

Reliability and accuracy of wound surface measurement using mobile technology

Dr. P.I. Sigam¹, Dr. M. Denz²

¹Institut of Global Health, University of Geneva, patricia.sigam@gmail.com
Campus Biotech, chemin des Mines 9, 1202 Genève, Switzerland

² Swiss Association for Telemedicine and eHealth, martin.denz@me.com
Grubenweg 8, 4153 Reinach, Switzerland

Introduction

As the population ages and the chronic diseases raised, chronic wounds also increase, creating a huge burden on the health system. In outpatient care, the most common wound measurement technique remains the gradual ruler^[1], which is a simple and fast but relatively inaccurate method. Mobile phones enable permanent access to a camera and the technology now integrates image processing. A mobile application that takes reproducible and reliable wound surface area measurements would help obtain useful indications on the prognosis and effectiveness of applied treatment. This also enables faster detection of complications and reduces healing time^{[2],[3],[4]}. +WoundDesk[®] is a mobile application that enables to take photographs, define wound margins and make wound surface area measurements in a few clicks.

Aim

The study aims to assess the reliability and accuracy of digital semi-automated wound surface areas measurement using the mobile health application +WoundDesk[®] (version 0.06, digitalMedLab GmbH, Technoparkstrasse 2, Winterthur, Switzerland) compared to digital planimetry, which is one of the reference measurement methods^[5].

Method

An experimental comparative non-randomized study has investigated the validity and the repeatability of wound surface measurement. 30 wound

drawings were measured using two different methods, a) the mobile phone application +WoundDesk and b) digital planimetry as the reference method. The repeatability has been measured using the inter-rater and intra-rater reliability. The accuracy was assessed using Pearson concordance correlation and the standard error of measurement (SEM). To fully appreciate the correlation between the 2 techniques, the graphical method of Bland and Altman was used.

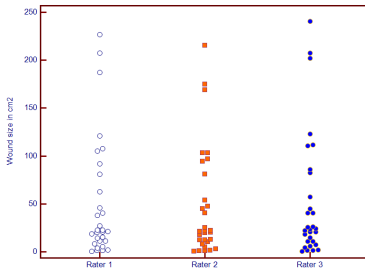


Fig. 1, Measurement plot for each of the 3 examiners according to surface area

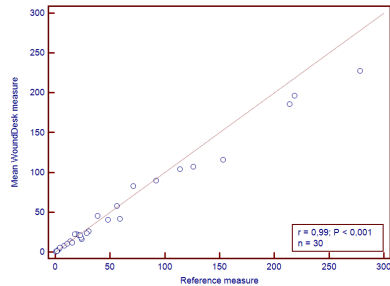


Fig. 2, scatter-graph of correlation between reference measure and +WoundDesk measures (with r = Pearson coefficient).

Results

The intra-rater correlation was good with an ICC (Intraclass Correlation Coefficient) at 0.99. Inter-rater correlation was also good with an ICC at 0.98. The Pearson correlation coefficient (r) was 0.99 ($p < 0.001$). Compared to the reference measurement, +WoundDesk measurements represent an average overestimation of 13 % of the surface.

Discussion

Under the study conditions, the use of the mobile Health application +WoundDesk[®] for wound surface area measurement was reliable and reproducible. With an intra- and inter-rater reliability values >0.98 , the technique used by the application is equivalent to other methods for which an intra- and inter-rater reliability >0.96 is usually considered to be excellent^[5-8]. With a Pearson coefficient of 0.99, the linear correlation is also good.

Intraclass correlation coefficient (ICC)	Rater 1	Rater 2	Rater 3	Inter-rater reliability
ICC single measures	0.9988 (CI 0.9977-0.9994)	0.9970 (CI 0.9945-0.9985)	0.9939 (CI 0.985-0.996)	0,9854 (CI 0,9741-0,9924)
ICC average measures	0.9996 (CI 0.9992-0.9998)	0.9990 (CI 0.9982-0.9995)	0.9980 (CI 0.9963-0.9990)	0,9970 (CI 0,9947-0,9985)

Table 1: intra-rater and inter-rater Intraclass Correlation Coefficient with Confidence Interval (CI)

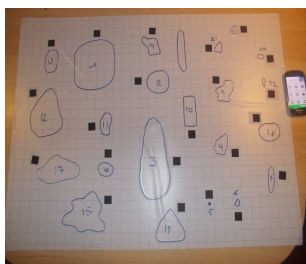


Fig. 4 wounds drawings measured during the study

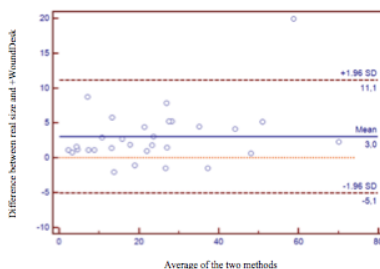


Fig. 3 Bland-Altman graphical plot comparing the real actual size with the mobile application measures

However, the measurements made by the application shows an average variation of 13% compared to reference measurement. This result is in line with the literature; a variation of 21-28% is expected by photographic wound measurements^[8].

The mobile application uses the ellipse formula to estimate the wound surface ($0.785 \times \text{height} \times \text{width}$)^[1,5]. According to Shaw and al. the ellipse formula used to measure wound surface areas causes an overestimation by 10-25%^[9].

In our study, it appears that variations in surface measurement (overestimation or underestimation) are closely related to wound shapes.

Indeed, the ellipse formula applied on rounded or oval wounds is relatively accurate, as the variation does not exceed 5%. In contrast, the variation may reach 25% for wounds of irregular or ellipsoid shape and 35% for large rectangular wounds.

According to the Wound Healing Society's guidelines, "if ulcer does not reduce by 40% or more after 4 weeks of therapy, re-evaluate and consider other treatments"^[10]. Indeed, as described by Sheehan et al.^[11], the percentage of wound surface reduction to 4 weeks is a strong predictor of healing at 12 weeks. The retrospective study by van Rijswijk et al.^[12] shows that the reduction of ulcer surface by 40% or more during the first 4 weeks is a positive predictor for healing. It's accepted that a 50% decrease in size after 6 weeks is a sensitive predictor (93% sensitivity) to complete healing at 12 weeks^[4,8]. As the consecutive measurements are compiled in the application and available as a graphic, the mobile solution gives the care provider some critical information about wound healing evolution and prognosis.

Limitation of the study

This is a first study being conducted on a relatively small sample of 30 wounds. They are flat artificial wounds with easily identifiable edges. In practice, wounds are rarely flat. They are often on body curvature causing additional error factor.

Conclusion

The wound surface measurements performed with the mobile phone application +WoundDesk are reliable, repeatable and reproducible. The accuracy is good for small irregular wounds, but decreases for large rectangular wounds. Further studies with real wounds are needed to confirm the first conclusion.

Conflict of interest: As one of the authors has developed the application, there is a risk of partiality.

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