Objective Wound Care Decisions: Leveraging the Diagnostic Synergy of Bacterial Fluorescence and Thermal Imaging

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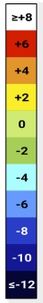
Introduction

The synergy between fluorescence imaging and thermal imaging (MolecuLight® **DX**) may prove to be a powerful diagnostic duo. Fluorescence imaging accurately and in real-time pinpoints bacterial presence at problematic/pathogenic loads[1], while thermal imaging offers insights into tissue inflammation and perfusion, with evidence suggesting strong diagnostic potential in skin and soft tissue infection[2-4]. Together, these modalities show great promise for enhancing the diagnostic accuracy of wound assessment, guiding targeted interventions, and facilitating comprehensive wound assessment to improve patient outcomes.

Aim

To illustrate the potential clinical applications of the combined utilization of fluorescence and thermal wound imaging (MolecuLight **DX**).

Relative color scale for thermal maps:



Warmer

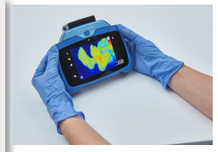
Potential marker of inflammation and/or infection

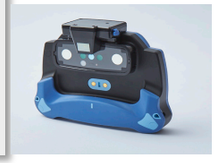
Integers along the scale denote differences in temperature (°C) in 2°C increments along a typical biological range.

E.g. +2 (yellow) indicates that those regions are 2°C warmer than areas of green (0).

Cooler

Potential marker of decreased localized oxygen delivery, undermining, devitalization





Take Home Points

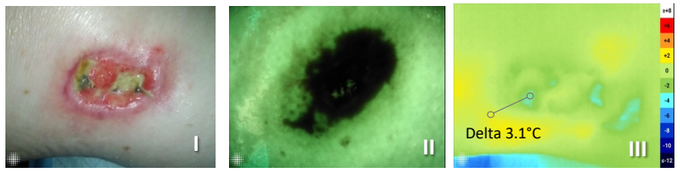
- The applications of combined fluorescence and thermal wound imaging technology are varied and broader than the standalone features.
- The integration of data from both diagnostic methods offers a holistic understanding of the patient's condition. When considered within the clinical context, this combined information is not only thorough but also actionable.
- Many other applications such as evaluation of vascular status and risk assessment of pressure injury formation should be considered for future studies.

Potential Synergies

Next, we showcase sample scenarios where the combined information from both technologies synergistically complements each other, aiding in determining the optimal therapeutic approach.

✓ **Identifying issues underneath intact skin**

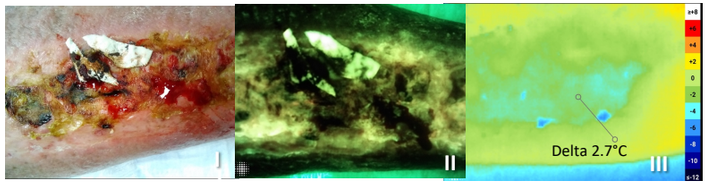
Sinus tracts and undermining:



I. Standard Image II. Fluorescence Image (Negative) III. Thermal Imaging (blue areas are cooler relative to the surrounding tissues)

Cooler temperatures surrounding the wound, in areas covered by intact skin (not directly imageable by fluorescence imaging), may suggest tracts and undermining. Following debridement, probing confirmed the presence of undermining and sinus tracts.

Flagging potential involvement of underlying bone

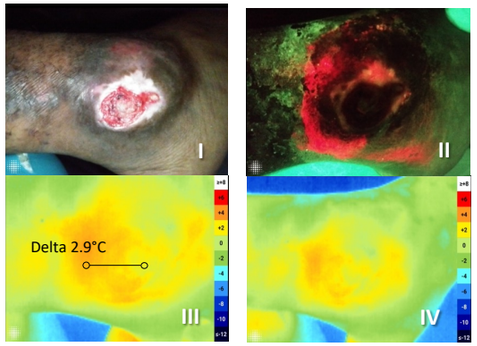


I. Standard Image II. Fluorescence Image shows faint blush fluorescence signals under scabs (arrows) III. Thermal Imaging (blue areas are cooler relative to the surrounding tissues)

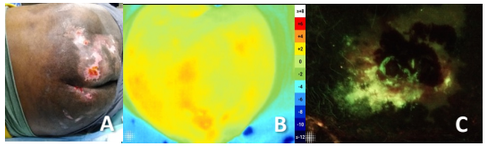
Cooler temperatures within infected wounds, particularly overlying the bone, may raise concern for bone involvement. This patient with chronic post-radiation wound over the pretibial area, presents thermal findings suggesting osteomyelitis, which were confirmed by MRI. IV antibiotics were initiated.

✓ **Aiding in the diagnosis of wound infection, inflammation and healing**

Indicators of infection & inflammation



I. Standard Image II. Fluorescence Image (red bacterial fluorescence detected) III. Thermal Imaging IV. Thermal image at a distance



28-year-old with paraplegia and recurrent PIs on multiple locations, shows no major signs of infection during standard clinical inspection to the R lateral malleolus. (I) Fluorescence imaging (II) detects bright red signals around the right lateral malleolar wound, indicating pathogenic bacterial loads that need debriding and topical antibiotics. Thermal imaging (III) confirms increased temperatures in the same area, the temperature change is even more evident when captured from a further distance (IV). Local debridement and topical antibiotics are administered. Other areas of pressure with wounds in different stages (A) show increased temperature (B) but fluorescence rules out bacterial presence. Treatment on those areas focuses on offloading.

Indicators of healing

I. Standard Image
II. Fluorescence Image (no bacteria detected)
III. Thermal Imaging shows a more discrete difference between the wound and the reference point, with a uniform distribution of heat. While abdominal warmth is usually uniform, negative fluorescence imaging indicates minimal bacterial presence, helping rule out infection.

Standard clinical assessment may be subjective, but combining results from fluorescence and thermal imaging can mitigate concerns about complications. For instance, in an abdominal surgical wound with granulation tissue and serous exudate, thermal imaging reveals moderate to low relative temperatures with a uniform distribution.

1. Le L, et.al.; Diagnostic Accuracy of Point-of-Care Fluorescence Imaging for the Detection of Bacterial Burden in Wounds: Results from the 350-Patient Fluorescence Imaging Assessment and Guidance Trial. Adv Wound Care (New Rochelle). 2021 Mar;10(3):123-136. doi: 10.1089/wound.2020.1272. Epub 2020 Sep 25. PMID: 32870774; PMCID: PMC7876364. 2. Ko LN, Raff AB, Garza-Mayers AC, et al. Skin surface temperatures measured by thermal imaging aid in the diagnosis of cellulitis. *J Invest Dermatol* 2018; 3. Li DG, et.al; The ALT-70 predictive model outperforms thermal imaging for the diagnosis of lower extremity cellulitis: a prospective evaluation. *J Am Acad Dermatol* 2018; 4. Amendola JA, et.al; Using Thermal Imaging to Track Cellulitis. Open Forum Infect Dis. 2023