

# Digital Measurement of Surface Wound Area and Depth: Assessing Accuracy and Reproducibility in Benchtop and Clinical Settings

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**Key takeaway**  
MolecuLightDX provided accurate, reproducible, contactless wound area and depth measurements, with substantially lower error than ruler-based methods and consistent performance across diverse clinical wounds



## Background

- Accurate and reproducible wound measurement is important for monitoring healing progression and supporting clinical decision-making.
- Traditional ruler-based length × width methods are prone to geometric overestimation and operator-dependent variability.<sup>1,2</sup>
- Digital imaging technologies enable automated, contact-free wound measurement, but further validation of their surface-area and depth accuracy against reference standards is still needed.

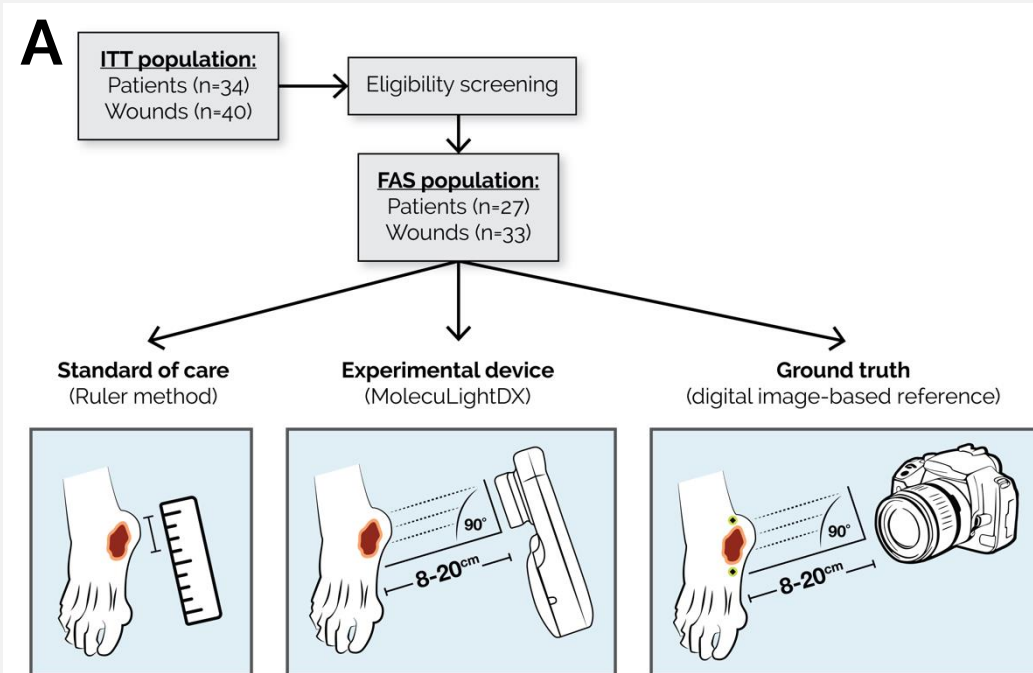
## Aims

- To determine whether the wound measurement feature of the MolecuLightDX imaging device provides acceptably accurate surface area and depth measurements compared with reference standards, and to assess measurement reproducibility across users.

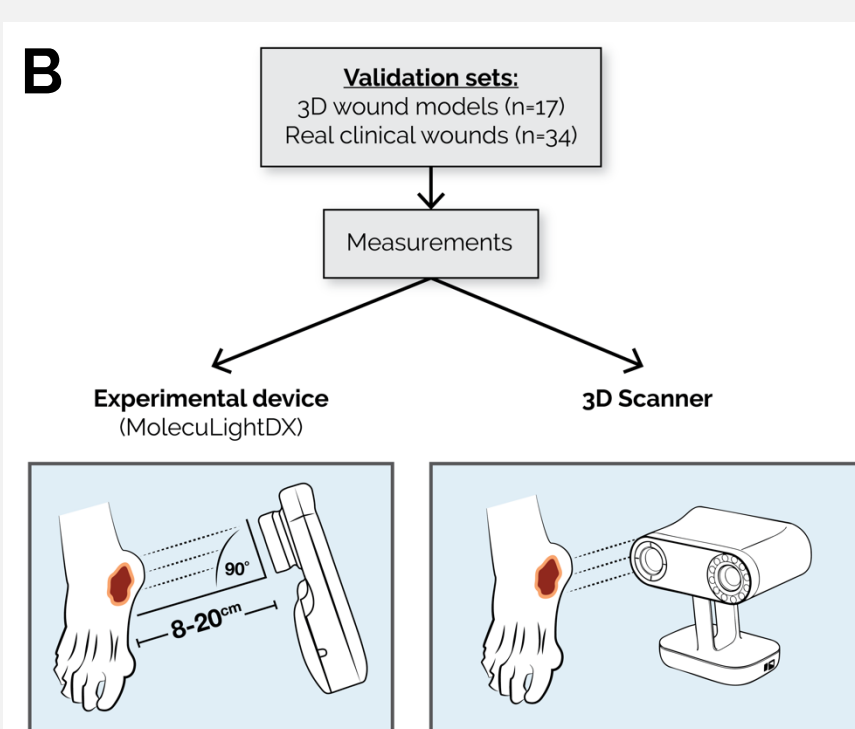
## Study design

- Two companion investigations evaluated the measurement accuracy and reproducibility of the MolecuLightDX device (MolecuLight Inc., Toronto, ON).

### Area measurement study (Figure 1A)



### AutoDepth validation study (Figure 1B)



## Wound Area Accuracy and Reproducibility

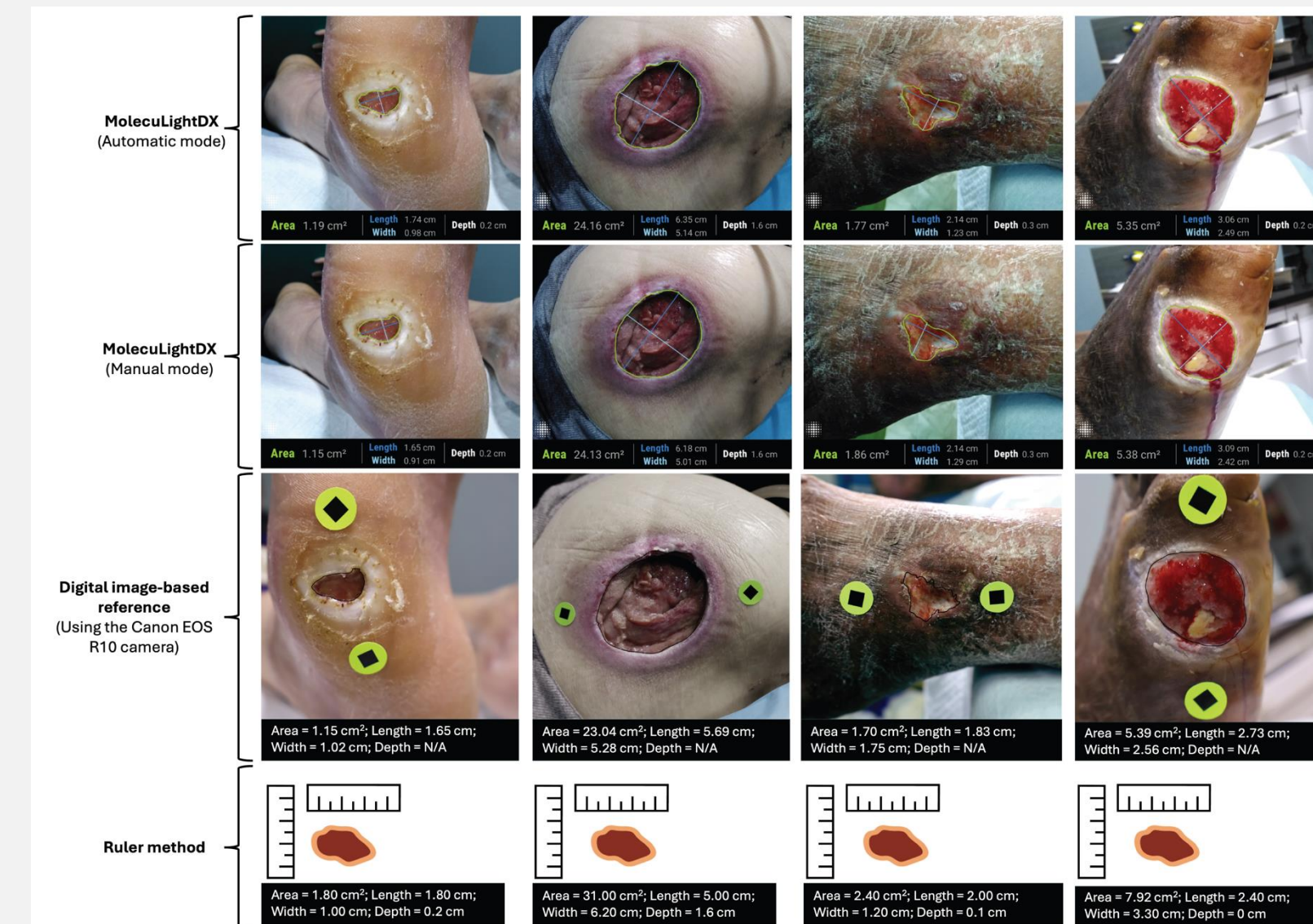
- The study included 27 patients (33 wounds), all adults aged ≥22 years with wounds ≥0.5 cm<sup>2</sup> and clearly defined borders. Each wound was measured in triplicate by 3 users in both automatic mode (the device algorithm automatically detected the wound margins and allowed optional user adjustment) and manual mode (users were required to trace the wound edges precisely on the touchscreen interface). Measurements from both modes were compared with the ground truth to determine the mean percentage error and inter- and intra-user variability. In addition, 17 wound models of known areas, length and widths were imaged in triplicate by 3 users and compared with their known dimensions.

**Table 1. Summary of Clinical Wound Characteristics**

Characteristic	Count (n)
<b>Demographics</b>	
Age range, years	42–90
Sex	
Male	20
Female	7
<b>Wound etiology</b>	
DFU	12
VLU	9
Traumatic	5
PU	4
ALU	3
<b>Wound size</b>	
Area range, cm <sup>2</sup>	0.56–23.04
<2 cm <sup>2</sup>	13
2–10 cm <sup>2</sup>	14
>10 cm <sup>2</sup>	6
<b>Wound duration</b>	
<12 months	20
>12 months	13
<b>Fitzpatrick skin-type</b>	
Type I	6
Type II	5
Type III	11
Type IV	4
Type V	4
Type VI	3

Abbreviations: ALU, arterial ulcers; DFU, diabetic foot ulcers; FAS, full analysis set; ITT, intention-to-treat; PU, pressure ulcers; VLU, venous leg ulcers.

**Figure 2. Illustrative Examples of Wound Measurement Using Four Different Methods**



Each column represents a distinct wound case, from left to right. **Column 1:** DFU, Fitzpatrick skin type II; **Column 2:** PU, Fitzpatrick skin type III; **Column 3:** ALU, Fitzpatrick skin type IV; and **Column 4:** DFU, Fitzpatrick skin type VI. Depth data were not available for these reference images, as they were used solely for surface-area validation.

**Table 2. Summary of Accuracy and Reproducibility Results for Wound Area of MolecuLightDX and Ruler Measurements**

Measurement technique	Wound models	Clinical wounds	Wound models	Clinical wounds	Wound models	Clinical wounds
	Mean percentage error (P-value <sup>a</sup> )		Inter-user CV		Intra-user CV	
Automatic	2.57%	6.61% (P < 0.0001)	1.17%	5.26%	1.65%	3.80%
Manual	3.34%	7.57% (P < 0.0001)	2.22%	5.10%	3.14%	3.69%
Ruler	N/A	77.90%	N/A	N/A	N/A	N/A

<sup>a</sup>MolecuLightDX as compared to ground truth measurements. Maximum acceptable error = 10%, maximum acceptable inter- and intra-user CV = 10%. Abbreviations: CV, coefficient of variation; N/A, not applicable.

### Wound area accuracy and reproducibility

- High accuracy was demonstrated in both benchtop and clinical evaluations (Table 2).
- For clinical wounds, there was an approximate 10-fold reduction in MPE versus ruler estimation (P < 0.0001).
- Paired comparisons demonstrated statistically significant differences between both MolecuLightDX modes and the ruler method (P = 0.00029 in automatic mode; P = 0.00022 in manual mode).
- Low coefficient of variance (CV) of <10% demonstrates high reproducibility among measurements.

## AutoDepth Accuracy and Reproducibility

**Table 3. Summary of Accuracy and Reproducibility of the MolecuLightDX AutoDepth Function**

Metric	Benchtop models (n = 17)	Clinical wounds (n = 34)	Predefined acceptance criterion
Depth range (cm)	0.13–2.78	0.06–4.13	—
Mean absolute error (mm)	0.87 (SD, 0.51; 95% CI, 0.80–0.93)	0.98 (SD, 0.70; 95% CI, 0.89–1.06)	±2.0
Intra-user ICC	0.999 (95% CI, 0.997–1.000)	0.992 (95% CI, 0.984–0.996)	≥0.90
Inter-user ICC	0.998 (95% CI, 0.996–0.999)	0.997 (95% CI, 0.994–0.998)	≥0.90
Accuracy specification met	Yes	Yes	—

Abbreviations: CI, confidence interval; CV, coefficient of variation; ICC, intraclass correlation coefficients SD, standard deviation.

- The AutoDepth validation study included 17 wound models and 34 images of real wounds, encompassing DFU (n=15), VLU (n=7), PU (n=11), and one surgical site wound (n=1).
- Ground truth reference depths for the benchtop models ranged from 0.13 cm to 2.78 cm and for clinical wounds from 0.06 cm to 4.13 cm.
- The depth was measured twice by 4 users and compared to the ground truth 3D measured depth.

### AutoDepth accuracy and reproducibility

- High agreement with calibrated 3D optical scanner reference was observed (Table 3).
- For clinical wounds, depth measurements demonstrated high accuracy within 2.0 mm of the 3D measured deepest depth.
- High ICC values demonstrate high reproducibility.

## Conclusions

- MolecuLightDX provided accurate, reproducible contactless wound area and depth measurements.
- Surface area error was <10% and ~10-fold lower than ruler-based estimation versus ground truth; AutoDepth showed sub-millimeter accuracy with excellent inter- and intra-user agreement.
- Performance was consistent across skin types, wound sizes, and etiologies.
- These findings support integration of standardized digital measurement into clinical workflows to enable reliable healing assessment and objective evaluation of treatment response.

### References:

- Rogers LC, et al. *J Diabetes Sci Technol*. 2010;4(4):799–802.
- Langemo D, et al. *Adv Skin Wound Care*. 2015;28(3):116–121.

**Abbreviations:** 3D, three-dimensional; ALU, arterial ulcers; CI, confidence interval; CV, coefficient of variation; DFU, diabetic foot ulcers; FAS, full analysis set; ICC, intraclass correlation coefficients; MPE, mean percentage error; PU, pressure ulcers; SD, standard deviation; VLU, venous leg ulcers.