

The effectiveness of digital imaging and remote expert wound consultation on healing rates in chronic lower leg ulcers in the Kimberley region of Western Australia

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Abstract

The incidence of chronic lower limb ulcers in remote regions of Australia is high and results in significant morbidity, decreased quality of life and high cost. These wounds present challenges to clinicians due to their complex nature, high levels of comorbidity and the difficulty of gaining expert wound consultation due to distance.

A 12 month prospective randomised controlled trial was conducted at four sites in the Kimberley region of Western Australia (WA). The aim was to examine the effect on clinical outcomes and costs of providing remote expert wound consultation using the Alfred/Medseed Wound Imaging System (AMWIS) for patients with chronic leg and foot ulcers. All patients (n=93) had sequential wound assessments conducted using AMWIS at each clinic attendance. Control patients (n=43) received standard wound care, whereas intervention group patients (n=50) had their digital records transmitted to Perth every 2 weeks for remote review by a wound care consultant; these were then returned to their treating clinician with wound management advice.

Results indicate that intervention group patients had a positive healing rate of 6.82% per week, whereas controls had a negative rate of -4.90% per week (p=0.012). There were six amputations in the control group and one in the intervention group. The estimated treatment cost difference between the groups at 12 months was \$191,935 lower in the intervention group. We believe that our findings provide early evidence of the clinical and cost effectiveness of remote expert wound consultation using a digital wound imaging system in geographically remote regions.

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Introduction and background

Chronic wounds of the lower extremity (leg ulcers) are a major source of morbidity and decreased quality of life in the Australian population. Indigenous communities in particular have a very high incidence of chronic lower leg ulcers; this is in part due to the high incidence of diabetes within these communities, estimated to be 7-8 times higher than non-indigenous Australians¹. Diabetes is a major aetiological factor in the development of chronic leg and foot ulcers²; these ulcers can persist for months or even years. They have a significant negative impact on the individual's quality of life, are expensive to treat, and can lead to amputation of the affected limb³.

The remote Kimberley region of Western Australia (WA) is characterised by a large land mass and a widely dispersed but relatively small population of approximately 33,000⁴. Forty two percent of this population is Aboriginal. This group generally experience poor health status; the incidence of hospitalisation for diabetes in the Kimberley Aboriginal population was reported as 10-16 times that for the rest of WA and the death rate from diabetes in 1997 was the highest in the nation, at four times the Australian rate⁵ (Figure 1).

With such high rates of diabetes in this population, the sequelae of vascular disease is correspondingly high, as is the incidence of lower leg ulceration. A review of inpatient

episodes for diagnosis related groups (DRGs) associated with lower leg ulceration treated by the Kimberley Health Service between 1997 and 2003 reveals that there were a total of 473 admissions⁴. Effective treatment of chronic lower leg ulcers of any aetiology is dependent on the appropriate management of the underlying cause. However, it is also significantly influenced by the wound care knowledge level of the treating clinician, accurate assessment and documentation and, where necessary, consultation with wound care experts⁵.

The Kimberley region presents wound care clinicians with additional challenges due to local factors such as the mobility of the population, the difficulty and cost of obtaining expert wound consultation, availability of advanced documentation systems, high staff turnover and geographical isolation.

Telemedicine systems have been suggested as potentially offering benefits to remote communities because of their capacity to provide rapid communication for consultation,



Figure 1. Kimberley patient with diabetic neuropathic foot ulcer complicated by Hansen's disease.

minimise social disruption to patients and their families and reduce health care costs⁶. Telemedicine wound care systems such as the Alfred/Medseed Wound Imaging System (AMWIS)⁷ are increasingly being used in the hospital sector for the management of acute, complex and chronic wounds⁸ due to their advantages over existing methods^{9,10}. However, to date, we are not aware of any studies reported in the literature that have specifically investigated the clinical and cost effectiveness of using digital wound imaging systems combined with expert consultation in remote locations. Consequently, the aim of this study was to investigate the clinical effectiveness of using the AMWIS system, combined with remote expert wound consultation on the healing rates in chronic leg and foot ulcers in the Kimberley region.

Methods

Design

A 12 month prospective randomised controlled trial was conducted at four sites in the Kimberley region of Western Australia (Broome, Derby, Wyndham and Kununurra) between October 2002 and October 2003. The unit of randomisation was the clinical site; this was in order to avoid the potential for confounding the results due to changes in clinician knowledge level stemming from consultation with the wound care expert. All sites were provided with the current version of the AMWIS software and a Kodak digital camera.

Control group subjects received standard wound care as determined by the local wound care clinician and had their wound photographed and measured at each clinic attendance. Intervention group subjects also had their

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wound photographed and measured at each clinic attendance; however, these images and measurements were electronically transferred every 2 weeks to a wound care consultant (KC) located in Perth.

Hypothesis

The hypothesis was that intervention sites will have improved wound healing rates in chronic lower leg and foot ulcers and will have lower wound care costs than the control sites.

End points

- The healing rate was expressed as the percentage change in wound size divided by the number of weeks since enrolment in the trial.
- The clinical cost of wound treatment was considered to be the cost between admission and discharge from trial.

Subjects & setting

All patients meeting the inclusion criteria and giving informed consent at Broome, Derby, Kununurra and Wyndham hospitals were eligible for enrolment in the study. Patients predominantly had venous, arterial, mixed or diabetic neuropathic ulcers of the lower extremity and were being treated as outpatients at the respective hospitals. We calculated that to detect a clinically meaningful effect size of 12% in the healing rate of wounds with a power of 0.8 and significance level set at 0.05 would require two groups of at least 42 patients each. Prior to commencement of data collection, approval was granted by the Human Research Ethics Committee of The Alfred Hospital and the Western Australian Aboriginal Health Information and Ethics Committee in 2002. Data collection commenced in October 2002 and was completed in October 2003.

Inclusion criteria

- Documented diagnosis of chronic ulcer of the lower extremity.
- Treated as a wound care outpatient at one of the trial site hospitals.
- Informed consent.

Exclusion criteria

- Under 18 years of age.
- Disorientation or mental impairment.
- Unstable medical comorbidity.

Wound measurement

The AMWIS v1 was used to measure and document all wounds according to published methods⁷. All clinical staff involved in the trial were educated by one of the study team (NS) in the use of the AMWIS system and in the process of digital photography. All wounds were photographed, measured and assessed at each clinic attendance by the local wound care nurse. Wound images were recorded using a Kodak DC 440 digital camera. Healing rates were calculated by determining the percentage decrease in surface area calculated in mm² between first visit and the discharge visit divided by the total number of weeks treated¹⁰. This healing rate calculation method was chosen for the study in preference to a per visit healing rate because it is less affected by short term variation in healing that may occur between visits¹¹.

Remote consultation intervention

Wound care nurses at the two intervention sites used the AMWIS remote consultation function to transmit patient files in encrypted form to the wound care consultant every 2 weeks for the duration of the patients' care. The consultant reviewed the wound progress depicted in the electronic AMWIS file of each patient and then transferred the file back to the originating site with comments on the management of the wound entered into the AMWIS 'consultant advice' screen. Below is an example of the AMWIS measurement screens and associated wound management advice provided for one of the intervention group patients with a diabetic neuropathic foot ulcer (Figures 2-4). The consultant also often telephoned the local clinicians to discuss the images, progress of the wound and management options.

Clinical costing model

The model used to estimate clinical costs was based on international data on the cost of treating a chronic leg ulcer^{12,13} that indicates that the average cost to treat a chronic leg ulcer is A\$27,493 per annum. Using healing rate data that suggests that 83% of chronic wounds heal within 24 weeks¹⁴, we derived a healing cost per chronic wound of at least \$13,746 after adjusting for cost increases since 2000. Based on this model, overall healing rate costs were allocated thus; 80% of patients were costed at \$13,746 and 20% were costed at \$27,493. These costs were then adjusted based on the actual healing rates for each group. It should be noted that actual costs for individual subjects were not available from the trial sites, therefore we chose to estimate the total group costs for the study.

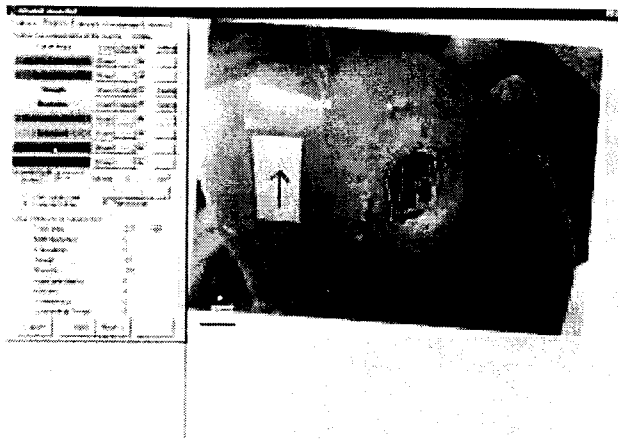


Figure 1. AMWIS information as at 4 March 2003.

"...this chap has multiple comorbidities that will compromise healing. He obviously has small vessel disease and peripheral neuropathy. All you can do to promote better health i.e. diet and diabetes management is important. However, the principal wound management will be to off-load the pressure on the plantar surface and infection control. Once again we need a good orthotic sandal i.e. a Darco shoe with sufficient off-loading.

He would benefit from Iodosorb paste as it will debride and maintain a bacterial balance. Also it would be easy for him to use. A foam secondary dressing would give added pressure relief and protection. I am going to talk to a podiatrist down here to arrange to get you some foot moulds. The idea is to get a foot impression so that we could get temporary off-loading Darco footwear".

Consultant costs are calculated at \$40 per consultation for intervention group patients. Transport costs to Perth were \$1330 per commercial return flight from Broome and \$1980 from Kununurra and approx \$12,000 per Royal Flying Doctor Service (RFDS) one way flight. Flight costs were only included for patients within the study who went on to amputation in Perth during the study. Patients that required RFDS transport from the Kimberley to Perth for amputation due to the severity of their disease and or comorbidity were costed on the basis of DRG IO7Z. *Below knee amputation for vascular disease with comorbidity* at \$18,560 per episode.

To enable a balanced comparison between the two groups, the above costing model was applied to 43 patients per group due to the larger number of patients in the intervention group (50 vs 43).

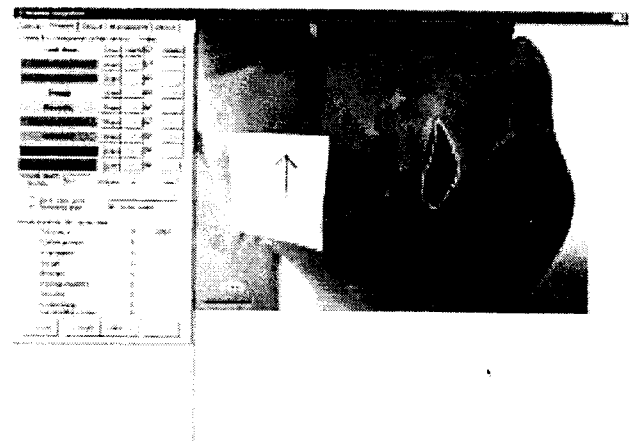


Figure 2. AMWIS information as at 25 March 2003.

"... it was a good thing that he was commenced on OABs. Diabetics with small vessel disease and neuropathy have reduced erythema and sensation and, as these are two of the signs and symptoms of infection, it is frequently missed or not recognised as being significant. So one looks for other signs such as deep sensation, oedema or exudate. The wound looks slightly smaller though. Removal of the surrounding callus is important".

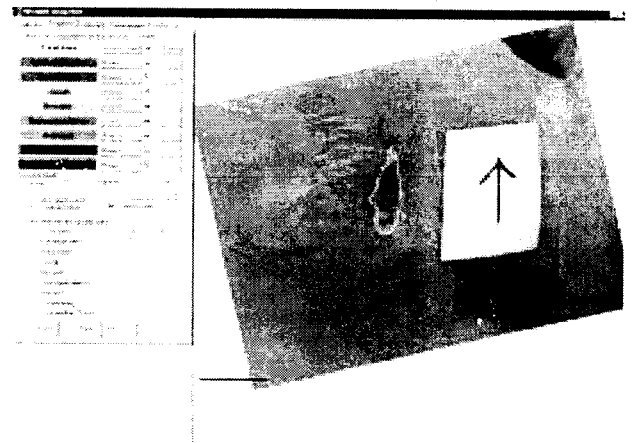


Figure 3. AMWIS information as at 25 May 2003, 2 weeks prior to discharge.

Analytical procedures

Descriptive statistics were calculated for all subjects. Differences in healing rates between the groups were compared with t tests for independent samples and linear regression was calculated to determine the significance of the differences in healing rates between the groups after adjustment for age and gender. In all cases, significance level was set at 0.05 and all statistical tests were carried out with SPSS V11.