

Pseudomonas Scrub Down: Advances in Wound Imaging Objectively Confirm the Efficacy of Acetic Acid Against this Pathogen

Background

- *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Escherichia coli* are **opportunistic pathogens common in chronic wounds that delay healing**¹.
- Infections can progress to multidrug resistance given these species' ability to rapidly mutate and form biofilms impenetrable to antibiotics.
- For patients in rural areas with **resource limited** hospitals, infection detection & treatment are often delayed.
- Few clinical investigations have rigorously quantified the difference in effectiveness of commonplace topical agents against varying bacterial species².

We studied the efficacy of acetic acid as a cost-effective cleanser in reducing the area of bacterial load.

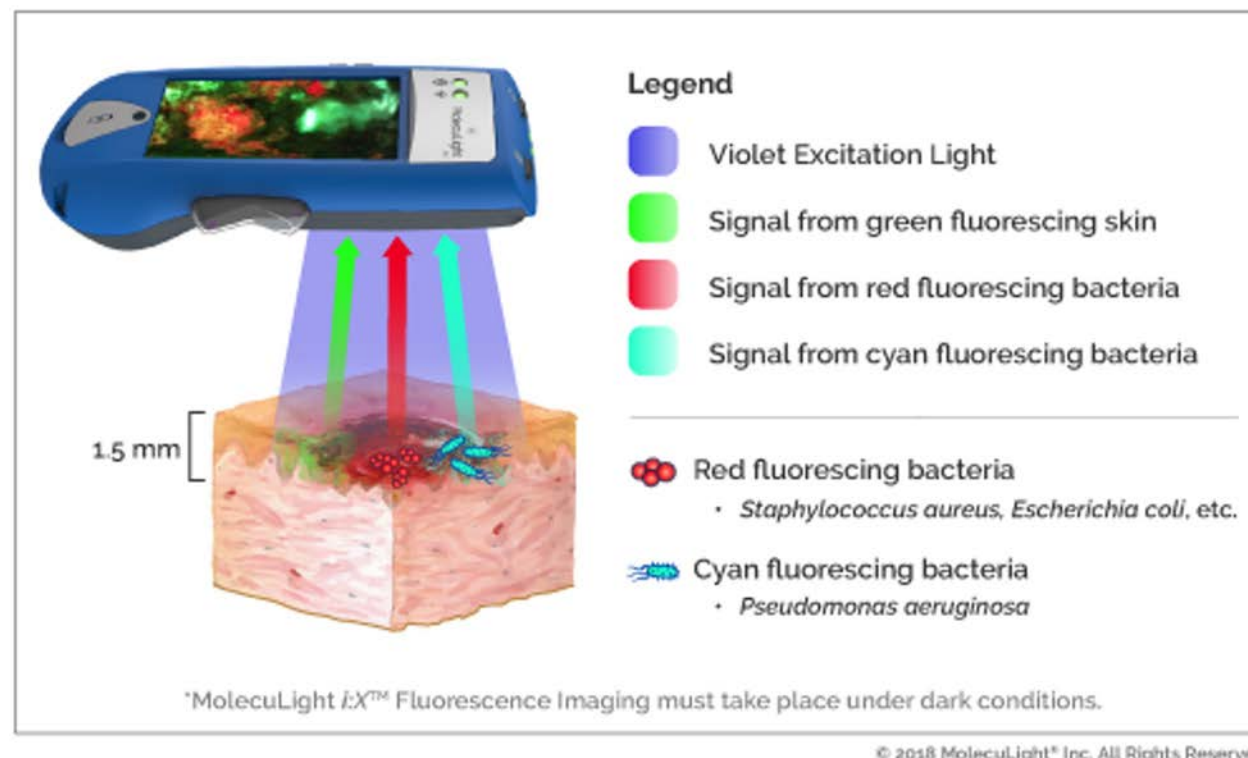
Methods

Procedures

- **Fluorescence imaging (MolecuLight i:X)** was performed on **15 chronic wounds** before and after a vigorous 30 second "scrub" of the wound and periwound with dilute acetic acid (5%).

Image Masking

- A fluorescence image interpretation expert **masked fluorescence positive (FL+) areas indicating bacterial loads >10⁴ CFU/g**.
- The masker was blinded to the type of image (i.e., pre/post hygiene), cleanser, and cleansing technique.



Methods

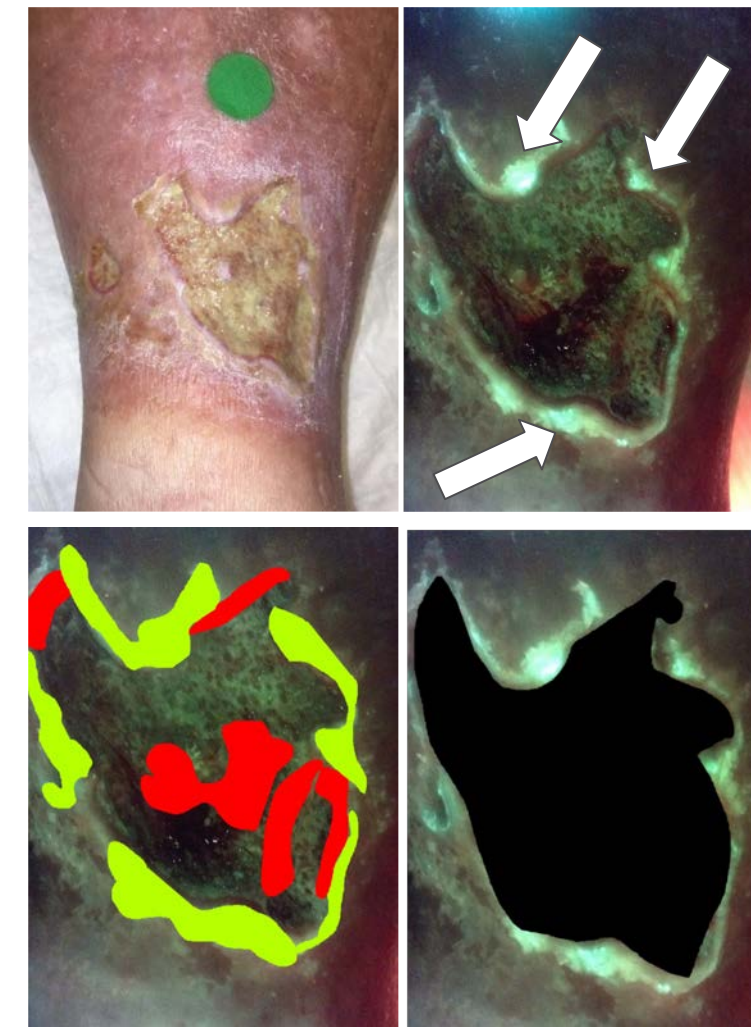


Image Masking (Steps from left to right)

1. The standard image.
2. FL image showing subtle red/pink and bright cyan areas (arrows), all indicating bacteria at loads of concern clinical (>10⁴ CFU/g^{2,3}).
3. The FL positive areas are masked (separately for red and cyan).
4. The wound bed is masked.

Masked areas were reviewed by a panel of 3 other experts for any errors, and then quantified using a custom image analysis algorithm.

Image Analysis

- Differences in FL positive (+) area pre- and post-cleansing were determined for each wound (i.e., relative % change).
- Data were processed, zeroing positive relative % changes in FL areas.
- Median % change in FL+ area were compared between red vs cyan FL.
- Statistical significance was assessed using a Mann-Whitney t-test.

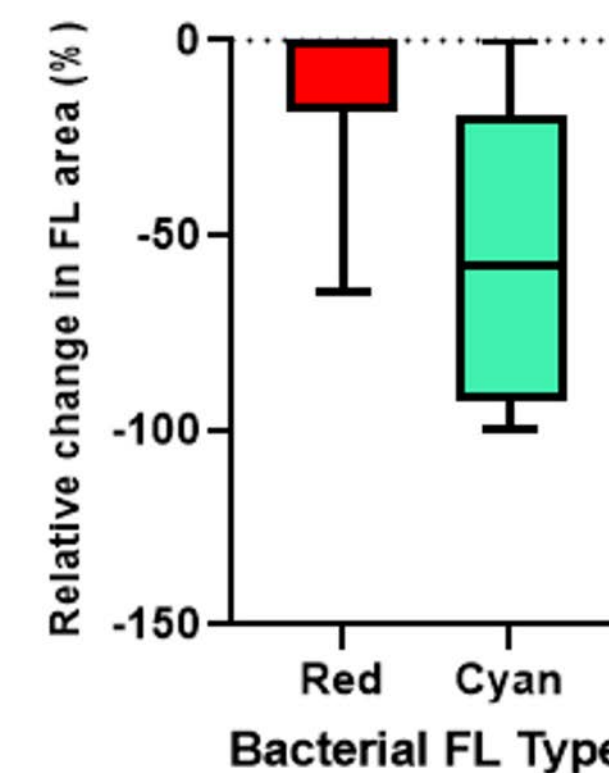
Results

Fluorescence Area Reduction

- The average wound size was 8.34 cm². 12 venous ulcers were included, with the remaining 3 wounds being an arterial ulcer, a traumatic wound, and a wound of another type.
- Among the 15 wounds in the study, 5 displayed only red FL, 10 displayed both red and cyan FL, and none displayed only cyan FL.
- The median reduction in FL area post intervention with acetic acid was 0% for red FL (most bacterial species).
- The median reduction in FL area post intervention with acetic acid was -57.49% for cyan FL (*Pseudomonas aeruginosa*).
- The difference in median FL area reduction were statistically significant per a two-tailed Mann-Whitney test (p=0.083).

Thus, vigorous 30 second scrubbing with acetic acid targeted to cyan FL+ regions can reduce bacterial loads.

Acetic Acid Red vs Cyan Distribution of Change in FL+ Area



Red = 0% decrease
Cyan = 57.49% decrease (-)

Cases



White arrows in images denote regions of high bacterial loads (appears red on image). Yellow arrows in images denote regions of *Pseudomonas aeruginosa* (appears cyan on image).

Example 1

- 50-year-old male with a venous leg ulcer (10.62 cm²).
- A 65% decrease in red fluorescence area and a 90% decrease in cyan fluorescence area were observed after a 30 sec scrub with dilute acetic acid.



Example 2

- 94-year-old female with a venous lymphedema ulcer (54.49 cm²).
- A 36% decrease in cyan fluorescence area was observed after a 30 sec scrub with dilute acetic acid.

Conclusions

- FL-imaging informed cleansing reveals that acetic acid is a promising, low-cost cleanser that can be used to specifically target *P. aeruginosa* infected wounds.
- Our findings are especially meaningful for advancing evidence-based care in resource limited settings and at-home wound management where more expensive cleansers are unavailable³.
- **Performing a FL-informed 30 second scrub with acetic acid can reduce *Pseudomonas* bacterial loads while having lesser efficacy against other bacterial species.**