Is My Wound Infected?
Use Of Hyperspectral Imaging To Assess A Wound's Infectious Status

SWIFT

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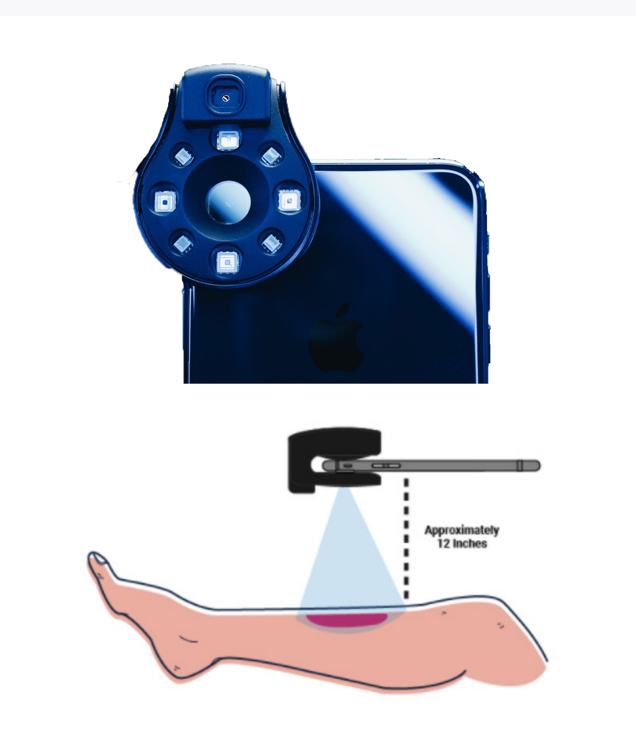
Introduction

Here, we describe our findings on the use of infrared thermal imaging (IRT) of wounds and how this technology can be used to discriminate between inflamed and infected wounds.

Background

- More than 8 million North Americans deal with chronic wounds and their complications. Therefore, there is an immediate need for tools which guide the appropriate and rational use of antibiotics as evidenced by the rapid growth of antibiotic stewardship programs.
- Because the traditional signs of infection, rubor, dolor, calor, and tumor, are shared between incipient infections and aseptic inflammation, discriminating between these entities in the context of wound care represents a challenge.
- IRT is a non-contact, non-invasive imaging modality that has demonstrated to be useful for the routine assessment of patients with wounds.
- IRT captures the heat emitted by the wound and surrounding tissues and allows its visualization and quantification.
- Thermal asymmetry, or the difference between a region of interest and non-affected skin, has prognostic value for suggesting inflammation, infection, and decreased blood supply.
- In addition, when in high enough concentrations, bacteria fluoresce when excited by violet light. This capability has been exploited to detect them in wound beds.
- Recently, Swift Medical launched a novel hyperspectral imaging device capable of capturing IRT and violet-light fluorescent images for bacterial detection, which are then integrated into their measurement software.
- The combined use of wound measurement, temperature measurement, thermal asymmetry quantification, and bacterial fluorescence can potentially be used to predict the inflammatory status of a wound.
- **The Swift Ray 1 hyperspectral imaging device offers the capability of acquiring multi-modal images of tissue that can then be used to predict whether a wound is infected or not.**

Methods



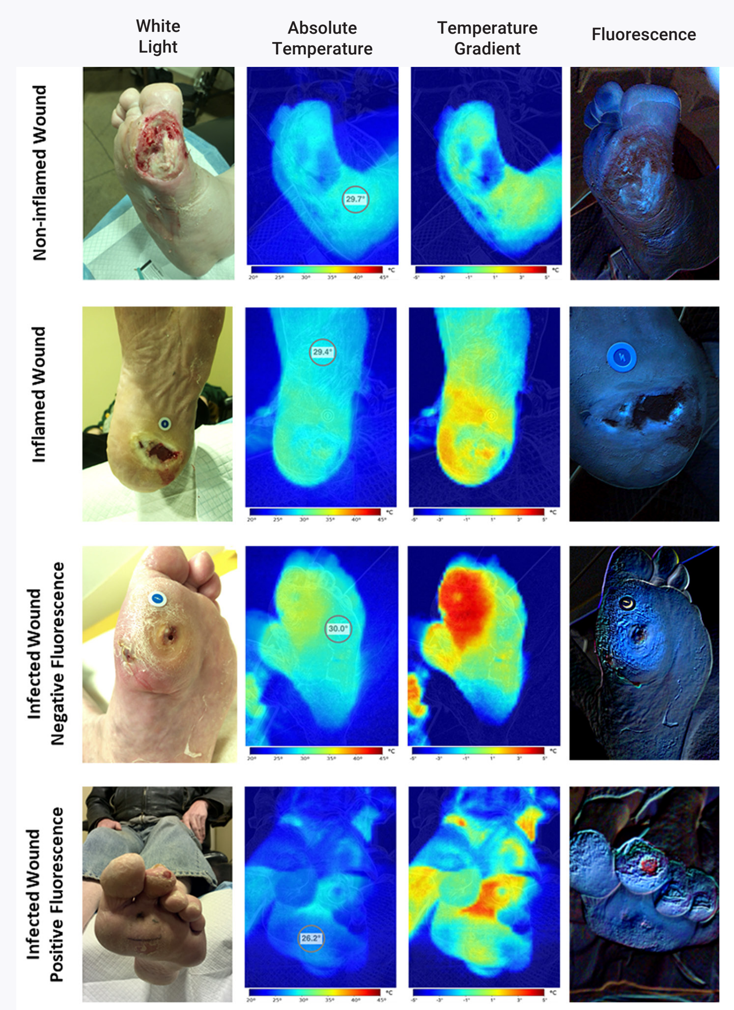
- A series of 64 patients with wounds suspicious of infections were imaged using the Swift Ray 1 hyperspectral camera.
- Confirmation of an infectious process was done either by tissue biopsy microbiological culture or clinically on-site by an expert surgeon.
- Analysis of the images was performed and the features that correlated with an inflammatory vs. infectious process are presented here.
- For the development of predictive analytics, principal component analysis (PCA) followed by K-nearest neighbor clustering (KNN) was done. 80% of the data was used to train the model and 20% was held for test.
- Analysis was conducted using the R v.4.0.2 statistical package at the 95% CI.

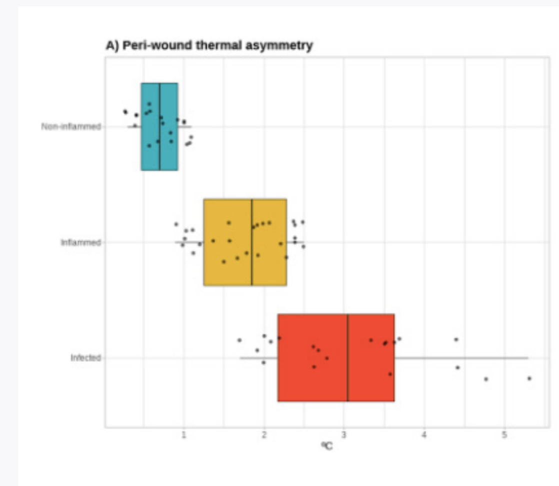
Results

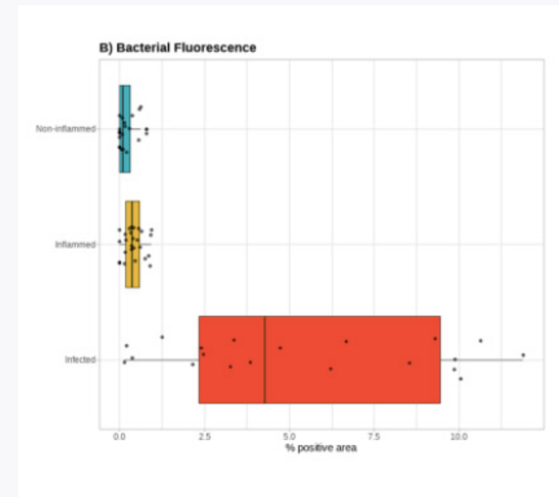
- Wound type, wound area, wound bed thermal asymmetry, peri-wound thermal asymmetry, presence of bacterial fluorescence, and area of fluorescence were recorded.
- Wound type and area were not correlated with infection status.
- Qualitative analysis of the images show 4 patterns:

STATUS	WOUND BED THERMAL ASYMMETRY	PER-WOUND THERMAL ASYMMETRY	BACTERIAL FLUORESCENCE
Non-inflamed	Decreased	Slightly increased	Negative
Inflamed	Decreased to slightly increased	Moderately increased	Negative
Infected with Negative Fluorescence	Slightly increased to increased	Increased	Negative
Infected with Positive Fluorescence	Slightly increased to increased	Increased	Positive

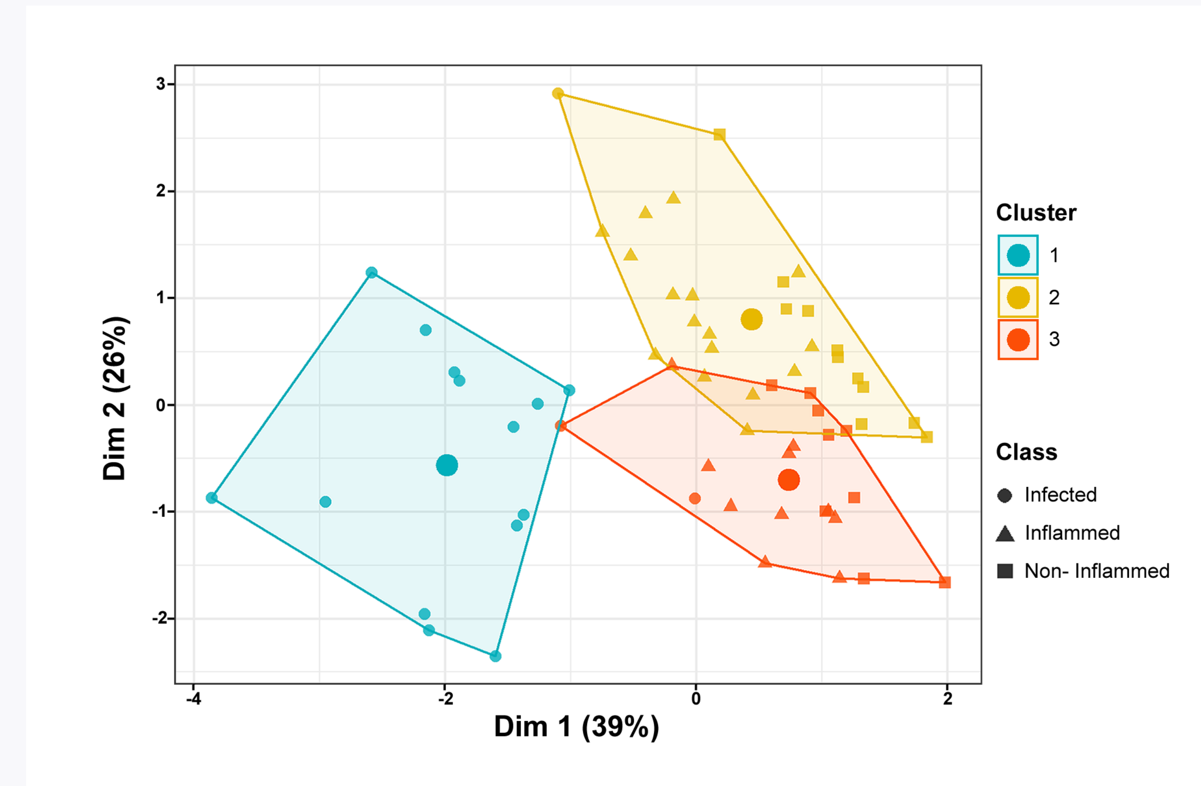
Results







PCA-KNN Clustering



PCA-KNN clustering show an accuracy of 71% for the model to discriminate between Non-Inflammed, Inflamed, and Infected wounds based on the hyperspectral and clinical data.

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              Accuracy : 0.714
                95% CI : (0.419, 0.916)
   No Information Rate : 0.571
   P-Value [Acc > NIR] : 0.211

                 Kappa : 0.548

                     Class: Infected Class: Inflammed Class: Non-inflammed
Sensitivity                    1.000            0.625                0.667
Specificity                    0.909            0.833                0.818
Pos Pred Value                 0.750            0.833                0.500
Neg Pred Value                 1.000            0.625                0.900
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Discussion

- Here, we demonstrate that the combined use of clinical data plus hyperspectral imaging, including thermal imaging and bacterial fluorescence, can be used to discriminate between aseptic inflammation and wound infection.
- While more studies need to be done to analyze longitudinal data over an increased number of patients, this technology is a promising tool for developing better antibiotic stewardship programs and rationalizing antibiotic use.
- The Swift Ray 1 offers hyperspectral imaging capabilities that allow clinicians to acquire images to complement their clinical assessments and enhance point-of-care clinical decision making.
- In summary, along with clinical data, the use of the Swift Ray 1 hyperspectral imaging device can help categorize wounds as not inflamed, inflamed, or clinically infected; thus, helping clinicians make better decision making regarding further testing and antibiotic use.

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