ORIGINAL RESEARCH

Incorporating teledermatology into emergency medicine

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Abstract

Objective: The aim of the present study was to investigate the feasibility of using a store-and-forward Skin Emergency Telemedicine Service (SETS) to provide rapid specialist diagnostic and management advice for dermatological cases in an ED.

Methods: This pilot study was conducted at the Princess Alexandra Hospital between August 2008 and August 2009. Study subjects were consenting patients over 18 years of age who presented with a dermatological condition to the ED. The ED doctor sent the patient’s history, examination findings and the digital images of the skin conditions to a secure email address, which automatically forwarded this to the teledermatologist. The teledermatologist reviewed the cases and sent advice on diagnosis and management to the referring ED doctor via email and/or telephone. Face-to-face follow-up consultations with the patients were conducted within 2 weeks. The diagnostic and management concordance between ED doctors, teledermatologists and reviewing dermatologists were analysed.

Results: A total of 60 patients participated in the present study. SETS provided a rapid response with 56 (93%) of ED consultations receiving a dermatology opinion within 2 h. Face-to-face follow up occurred in 50 patients (83%). Statistical analysis showed significant levels of agreement between tele-diagnosis and ED diagnosis of 71.2% (Kappa 0.42) and tele-diagnosis and final clinical diagnosis of 98% (Kappa: 0.93). The clinical management concordance was 96% in complete agreement and 4% in relative agreement between the teledermatologists and reviewing dermatologists, based on chart review.

Conclusion: The present study has shown that SETS can provide rapid and accurate diagnostic and treatment advice from a specialist for dermatological presentations to the ED.

Key words: dermatology, emergency medicine, skin emergency, teledermatology, telemedicine.

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Introduction

Prevalence data on dermatological presentations to Australian EDs are not well documented. However, it is known that they make up about 25% of all visits to medical practitioners and approximately 4–12% of presentations to EDs in the USA. In Australia, dermatological diseases represent 17% of presentations in general practice. Skin presentations are usually not urgent and are safe to be managed at an outpatient clinic. However, exceptions do occur and patients can present with a skin emergency or with cutaneous signs of a serious, even life-threatening systemic disease. Early diagnosis and treatment is crucial to optimizing outcomes for skin emergencies such as toxic epidermal necrolysis, staphylococcal scalded skin syndrome, exfoliative dermatitis, pustular psoriasis, pemphigus vulgaris, the various autoimmune blistering disorders and vasculitis. Many of these conditions require aggressive inpatient treatment, and must be immediately recognized to the treating physician.

The authors have identified a lack of confidence in dealing with acute presentations to EDs of patients with rashes as a result of a paucity of dermatology teaching in undergraduate courses and the difficulty of learning this subspecialty with limited clinical training. In the authors’ experience, the lack of emergency dermatology on-call cover at most hospitals, public and private, can be a serious problem for EDs with patients potentially suffering as a consequence. Teledermatology has been increasingly utilized for delivery of a wide range of medical specialties in Australia and around the world. Teledermatology is one of the more useful telemedicine applications given the visual nature of skin diseases presentations. Numerous studies have demonstrated adequate accuracy and reliability of teledermic in diagnosing skin disease. It was reported that the diagnostic agreement rate between clinic-based dermatologists and store-and-forward teledermatologists ranged from 57% to 96% when both the diagnosis and differential diagnoses were considered. Clinical management concordance between teledermatology and conventional clinic has demonstrated similar agreement rates. Studies found that diagnostic accuracy rate is significantly higher by dermatologists compared with non-dermatologists across a whole spectrum of skin conditions.

There are 469 dermatologists and 101 trainees servicing 22 million Australians and most are based in private practice in capital cities or major metropolitan areas. In Queensland, there are only five major teaching hospitals with visiting dermatologists. Rural services are mostly provided by visiting dermatologists on a monthly to quarterly basis. Consequently, many patients are required to travel a long distance by road or air to see a dermatologist and often remain on waiting lists for weeks or months. Since the mid-1990s, Australian dermatologists have utilized teledermatology as an adjunct for clinical education and to provide ready access to the underserved communities. These include Tele-Derm National established by the Australian College of Rural and Remote Medicine (ACRRM) in 2004, teledermatology services for urban and rural New South Wales and also in Perth, Western Australia.

There is little published work on teledermatology services specifically dealing with dermatological emergencies. The aim of this Skin Emergency Telemedicine Service (SETS) study was to investigate the feasibility of using teledermatology to provide accurate and rapid management advice for dermatological cases in a hospital ED.

Methods

Study design

This was an observational pilot study of a non-consecutive convenience sample of ED patients presenting with acute and subacute dermatological conditions.

Setting

The Princess Alexandra Hospital (PAH) is one of three tertiary hospitals in Queensland. Its ED is a designated level 6 trauma centre with more than 46,000 annual attendances, approximately 35% of all presentations being admitted. In addition, the ED provides extensive clinical training for the medical house officers. Its Dermatology Department had 10,948 outpatient visits and 640 admissions in 2007/2008. The department provides dermatology specialty care, staff training and also houses non-invasive bio-imaging research. The University of Queensland (UQ) Dermatology Research Centre was established in 2007 as a joint initiative with the Queensland Skin and Cancer Foundation to represent Queensland’s first professorial research unit led by specialist dermatologists. The primary objectives are to initiate, conduct and promote international-standard translational and interdisciplinary research in skin disease.
In August 2008, a teledermatology system was set up using store-and-forward technology linking ED of PAH and a secured UQ server based at the School of Medicine. A dedicated email router delivered the referral information simultaneously to the dermatologists who provided tele-consultations and to the SETS coordinator who also provided around the clock technical support to the service. The SETS directory was installed in the ED desktop computers with SETS referral proforma, instruction and patient information consent form.

**Patient recruitment and study procedure**

Patients were recruited over 1 year between August 2008 and August 2009. Study subjects were consenting patients over 18 years of age presenting with an acute or subacute dermatological condition to the PAH ED where it was felt by medical staff that specialist dermatology advice was warranted. Skin lesions caused by an accident or trauma were excluded. A total of 60 patients were enrolled. Appropriate ethics approval was obtained for the present study.

The ED treating doctor completed a SETS proforma documenting the patient’s history and examination findings. The patient’s skin lesions were photographed with a digital camera. The cameras included a Sony Cyber-shot (Model: DSC-P73), a Canon PowerShot (Model: G9), a Canon Digital IXUS (Model: 85 IS) and a Panasonic Lumix (Model: DMC-TZ3).

Both the completed SETS proforma and the digital images of the rash or skin lesions were sent to a secure SETS email address and automatically forwarded to the teledermatologist. The teledermatologist then reviewed the cases through their PC equipped with high resolution monitors and sent advice on diagnosis, further investigations required and management to be commenced back to the referring ED doctor via email and/or telephone. The ED doctor then executed investigation and management accordingly. Face-to-face (FTF) follow-up consultations with the patients were conducted either on the next ward round with a dermatologist or in the outpatient department (OPD) within 2 weeks. The reviewing dermatologists examined the patients and formulated an independent diagnosis and management plan. The diagnostic agreement and management concordance between teledermatologists and reviewing dermatologists (who might or might not have had access to histology results) were analysed.

Technical training and on-call support was provided to coordinate the tele-consultation process. These included a clinical tutorial session on Dermatological Emergency cases presented by one of the teledermatologists. Brief training sessions were conducted at the ED to provide the emergency doctors with the essential information for the present study.

**Data collection & analysis**

Data were collected on referral request, digital images of the skin conditions, diagnoses and treatment recommendations from the ED doctors, teledermatologists and reviewing dermatologists (FTF consultations). The diagnoses were recorded following standard medical terminology, and coded as ‘complete’ or ‘relative’ or ‘no’ agreement based on text reading. Complete agreement was defined as full concordance between the diagnoses taking into consideration the protean dermatologic nomenclature. The relative agreement was defined if the final diagnosis was in the list of differential diagnoses. Semantic differences in the dermatologic terminology were taken into consideration. Medical records (including diagnostic testing, histopathology results, recommendations of treatment and admission advice) were reviewed to allow analysis of diagnostic and management concordance between the teledermatologists and reviewing dermatologists. The data on response time (in minutes) of teledermatologists were recorded using time record of emails and telephone notes if telephone advice was provided.

Basic statistics on patient characteristics are presented by number (%), mean (SD) and median (inter-quartile range), as appropriate. The diagnostic agreement was presented by simple proportions and assessed by Kappa statistics.

**Results**

There were 60 patients referred from ED to the teledermatologists. The mean age was 47 (SD: 20) years old, and 21 (35%) of them were male. FTF follow up occurred with 50 patients (83%), 20 (33%) of the study patients being admitted to the hospital and 30 patients being reviewed in the dermatology OPD clinic. Ten patients (17%) did not attend to the follow-up clinics.

As assessed by the Australasian Triage Scale, most patients were triaged as Australasian Triage Scale Category 3–5 (98%). The median of the SETS response time was 27 (interquartile range: 17, 39) minutes. SETS provided a rapid response with 56 (94%) of ED consultations receiving a dermatology opinion within 2 h, including 49 cases (82%) within 1 h and 37 (62%) within
30 min (Fig. 1). Among these, 19 (32%) cases were submitted after-hours (18:00–08:00 and weekends). Comparing in-hours and out-of-hours SETS response times found no significant difference \((P = 0.087)\).

Among the 60 study patients, ED doctors made correct diagnoses in 26 cases (43%), made differential diagnoses in 23 cases (38%) and made incorrect diagnoses in 3 cases (5%). ED did not provide diagnoses in eight referrals (13%). Table 1 lists the main dermatological conditions seen in SETS based on the clinical assessments confirmed with the laboratory tests and/or histopathology results. This includes the conditions that ED referral doctors provided initial diagnoses and the conditions that ED referral doctors had difficulty with diagnosis. All referrals to SETS requested diagnostic and management advice from teledermatologists.

The rates of diagnostic agreements and management concordance are presented in Table 2. The level of observed agreement between tele-diagnosis and ED diagnosis was 72%, with significant Kappa statistic of 0.42 (95% CI: 0.31–0.53). The level of agreement between tele-diagnosis and the final clinical diagnosis was much higher at 98% with Kappa statistic of 0.93 (95% CI: 0.90–0.95). The clinical management concordance between the teledermatologists and reviewing dermatologists was complete agreement in 48 cases (96%), and partial agreement in 2 cases (4%).

Relevant clinical tests ordered by the treating doctors in the ED were followed up in the wards and/or the dermatology OPD. These included blood, urine, swab, skin scraping and patch tests. Skin punch biopsies were requested for 23 patients (38%), 10 cases were performed by ED doctors during the initial ED presentation, directed by the SETS on-call teledermatologist. The other 13 punch biopsies were performed by dermatology OPD doctors during the follow-up consultations, or during the admissions on the wards. All specimens were collected adequately and examined by pathologists at the PAH.

Nearly half of the SETS patients (27 cases) were deemed to have acute or severe conditions (Table 1). A

![Figure 1. Skin Emergency Telemedicine Service (SETS) response time.](image)

### Table 1. Main dermatological conditions seen in SETS

<table>
<thead>
<tr>
<th>Dermatological conditions</th>
<th>Number of cases</th>
<th>ED made wrong Dx</th>
<th>ED did not provide Dx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dermatitis/eczema</td>
<td>9</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Urticaria</td>
<td>9</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Allergic reaction/drug eruptions</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psoriasis</td>
<td>6</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Arthropod bite reaction</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Photocontact dermatitis†</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erysipelas/cellulitis†</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scabies</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Impetigo</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Vasculitis†</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darier disease</td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>Tinea</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute varicella/zoster†</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bullous pemphigoid</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Dermatomyositis</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrombocytopenic purpura</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
<td><strong>3 (5%)</strong></td>
<td><strong>8 (13%)</strong></td>
</tr>
</tbody>
</table>

†These conditions are considered potential dermatological emergencies or severe conditions. SETS, Skin Emergency Telemedicine Service.

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total of 20 patients were admitted from the ED to the hospital inpatient wards following the tele-consultations, giving an admission rate of 33%. Ten patients (17%) did not attend the OPD follow-up appointments. Attempts were made to contact these patients by telephone to verify their reasons for non-attendance. Two patients indicated that their conditions had resolved and the remaining eight could not be contacted.

A total of 390 digital images were received in JPEG and Bitmap format from ED referrals, ranging from 1 to 20 images per patient (mean 6.5). Of these, 320 (82%) images were adequate and 70 (18%) were out of focus. Image resolution varied between 640 ¥ 480 pixels and 4000 ¥ 3000 pixels, with 24-bit colour resolution. The teledermatologists were able to make a diagnosis based on the digital images and history provided in every case.

### Discussion

The diagnosis and management of dermatological conditions in the ED has until now, been problematic at times. Lack of experience and ongoing exposure, a relatively junior and transient medical work force has contributed to this. These patients are most commonly subacute in their presentations, and so, do not always receive the highest priority in the ED environment. Many hospitals do not have a dermatological service, and those that do have limited hours where that service is on site. Another very important factor has traditionally been the reliance on non-visual means of communication to a dermatology consultation service. Historically, these factors have combined to cause a long delay to diagnosis and effective definitive treatment for many patients who presented to ED with dermatological complaints.

In a specialty where the conditions and examination findings are predominantly visual in nature, a primarily visual form of communication has obvious attractions. If that communication is simple, and makes use of existing technologies that most people are familiar with, then this could lead to better care of this population group. Teledermatology can be conducted using a variety of technologies with varying level of image quality. The image resolution required for adequate diagnosis is under investigation. A previous study indicated that image resolutions of 1490 ¥ 1000 pixels were not significantly better than 720 ¥ 500 pixels in one study. In our study, the image resolution varied between 640 ¥ 480 pixels and 4000 ¥ 3000 pixels. The teledermatologists considered that these were adequate for diagnoses along with case histories.

The provision of SETS has enabled accurate and rapid diagnostic and treatment advice for emergencies. This trial provided an opportunity to evaluate emergency teledermatology service, which could improve outcome and community access for specialist dermatology care. This clinical study also provided further evidence to support the development of telemedicine services for remote communities.

The approach taken in the present study enabled participants to receive a diagnosis and treatment regime while waiting in the ED rather than having to wait days, weeks or even months for a face-to-face consultation to occur. The study suggests that the telemedicine application can provide a time-efficient solution to deliver specialist dermatology care to rural and remote communities.

This clinical trial was an observational study with no control group as a result of the urgent clinical presentations of the cases and the setting in the ED. However, the results suggest that SETS might provide significant improvements in quality of care for dermatology emergencies. There were a number of cases where important diagnoses were provided rapidly by dermatology specialists. In a number of cases ED staff found the confirmation of their provisional diagnosis as being correct and advice on investigation and management by teledermatology useful. The teledermatologists estimated

<table>
<thead>
<tr>
<th>Table 2. Level of diagnostic and management agreement with teledermatology</th>
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<tbody>
<tr>
<td><strong>Teledermatology</strong></td>
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<tr>
<td>Tele-diagnoses</td>
</tr>
<tr>
<td>Kappa: 0.42 ($P = 0.0001$)</td>
</tr>
<tr>
<td>95% CI: 0.31–0.53</td>
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<tr>
<td>Tele-management</td>
</tr>
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</table>

The ‘complete agreement’ and ‘relative agreement’ on diagnoses were combined together for the estimation of Kappa.
that the time to review and to make assessments of the referrals is about 5 min. This service rapidly facilitates specialist access and significantly improves the clinical management of patients with acute and subacute dermatological conditions.

**Study limitations**

As an observational study it suffers from potential selection bias. Current practice of dealing with dermatology cases in ED has not been studied. Our study probably underestimated the value of teledermatology to medical officers in ED because we only measured the broad diagnostic accuracy and did not measure their confidence in the diagnoses and accuracy of their proposed management. The intended management by ED doctors before the dermatologist advice were not recorded; therefore, adequacy could not be determined.

In the present study, the accuracy of ED diagnoses might have been artificially high as some of the patients already had established diagnoses. The teledermatologists estimated time to review and to make assessments of the referrals could have been better documented. We did not attempt to conduct cost analysis on standard referral or the cost of ED referrals.

**Conclusion**

The present SETS study in PAH has found that teledermatology provided accurate and rapid diagnostic and treatment advice for patients presenting with acute and subacute dermatological emergencies. This process has also enhanced medical training in emergency dermatology through direct consultations with teledermatologists. The implementation of this service could generate improved patient care and service outcomes in other EDs.

As technology advances rapidly, the technical platform and specialty applications of telemedicine are continually evolving. Based on this model, the implementation on a larger scale of the SETS in the State and National health-care systems will enable the access to specialist dermatology care for both urban and rural communities.

**Acknowledgements**

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**Author contributions**

JM, MS, CX, HPS, AS and IM were involved in the development and implementation of the study. SP provided statistical analysis and manuscript editing. PS and SD contributed to the data collection and analysis.

**Competing interests**

None declared.

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**References**