by S. aureus whilst non-bullous lesions are associated with both S. pyogenes and S. aureus as described above. Ecthyma is a deep form of impetigo in which ulceration extends into the dermis. In the developed world impetigo is a common reason for presentations to primary healthcare providers but it is generally a self-limiting condition in this setting. In resource-limited settings severe disease and complications of impetigo remain problematic.3,5,10

Invasive infections such as erysipelas (involving the dermis and lymphatics), cellulitis (involving subcutaneous tissue), osteomyelitis, septic arthritis and bacteraemia can all complicate impetigo. S. pyogenes bacteraemia and streptococcal toxic shock syndrome are commonly preceded by skin and soft tissue infection.11,12 S. aureus bacteraemia carries a high mortality and skin infection is an important risk factor in settings where impetigo is common.1,11

Where S. pyogenes is the predominant pathogen, impetigo can also lead to significant immune-mediated complications. In endemic settings most cases of acute post-streptococcal glomerulonephritis (APSGN) are preceded by impetigo.11,14 Individuals with a history of APSGN in childhood are at increased risk of developing ongoing albuminuria and chronic kidney disease in later life.15,16 There is also a plausible link between S. pyogenes skin infection and acute rheumatic fever.17 This hypothesis is supported by the presence of very high rates of rheumatic fever and rheumatic heart disease in Aboriginal populations in Australia wherein impetigo is pervasive and S. pyogenes throat infection is uncommon.18,19

The diagnosis of impetigo is generally made clinically. The use of clinical algorithms may aid in the identification and treatment of impetigo in resource-limited settings. For example, the WHO Integrated Management of Childhood Illness (IMCI) skin algorithm has been assessed in Fiji and demonstrated improvement in the clinical recognition of impetigo.21 Elsewhere, flipcharts using high quality photographs and clinical descriptions are used to train health care workers in diagnosing impetigo.22 Gram stain and culture of skin swabs to confirm the aetiological agent are often recommended22 but adequate laboratory resources are not always available in resource-limited settings and treatment of typical cases without microbiology is empiric.22 Nonetheless, in the current milieu of increasing antimicrobial resistance, regional data on causative bacteriological agents and their antibiotic sensitivity profiles remain vital to best direct empiric therapy and to monitor for changing patterns of resistance.21

Treatment

When determining impetigo treatment, there are several important factors including the extent of disease, community-wide prevalence, likely adherence to treatment and known antimicrobial resistance. Most of the clinical trials for impetigo treatment relate to limited or uncomplicated impetigo, defined as fewer than 5 lesions. Where, impetigo is extensive (greater than 5 lesions) or community prevalence is high, refer to the treatment section on extensive impetigo.

Limited or uncomplicated impetigo

A Cochrane systematic review concluded that topical antibiotics are the most effective treatment for limited impetigo.24 This review included 68 randomised control trials representing 5578 participants,25 finding that mupirocin, fusidic acid and retapamulin were all superior to placebo and there was no difference demonstrated between the most commonly studied topical agents: mupirocin and fusidic acid. In addition, there was no significant difference found in 7-day cure rates between topical and oral antibiotics (excluding erythromycin which is inferior to topical mupirocin) and topical antibiotic use was associated with fewer adverse events.25 The review also cited a lack of supportive evidence for the use of disinfectant solutions in the treatment of impetigo.23

There are several factors to consider when selecting a topical antibiotic. Resistance to mupirocin and fusidic acid among S. aureus isolates is increasing in association with increased use of these agents.26,27 Although mupirocin has demonstrated good In vitro activity against meticillin resistant S. aureus (MRSA), its efficacy in clinical trials against MRSA infections has been variable28,29 and it is not approved for the treatment of MRSA infections. Moreover, S. aureus isolates with elevated minimum inhibitory concentrations (MICs) to retapamulin have been described, although the clinical significance of this is uncertain.29,30 There are calls to restrict the use of topical fusidic acid in order to preserve the oral formulation as a useful agent. In combination with rifampicin, for difficult-to-treat MRSA infections.30 Topical fusidic acid is not available for use in the USA and this is reflected in the Infectious Diseases Society of America (IDSA) guidelines for skin and soft tissue infection which recommend topical retapamulin or mupirocin for uncomplicated impetigo.29

Extensive impetigo

Determining the optimal treatment of extensive impetigo, particularly in resource-limited settings where the burden of disease is highest, remains a challenge.4 It is generally accepted that the use of systemic antibiotics for extensive disease is practical and appropriate, yet there are limited...
Impetigo and scabies

 predefined therapies for this indication and this is a clear limitation of the Cochrane review on treatment of impetigo. Furthermore the demonstrated frequency of co-infection of S. pyogenes with S. aureus and the emergence of CA-MRSA present additional challenges in selecting appropriate therapy. Antibiotic treatment of affected individuals leads to resolution of impetigo lesions which likely reduces transmission. Studies to date have not explored the effect of antibiotics on rarer endpoints such as invasive infection or AOM which is a large sample size required. Further work is needed to understand the full benefits of treatment of extensive impetigo, and the potential risk of inducing more widespread antimicrobial resistance if antibiotics are widely dispersed in high-risk communities.

The available systemic treatment options for impetigo have some limitations. Benzathine penicillin G (BPG) has been widely used however it is poorly accepted in some settings due to its intramuscular (IM) route of administration and its efficacy has been questioned with the emergence of S. aureus as a pathogen in impetigo. Empiric therapy with S. aureus cover is recommended for extensive impetigo however oxacillin and first generation cephalosporins lack activity against MRSA and may not be appropriate in settings where methicillin-resistance is common. Amongst oral agents with activity against MRSA, tetracyclines are contraindicated for use in children and liquid formulations of tetracyclines are unpalatable for children. Co-trimoxazole (TMP-SMX) is an attractive option in that it is cheap, licenced for use in children and is available as a palatable liquid formulation. Although the MIC of S. pyogenes against TMP-SMX is lower against S. pyogenes there are both in vitro and in vivo data to challenge this perception.

A recent large clinical trial demonstrated non-inferiority of oral co-trimoxazole compared to IM BPG in the treatment of impetigo in Indigenous children in Northern Australia. The majority of participants (72%) had extensive disease and S. pyogenes and S. aureus were isolated from 90% and 81% of participants respectively. Clearance of S. pyogenes (not S. aureus) was associated with clinical resolution of sores, highlighting the primary role of S. pyogenes in impetigo pathogens in this setting. The only other study that has clear findings for this context compared oral axicllxin with oral erythromycin for treatment of impetigo. Treatment success was achieved in 89% of both groups, although microbiology was not available. Presumably the high success rate seen in this study was also due to the dominance of S. pyogenes in the microbiology of impetigo.

Community treatment and prevention

Community based drug administration in certain scenarios may reduce the burden of disease associated with impetigo particularly in the setting of APSGN outbreaks and in communities where scabies infestation is widespread. A review of observational studies of such outbreaks in Northern Australia concluded that targeted treatment of children with skin sores and household contacts of cases using BPG was warranted. In communities where scabies is endemic, targeted or mass community treatment of scabies has also been shown to reduce the prevalence of impetigo.

Bacterial decolonisation may play a role in the management of patients with recurrent skin infections, the prevention of post-surgical infections and in hospital based MRSA control, however the utility of decolonisation in the prevention of impetigo on a community level is unclear. Recent randomised controlled trials assessing nasal mupirocin and topical chlorhexidine respectively failed to demonstrate any reduction in S. aureus skin and soft tissue infections. In addition to the practical issues of implementing ongoing topical decolonisation measures on a community level, the widespread community use of mupirocin and/or chlorhexidine could result in the increased circulation of S. aureus strains resistant to these agents and thus limit their effectiveness. Recommendations for the use of chemoprophylaxis to decolonise household contacts of cases of invasive S. pyogenes disease vary and clear evidence of efficacy in preventing invasive disease is lacking. The role of broader community based S. pyogenes decolonisation in the prevention of skin disease has not been assessed.

It is clear that the greatest burden of impetigo and its complications is borne by resource-limited populations, where it is critical to focus on disease prevention. There is ongoing work in the development of a vaccine against GAS which could offer a cost-effective and practical avenue for disease prevention, although a vaccine is not imminent. In the interim, advocacy to improve access to antimicrobials, sanitation and to reduce overcrowding in areas where impetigo is highly prevalent should be a major focus in disease prevention. There is some evidence that greater access to chickens in the household and a combination of hand-washing and daily bathing can reduce the burden of Impetigo. On a broader scale, as evidenced in the industrialisation of Asian countries such as Singapore, complications such as APSGN can be virtually eliminated in the setting of improved socioeconomic status, housing and health services.

Scabies

Background

Scabies is an infection of the skin caused by the mite Sarcoptes scabiei var hominis. The adult mites burrow into the epidermis and reproduce. In the epidermis, the mites and their excreta produce a delayed hypersensitivity reaction which is responsible for the rash and pruritus associated with scabies infestation. Transmission is predominantly via prolonged skin-to-skin contact and most commonly occurs between members of a household.

Unsurprisingly scabies infection is associated with overcrowding and socioeconomic disadvantage and children carry the highest burden of disease. The prevalence of scabies was found to range from 0.2% to 71.4% in a recent systematic review of population based studies. The highest prevalence is seen in tropical regions, such as Central America, the Pacific Islands and Northern Australia. In developed countries prevalence is generally low but outbreaks amongst populations in institutionalised care are well described.
Clinical manifestations, complications and diagnosis

During primary infection, the appearance of symptoms is delayed until 4 weeks following initial contact. Patients present with a popular or vesicular eruption which is intensely pruritic, usually worse at night. The mites are most often found in web spaces of the fingers, on the wrists, in the axillae, around the umbilicus and in the groin or the popliteal fossa. Other family members may also have similar lesions. The duration of infestation is different in infants with involvement of the palms, soles and scalp. Scabies infestation is associated with significant complications related to secondary infection with bacteria. Bacterial infection, particularly with *S. pyogenes* and *S. aureus*, is a well-recognised complication of scabies infestation. The presence of scabies is associated with complications of impetigo including invasive bacterial infection and post-streptococcal glomerulonephritis. As discussed earlier, in endemic settings the treatment of scabies at a community level has been shown to reduce the prevalence and severity of skin sores and haematuria.

Crusted scabies is a severe form of scabies where the host immune system fails to control the number of mites. It is characterised by crusty, hyperkeratotic lesions with mite numbers reaching millions in some patients. Cases classically occur in immunosuppressed patients and those in institutional care although, in particular communities, patients with no underlying risk factors are also affected. Because of the high mite burden, contacts of patients with crusted scabies are at high risk of infestation themselves and this may drive community outbreaks.

Diagnosis of scabies is predominantly based on the clinical findings of intense pruritus and a typical distribution of papules. Skin scrapings occasionally reveal mites, ova or faeces, however microscopy is time consuming, of low-yield and may be impractical in resource-limited settings. While dermatoscopy is a potentially useful diagnostic tool, the cost of equipment and the reliance on appropriate training are limitations. As with impetigo, clinical algorithms designed for use in resource-limited settings have shown promise in increasing case identification and warrant further evaluation. Certainly comparison between studies examining prevalence and treatment outcomes is hindered by the lack of consensus criteria for the diagnosis of scabies. Further research in designing simple and accurate diagnostic tests for scabies is ongoing.

Treatment

Individual treatment

There are various topical therapies utilised in the treatment of scabies. In a Cochrane review of randomised control trials comparing scabies therapies, permethrin was found to be the most effective topical therapy (superior to lindane and crotamiton). Benzyl benzoate is another effective topical therapy that is preferred in some resource-limited settings due to the relatively high cost of permethrin, but is less well tolerated. The application of topical scabies therapies can result in skin reactions and tolerability may be further reduced in humid tropical climates.

Ivermectin is an oral scabicide which was previously reserved for cases of scabies refractory to topical therapy but is increasingly seen as a useful agent for both individual and community based treatment. As ivermectin is not ovicidal a second dose is recommended 8–15 days following the initial dose to prevent recrudescence. The efficacy of oral ivermectin is superior to placebo and topical trials comparing oral ivermectin to topical benzyl benzoate have demonstrated mixed results.

In the Cochrane review of scabies therapies, topical permethrin was found to be superior to oral ivermectin although the length of follow up in included trials ranged from 1 to 2 weeks only. Although ivermectin is an effective and well-tolerated agent in the treatment of scabies there remain some limitations to its use. Resistance is a potential concern particularly in endemic communities. Also, there are limited data demonstrating safety and tolerability of ivermectin in infants and it is not yet licensed for the treatment of uncomplicated scabies in many regions.

Community treatment and prevention

The treatment of the close contacts of patients with scabies is recommended in order to prevent re-infection and further transmission although there is a lack of data supporting this strategy. Topical permethrin is considered first-line therapy, however poor compliance amongst contacts has been identified as a barrier to the efficacy of this approach. Oral ivermectin is an alternative agent for the treatment of contacts which may prove effective and more acceptable than topical therapies but this has yet to be assessed in comparative trials. There is a clear need for further research in this area with a recent Cochrane review failing to identify any well-designed randomised trials assessing prophylactic measures to prevent the transmission of scabies.

Mass drug administration (MDA) may be an alternative approach to scabies control in settings where scabies is endemic. This strategy has been explored as a control measure using permethrin and ivermectin respectively with promising results. Notably, a recently published randomised trial assessing the effectiveness of scabies MDA in Fiji compared ivermectin MDA and permethrin MDA with standard care (i.e., permethrin treatment of cases and contacts) in three separate island communities. There was a significant and sustained reduction in scabies and impetigo in all three groups with the most marked effect in the ivermectin group followed by the permethrin MDA group. A significant reduction in the community prevalence of scabies has previously been demonstrated following the implementation of an ivermectin MDA program for the treatment of lymphatic filariasis in Tanzania. This study highlights the potential for collaborative research in assessing the effects of MDA programs on a number of neglected tropical diseases including scabies.

As with ivermectin, the long-term control of scabies in endemic settings is greatly dependent on addressing the social determinants of health within these populations.
Crusted scabies treatment
It is recommended that patients with crusted scabies be treated with a combination of topical permethrin and oral ivermectin. Keratolytic agents should also be applied to skin crusts to increase the efficacy of the topical scabicide. As yet there are no randomised control trials comparing treatment regimens for patients with crusted scabies. With regards to community control, active case identification and treatment of core transmitters with crusted scabies within a population is a potential adjuvant approach in endemic settings.

Conclusions
The significant impact of scabies and impetigo on the health of people in resource-limited settings has in the past been under-recognised. Promisingly, there is growing interest and advocacy concerning scabies and skin sores as demonstrated by the recent formation of the International Alliance for the Control of Scabies and the inclusion of scabies on the WHO list of neglected tropical diseases in 2013. There is advocacy for impetigo to be included on this list as well.

There are safe and efficacious treatments available for these common skin infections, yet in many stressed areas where disease burden is highest, little has changed with regards to control. Ongoing research exploring risk factors and epidemiology, improved methods for diagnosis and approaches to both individual and community based treatment is required. Arguably, addressing the environmental and socioeconomic factors which serve to perpetuate the high rates of skin disease in certain communities is of chief importance. Whilst in the industrialised world scabies and impetigo are often considered trivial, ongoing efforts to address the major impact of these infections in the developing world remain extremely important.

Conflict of interest
The authors have no conflict of interest to declare.

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