Reshaping Wound Care: Evaluation of an Artificial Intelligence App to Improve Wound Assessment and Management

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Abstract. This study evaluated the usability and effectiveness of an artificial intelligence application for wound assessment and management from a clinician-and-patient perspective. A quasi-experimental design was conducted in four settings in an Australian health service. Data were collected from patients in the standard (n=166,243 wounds) and intervention (n=124,184 wounds) group, at baseline and post-intervention. Clinicians completed a survey (n=10) and focus group (n=13) and patients were interviewed (n=4). Wound documentation were analysed descriptively, bivariate statistics determined between-group differences, and interviews were thematically analysed. Compared with the standard group, wound documentation in the intervention group improved significantly (<2 items documented 24% vs 70%, P < .001). During the intervention, 101/132 wounds improved (mean wound size reduction=53.99%). Positive evaluations included instantaneous objective wound assessment, shared wound plans increased patient adherence and enhanced efficiency in providing virtual care. Application use facilitated remote patient monitoring and reduced patient travel time while maintaining optimal wound care.

Keywords. Artificial intelligence, digital application, documentation, wound, wound care

1. Introduction

Recent advances in wound photography, such as digital wound applications, have improved the accuracy of wound care documentation, leading to improved wound

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management and patient outcomes [1-4]. Digital wound applications downloaded to a smartphone are capable of performing real-time wound analyses and tracking through image capture. Certain applications have algorithms and clinical decision-support tools to assist in determining the best treatment options, the type of wound products to use, the tracking of the wound healing progression and the next steps to take. A major metropolitan quaternary health service in New South Wales, Australia identified that the Tissue Analytics digital application ('TA app' hereafter) was able to captured wound images, integrate with eMR, aggregate wound data, integrate telehealth and clinical decision-support capability with an algorithm that provides clinicians with treatment options. The aim of this study was to evaluate the usability and effectiveness of the TA app to improve wound assessment and management.

2. Methods

2.1. Study Design

A quasi-experimental design was employed from June to October 2020. The data were compared with a historical patient group who received standard wound assessment and management (December 2019 to March 2020). Ethics approval was obtained from the Ethics Review Committee (RPAH Zone) 2019/ETH12459.

2.2. Setting and Sample

The study occurred in four settings in one health service in NSW, Australia. The health service is in a large urban setting that provides primary, secondary and tertiary care to a population of 700,000 people. Three settings were in a quaternary hospital, a 800-bed major referral hospital that provides services for many specialist areas. The fourth study setting was primary care community services across the health service.

Patients: Patients with a wound(s) and aged above 18 years were invited. Patients were excluded if they had a: (a) diagnosed non-healing wound (eg, palliative, malignant or fungating tumours; and wounds with a blind-ended track, such as pilonidal sinus); (b) wound that required specialised treatment, such as burn/scalds; or (c) superficial fast-healing wound, for example superficial lacerations.

Clinicians: A purposive sample of 13 clinicians (11 nurses, two doctors) were trained on the TA app and used the app with their patients.

2.3. Intervention

The TA app is a cloud-based application to measure, analyse and treat wounds. The TA app is designed to facilitate patient wound care delivery using artificial intelligence-based technology to support clinical decision-making. By capturing an image of the wound, the TA app analyses its dimensions and perimeters, surface area and tissue composition and presents augmented visual images. For this study, we tested a standalone solution that was not integrated with eMR, whereby the image and structured report generated from the TA app were to be uploaded to the eMR via the medical records department. The TA app was available for any smartphone and Android device with an integrated camera. No additional optics or hardware were needed to run the app. The TA app comprises two components, each with a separate login, a clinician interface and a patient interface. Clinicians used the clinician interface to take photos and document

wound assessment and management. The patient interface was used by patients who care for their wound at home and require regular monitoring by clinicians. The patient interface was linked to the clinician interface for oversight.

2.4. Standard Practice

The health service uses wound iView in the eMR for wound documentation. Wound iView at present has wound documentation fields, such as wound location, colour and exudate, with drop-down options to document wound assessment. Wound iView does not have inbuilt functionality to store visual images; therefore, the wound information is stored only as text. Wound iView in the eMR has the functionality for wound assessment and management documentation for patients with one wound.

2.5. Outcome Measures

The outcome measures of this study were: (a) patient and clinician usability, and acceptability of the TA app; (b) reduction in wound size at the point of discharge (inpatient cohort) and at the end of 3 months after enrolment (community and outpatient cohort); (c) completeness of wound-related documentation determined by the documentation of pain, wound size, exudate, odour and a management schedule.

2.6. Data Collection

Clinicians: The clinician survey included 21 questions regarding user experience in the following categories: usability and easiness, image capture, benefits to assessment and management, benefits to communication and continuity, benefits to workflow and time to wound assessment and overall perceived value. The survey used a 10-point Likert scale, with scores ranging from 0 to 10 (higher scores indicating stronger agreeance).
Patients: A patient data collection tool captured demographics, diagnoses and comorbidities; wound aetiology; wound size percentage decrease; completeness of wound documentation (pain, exudate, odour, size, wound management goal, wound assessment schedule) and potential saving in travel-related time. Usability and acceptability were measured via interviews.

2.7. Data Analysis

A convenience sampling was used for patients, with no a priori sample size calculation. Patient demographic and clinical data were analysed descriptively and compared using independent t-tests for continuous data and chi-square tests of independence for categorical data. Chi-square tests of independence examine for statistically significant differences between cohorts in wound documentation practice.
Mean clinician satisfaction with TA was calculated for each category. The higher score reflected greater satisfaction.

Thematic analysis on the focus groups and interviews was conducted in six steps: familiarisation with data; generation of initial codes; search for themes; review of themes; definition and naming of themes; and preparation of a written report [5].

Potential travel time of patients was estimated using Google Maps. The patient's address and the hospital's address were used to calculate the time using Google Maps.

The time of travel was set at 12 PM. The mean travel time was calculated using the minimum and the maximum travel time provided by Google Maps. The average fuel cost of 122.6 c/L over the period of the study was used to calculate the cost of travel.

3. Results

A total of 290 patients were enrolled in this study. 13 clinicians trialed the TA app clinician interface on 124 patients with 184 wounds and the outcomes were compared with a standard group of 166 patients with 243 wounds treated with standard care. There was no statistically significant difference between the two groups by age, gender or study settings. The standard care group had statistically significant higher proportions of wound types such as blister/abrasion/skin tear and lower proportion of ulcers than the intervention group. 13 out of 124 participants in the intervention group trialed the patient interface, which provided data to calculate the potential travel-related time, and cost.

3.1. Feasibility, Usability, and Acceptability of the TA App

Table 1. Clinician survey TA app results.

Category	Mean score
Image capture	7.93
Ease of use	6.92
Benefits to patient assessment and management	8
Benefits to communication and continuity	8.19
Benefits to workflow and time to wound assessment	7.41
Overall perceived value of the TA app	8.44

Clinician focus groups and patient interviews: Data were collected from four patients and 13 clinicians in five focus groups. Two major themes emerged from the data: (a) Connecting treatment and continuity of care and (b) Engaging with a new technology.

3.2. Reduction in Wound Size

Fifty-two patients (42%) in the intervention group had multiple wounds. In this group, the size of 132 wounds was measured; 101 out of 132 wounds over an average of 36.47 days (SD 41.76) improved, with a mean reduction of 54.0% (SD 31.60) in wound size.

3.3. Completeness of Wound-Related Documentation

The use of the TA app by clinicians significantly increased the completeness of documentation compared with standard care. Completeness of the documentation was based on the number of dressing changes. In particular, the recording of wound size increased from 8.3% completion rate in the standard care group to 100% completion rate in the intervention group and that for exudate increased from 31.9% in the standard care group to 87.2% with the use of the TA app.

3.4. Potential Travel-Related Time Avoided

Out of 13 patients who used the TA app, travel related data were collected on 12 patients. Nine patients used the patient interface from their home in the Sydney metropolitan area

and three patients used the patient interface from their rural home. Patients used the TA app on average, 11.2 times (range 4-21 times) over an average period of 45.3 days (range 12-104 days). The travel-related fuel cost avoided to a patient living in metropolitan Sydney was on average $4.54 ($0.42-$11.78) for every visit to the hospital and for rural patients was on average $72.90 ($16.20-$124.00).

4. Discussion

This is the first Australian study to report a wide-ranging wound care service using a digital application that provides real-time wound data with an interface for communication between the patient and the clinician, and clinicians in a hospital, community and outpatient setting. The use of the TA app demonstrated positive documentation and data management of wound care, clinician-and-patient communication and patient travel time and costs. This study demonstrated the feasibility of the use of the TA app in acute, community and outpatient settings. The TA app facilitated remote monitoring via telemedicine for patients, thus reducing face-to-face visits and travel time.

5. Conclusions

As an innovative application that supports clinicians and patients in wound care, the TA app has the potential to improve patient wound outcomes. The findings of this study will be used to guide further application in other settings and scale up across the health service and eventually the state.

Acknowledgements

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