Tools to Aid in Measuring Complete Wound Debridement

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BACKGROUND

Wound debridement has been standard of care for over a decade. It is beneficial by removing necrotic tissue, bacteria, and senescent cells while also stimulating activity of growth factors. There does not currently exist a standardized definition of what constitutes adequate debridement. The closest standard is “an attempt to remove all non-viable tissue and bacteria”. This is sub-optimal as non-viable tissue or bacterial colonization is not always clinically evident. The advent of near-infrared spectroscopy (NIRS) has allowed for precise identification of non-viable tissue with hemoglobin metrics. Paired with bacteria fluorescent imaging, these two technologies allow for complete removal of non-viable tissue and bacteria. The objective of this study was to create a standardized set of guidelines for what defines adequate debridement: Complete removal of non-viable tissue and/or infected tissue with the assistance of NIRS and bacteria fluorescent imaging.

OBJECTIVE

To create a new set of objective guidelines with no dispute as to whether or not a wound has been 100% debrided. All bacteria > 10^4 per gram of tissue and all tissue with an Hb reading > 0.5 will be removed as long as removal does not delay healing (ie. CLI, osteomyelitis risk).

METHODS & RESULTS

Patients who had an open wound or prominent callus were initially evaluated for debridement based solely on clinical assessment. NIRS and bacteria fluorescent imaging was then performed to determine if advanced imaging would change the debridement plan. Any tissue with a deoxyhemoglobin (Hb) value greater than 0.5 with NIRS was classified as non-viable and was sharply debrided to reduce infection risk. Any tissue that fluoresced red or cyan was determined to have greater than 10^4 bacteria/gram of tissue and was thoroughly cleansed or debrided to remove colonized bacteria. The wound was reimaged post-debridement to ensure completeness.

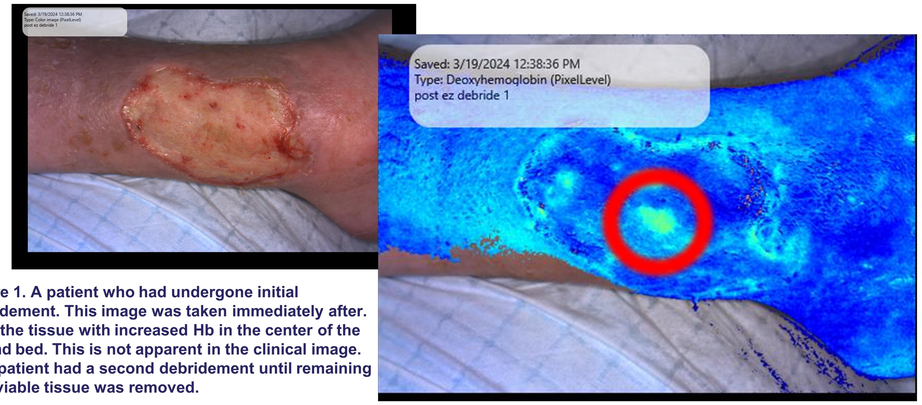


Figure 1. A patient who had undergone initial debridement. This image was taken immediately after. Note the tissue with increased Hb in the center of the wound bed. This is not apparent in the clinical image. This patient had a second debridement until remaining non-viable tissue was removed.

NIRS was able to detect non-viable tissue with greater sensitivity than clinical assessment alone. Bacteria fluorescent imaging was able to detect bacteria that was not clinically evident. This study is still ongoing with 16 patients currently enrolled. Data will become more compelling as enrollment grows, however so far NIRS has been able to identify non-viable tissue on 7 separate occasion across all patients when it was not immediately clinically evident. These instances consisted of early callus formation, necrotic tissue, tunneling, deeply macerated tissue, and fibrous tissue. Two cases are presented to show significance.

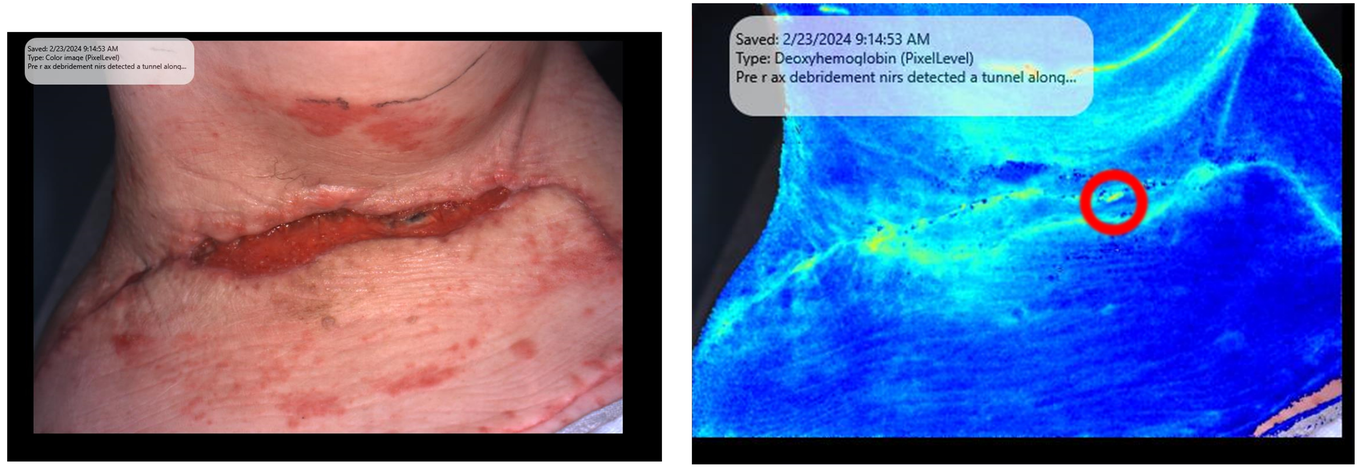
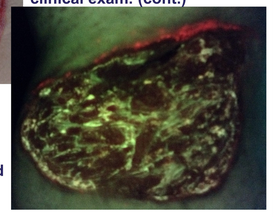


Figure 2. Clinical image (left) and tissue deoxyhemoglobin (right) image of axillary wound being screened for nonviable tissue. NIRS detected a pinpoint with Hb > 0.5. A tunnel was discovered, and drainage was expressed. Drainage was serosanguineous so no further prophylactic measures needed to be taken. Concurrently this patient was being treated with NPWT. Stagnant drainage not removed by a wound vac may have become a site of infection and complicated healing.

DISCUSSION

- Incidence of bacterial colonization greater than 10^4 simultaneous to presence of non-viable tissue is still being compared.
- The two factors go hand in hand.
- Necrosed or static tissue especially along wound margins may harbor bacteria that is not clinically visible.
- Bacterial fluorescence in addition to NIRS is the most objective and thorough debridement to date.

Figure 3. A paratrooper who suffered abdominal trauma by mis-landing on a branch during a jump. No remarkable erythema or drainage upon clinical exam. (cont.)



(Cont.) Bacterial fluorescence detected colonization along the superior margin. This was sharply debrided and irrigated before patient continued to heal.

CONCLUSION

- Utilizing NIRS and bacteria fluorescent imaging can be a significant aid in determining complete debridement.
- A routine and thorough debridement will promote re-epithelialization through removal of devitalized tissue, bacteria, and senescent cells.
- Advanced imaging can act as a guide as well as an assessment of adequacy of debridement.

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