



Near-Infrared Spectroscopy as an Alternative Approach for Pressure Injury Prevention in Inpatient and Outpatient Settings

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BACKGROUND

Pressure injuries (PIs) are focal damage to superficial skin and deep tissue caused by long durations of pressure. It most commonly occurs over bony prominences, often in patients with mobility issues or vascular disease. 2.5 million people in the United States develop pressure injuries annually according to the National Pressure Injury Advisory Panel (NPIAP) most occurring in healthcare settings and are especially prevalent in acute care settings (NPIAP, 2020). Patients who live in bed, frequently use a wheelchair, or have compromised mobility are at elevated risk, and intervening early may prevent the progression of pressure injury. This study intends to target risk of incidence at the source and minimize contributing factors at inpatient and outpatient medical centers for the prevention of wounds to these at-risk patients with the use of innovative imaging technology that has showed utility in various clinical applications.

METHODS

This observational study used prospectively collected data with retrospective analysis of inpatient and outpatient populations at Madigan Army Medical Center. Patients were enrolled based on clinician-identified pressure injury risk factors. The sacrum and heels were assessed clinically and assigned Braden scores, with pressure injuries documented and staged when present. Following clinical evaluation, all patients were imaged using a Near Infrared Spectroscopy (NIRS) device (SnapshotNIR, Kent Imaging, Calgary, Canada) to measure tissue oxygen saturation (StO₂), oxyhemoglobin (HbO), and deoxyhemoglobin (Hb). Early pressure injury was defined as a $\Delta\text{HbO} > 0.1$ or $\Delta\text{Hb} > 0.1$ compared to surrounding tissue. Patients with clinically or NIRS-identified injuries were offloaded; NIRS-driven care changes were recorded.

RESULTS

In a cohort of 100 patients (87 inpatients, 13 outpatients), near-infrared spectroscopy (NIRS) was used to assess early pressure-injury risk at the sacrum and bilateral heels. A NIRS-positive finding was defined as $\Delta\text{HbO} \geq 0.1$ or $\Delta\text{Hb} \geq 0.1$ at any region of interest. Braden scores were recorded, with scores < 13 classified as high-risk. Clinically visible pressure injuries were uncommon (13%), whereas NIRS detected subclinical tissue compromise in 83% of patients. All high-risk Braden patients (11/11) demonstrated at least one positive NIRS finding. Outpatients showed a higher rate of NIRS positivity (92.3%) than inpatients (81.6%). Patients with one NIRS-positive site had an 81.9% likelihood of positivity at an additional site, indicating frequent multi-site vulnerability. NIRS-related changes in care were documented to compare traditional risk assessment with NIRS-detected ischemia.

NIRS assessments frequently led to actionable clinical interventions. Sacral findings prompted changes in care for 46% of patients, while right-heel and left-heel findings resulted in changes for 68.4% and 65.3%, respectively. These modifications highlight the added clinical value of NIRS in identifying tissue compromise not evident on visual examination. NIRS findings aligned with 100% of positive clinical assessments, supporting the reliability of NIRS in detecting clinically meaningful, pressure-related tissue changes.

Figure 3. Distribution of Patients Exhibiting NIRS-Guided change in care plan management across different anatomical sites.

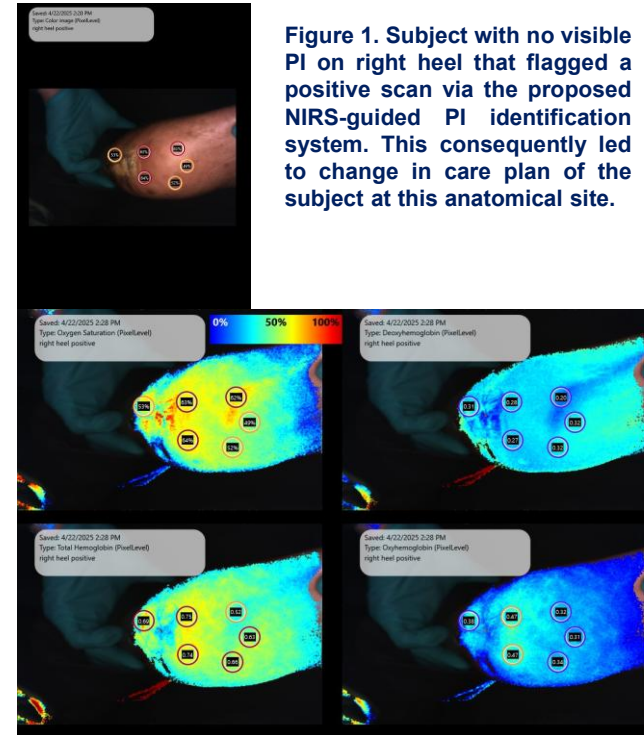
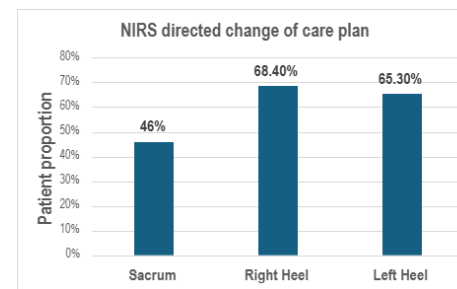


Figure 1. Subject with no visible PI on right heel that flagged a positive scan via the proposed NIRS-guided PI identification system. This consequently led to change in care plan of the subject at this anatomical site.



DISCUSSION

This study underscores the persistent challenge of pressure injuries across both inpatient and outpatient settings. Multiple pressure injuries were common, suggesting that once tissue damage occurs, patients are more likely to develop additional injuries or share underlying risk factors that affect multiple anatomical sites. Despite greater mobility, outpatients demonstrated a comparatively higher incidence of pressure-injury risk, likely due to comorbidities such as diabetes and vascular disease. These findings highlight that both patient populations remain vulnerable and that risk is often multifactorial and not confined to a single region.

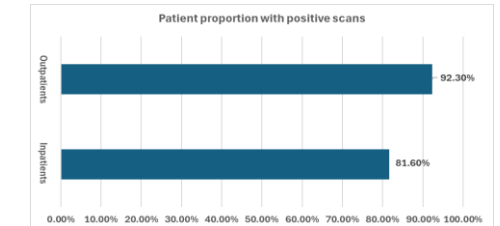


Figure 2. Distribution of positive NIRS scans across inpatient and outpatient populations, respectively.

CONCLUSION

This study highlights the value of targeted pressure-injury assessment and demonstrates that incorporating NIRS can enhance early detection of tissue compromise. By identifying subtle physiological changes before skin breakdown becomes visible, NIRS supports more proactive prevention, improving patient safety while potentially reducing hospital costs and liability. Continued research is needed to evaluate how interventions such as offloading, nutritional optimization, and moisture management contribute to long-term pressure-injury risk reduction.