Objective Wound Measurement Software on a point-of-care, hand-held fluorescence imaging device: Verification of measurement accuracy and repeatability

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Introduction

- Accurate, rapid tracking and documentation of wound size is an important component of wound care.
- Relative changes in wound surface area over time are used to determine if a wound is healing and to assess its response to treatment. [1]
- Wound size has traditionally been determined using a wound ruler by multiplying the length by the width; however, this approach often overestimates the area by up to 44 %. [2,3]
- A wound measurement software uses digital photographic planimetry to accurately calculate the wound area, length and width by using wound edge detection and two calibration stickers placed next to the wound.
- This study verified the measurement accuracy and repeatability of the wound measurement software on a point-of-care handheld fluorescence device.

Methods

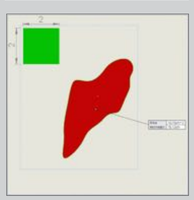
Wound Measurement Tool

User places two calibration stickers next to the wound and captures an image. The software offers automatic or manual draw options for delineation of wound boundaries. Wound surface area (cm^2), maximum wound length (cm) and maximum wound width (cm) are reported and saved on the image.

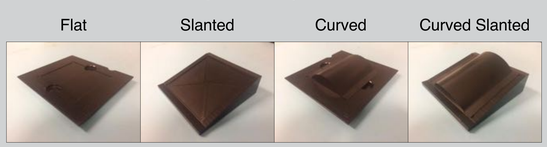
Part 1 Methods: Bench Model

- 17 wound models were designed to simulate the varying shapes and sizes of clinical wounds.
- Wound models were designed in SolidWorks such that the true area, maximum length and maximum width were known.

- Wound model prints were affixed to a flat surface, a slanted surface, a curved surface and a curved slanted surface to account for the typical variance in imaging planes found in wound care.



- Five clinicians performed 3 repeated measurements on the 17 wound models to assess the accuracy, inter-user repeatability and intra-user repeatability of the wound measurement tool in measuring wound area, maximum length and width.
- Both automatic and manual draw options for wound border delineation were independently assessed.



Part 2 Methods: Clinical Wound Images

- 17 images of real wounds were captured by an intended user in a clinical setting
- Five clinicians performed 3 repeated measurements on the 17 wound images to assess inter-user and intra-user repeatability of the measurement software when used in a clinical setting.
- Users selected either automatic or manual draw to optimally define the wound border based on their clinical expertise.
- Measurements acquired with both automatic and manual draw wound border delineation were assessed together to reflect the inherent variability in user preference when used in a clinical setting.

Results Part 1: Bench Model

Clinicians were able to accurately and reproducibly perform wound measurement using both manual and automatic modes.

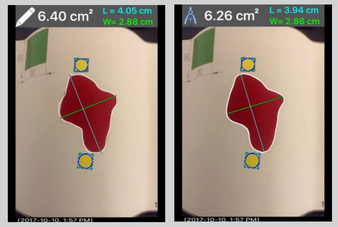


Figure 1: [Left] wound traced by user with manual mode [Right] wound traced by the same user with automatic mode.

Mean Measurement Error (MME)

The MME for wound area was 5.46% and 5.28 % for automatic and manual draw border delineation respectively. The MME for maximum wound length and width measurements were < 5% for both automatic and manual draw wound border delineation.

Intra-user Variation (CV)

The Intra-user coefficients of variation for wound area, maximum length and width were <4% for both automatic and manual draw wound border delineation.

Inter-user Variation (CV)

The Inter-user coefficients of variation for wound area, maximum length and width were <4% for both automatic and manual draw wound border delineation.

Figure 2: The mean measurement error calculated for the wound measurement tool manual and automatic modes are presented for the wound area, length and width. The mean measurement error reported in the literature for standard ruler measurements is also presented. [2,3] The error bars represent the standard error of each measurement.

Results Part 2: Clinical Wound Images

Users were able to delineate the wound borders on the clinical images accurately and reproducibly when given the option of either automatic or manual draw options.

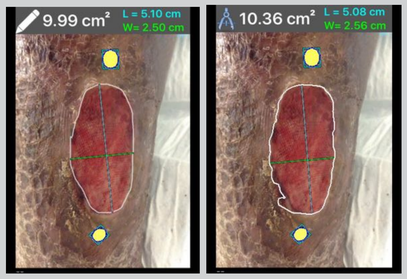


Figure 3: [Left] wound traced by user with manual mode [Right] wound traced by user with automatic mode.

Inter/Intra-user Variation (CV)

The intra-user and inter-user coefficients of variation for wound area, maximum length and maximum width measurements of the clinical wounds images were all < 6%.

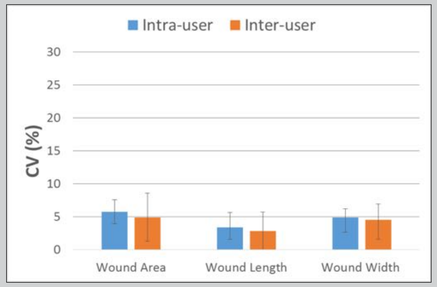


Figure 4: The inter- and intra-user variability calculated for the wound measurement tool is presented for the wound area, length and width. The error bars represent the standard error of each variability measurement.

Conclusions

- The wound measurement software using digital photographic planimetry and two calibration stickers can be used by clinicians to accurately and reproducibly measure wound area, length and width.
- The mean measurement error using both manual and automatic trace modes is < 5.5 % and therefore a significant improvement over measurement error of 10-44% [2,3] reported from standard ruler measurements in the literature.
- The intra-user and inter-user variability in measurements was < 4% for the bench model test and < 6 % for the clinical wound image test. Clinical wounds have less defined edges than the bench models and therefore more clinician judgement in wound border delineation was introduced. Therefore, this result was expected.
- The inter-user and intra-user variability were similar in value for clinical wound measurements; however, the standard error was greater for inter-user variability compared to intra-user variability. This result was expected because wound border definition can vary between clinicians.
- The wound measurement tool provides the ability to accurately and objectively track wound size over time.

References

1. Flanagan M. Improving accuracy of wound measurement in clinical practice. Ostomy Wound Manage. 2003; 49(10):28-40.
2. Goldman RJ, Salcido R. More than one way to measure a wound: an overview of tools and techniques. Adv Skin Wound Care. 2002;15(5):236–43.
3. Majeske C. Reliability of wound surface area measurements. Phys Ther. 1992;72(2):138–41.