POSTURE DETECTION FOR PRESSURE INJURY PREVENTION WITH A NOVEL SMART SURFACE SYSTEM FOR MONITORING AT-RISK PATIENTS IN A POST-ACUTE CARE FACILITY

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Evidence shows that healthcare-acquired pressure injuries (HAPIs) impact patient outcomes, length of stay, and hospital costs. Patient repositioning (caregiver assisted posture change) during scheduled rounds is the gold standard of care for HAPI prevention. Manual monitoring of patients' posture in a complex hospital environment is neither efficient nor practical.

Relieving interface pressure (IP) where high levels are suspected is fundamental to pressure injury prevention protocols. The accurate measurement of pressure exerted in a particular area (positioning) and how long a patient remains in one position (mobility) can be challenging. Evidence-based advice about optimal repositioning remains inconsistent.

Aim

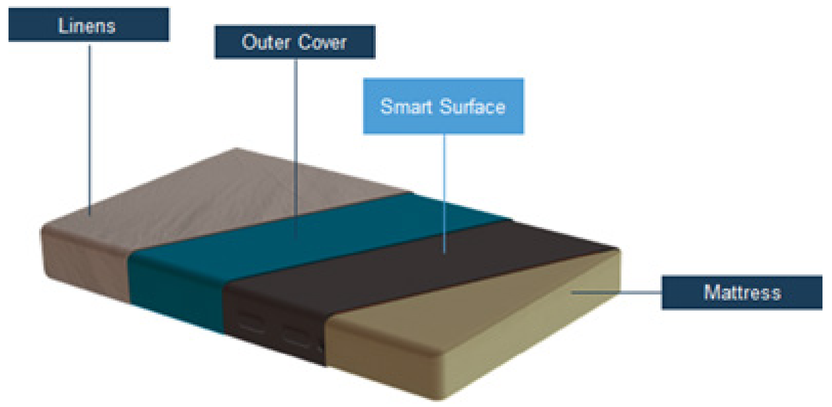
The goal of this analysis is to demonstrate the accuracy of a smart surface system (designed to monitor multiple HAPI risk factors) in detecting the postures of patients, compared to nurse observations of patient posture.

Methods

A prospective, single-site trial was conducted at an Ontario tertiary care facility. Ethics approval was granted. All staff on the study units received training in recruitment and study protocols. This poster represents one aspect of a more extensive study. Results of the microclimate analysis are published elsewhere.

The eligible population was recruited from complex continuing care and post-acute care rehabilitation settings. Inclusion criteria were adults, hospitalized for > 18 hours, at-risk of pressure injuries, as defined by the InterRAI Pressure Injury Risk Assessment Scale with or without a current pressure injury. Patients identified as being at-risk of pressure injury received standard of care while placed on the smart surface for timed intervals. Nurses' assessment data, including patients' position at the time of reposition, were collected at three-hourly time points–the smart surface recorded a range of data, including skin microclimate and IP. Comparative statistical analysis was conducted between the two datasets to determine the accuracy of the smart surface posture detection compared to the nurse assessment of posture.detection and nurse assessment of posture. Results of the microclimate analysis are published elsewhere.

Figure 1. A cross-sectional view of the smart surface platform installed over a mattress. The smart surface platform comprises an array of sensors embedded in a thin, flexible surface placed underneath the bedsheet. It is not in direct contact with the patient.



Participants received standard of care, including manual repositioning as appropriate, while placed on the smart surface for timed intervals. Nurses completed a baseline assessment at the start of the 18-hour period (time point T0). Following the same protocol at three-hourly intervals (timed to coincide with manual turns where applicable), any changes from baseline (T0) or the previous assessment (T1-5) were noted.

Sensors gathered data from the subject's bedding surface in the form of IP (mmHg), temperature (Celsius) and humidity (0-100% RH) at four-second intervals. For the initial analysis, data related to mobility/activity status were extracted from the head to toe assessment forms. A comparative statistical analysis was conducted between the two datasets.

To establish accuracy of the smart surface posture detection, the smart surface system used continuous IP visualizations to determine posture, and these were compared to patient posture's recorded by nurses. Nurses recorded postures as supine, left lateral, left fetal, right lateral, right fetal, and sitting. The smart surface posture detection did the same.

Results

A total of 104-patients met the inclusion criteria; the mean age was 59 years (range 21-92, ± 19.15). Sensor monitoring hours (1,407) generated 1,101,780 frames of surface data. Individual nurse-recorded patient postures used for this analysis totalled 600. Nurse-recorded posture observations were compared to the smart surface platform data generated at exact corresponding time points. The comparison resulted in a 92% accuracy, matching 552 out of 600 nurse postures. Using a binomial test this result was found to be statistically significant (P<.05) (CI 95%).

Table: Overview of trial results related to positioning. All tests of equal or given proportions of smart surface data accuracy produced p-values of less than.05.

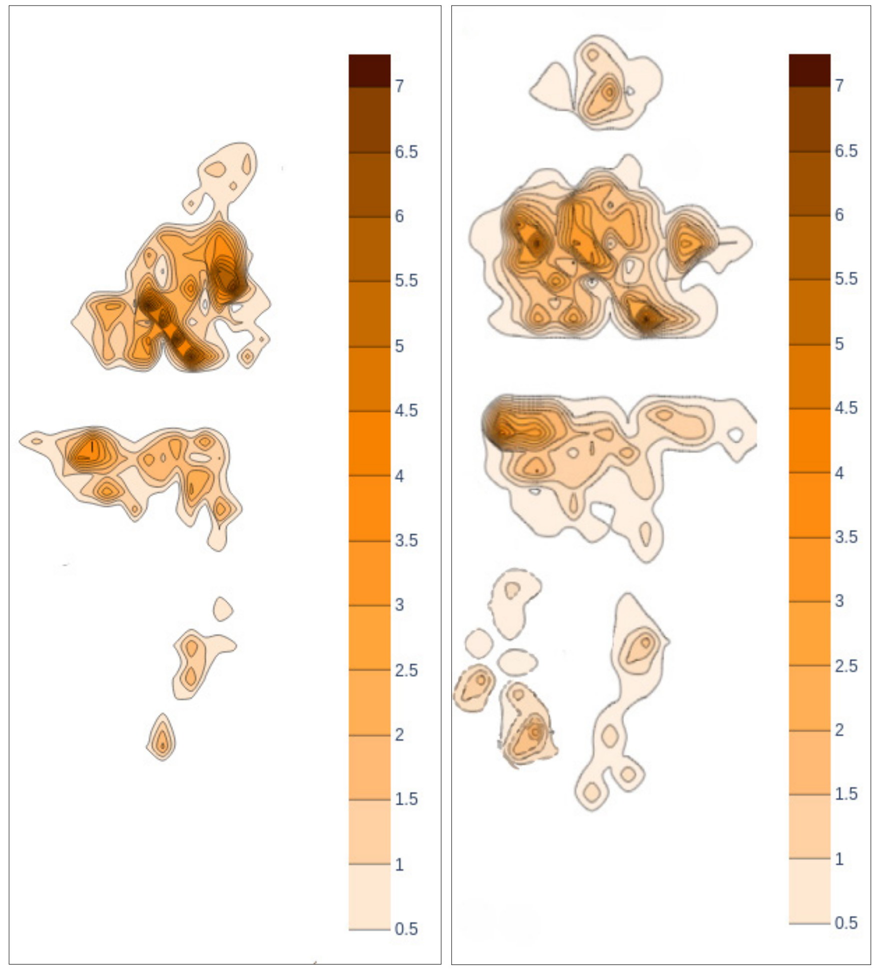
Number of times nurses recorded patient posture	Number of times smart surface platform data postures correlated
n = 600	n = 552, 92% (95% CI = (89%, 94%))

Implications

Monitoring and relieving IP from segments of the body where high levels are suspected are fundamental to pressure injury prevention protocols. However, accurately measuring how much pressure is being exerted in a particular area (positioning) and how long a patient remains in one position (mobility) can be difficult, particularly in patients with limited sensation or communication skills. Visual inspection is challenging as it is not possible to observe an at-risk area while a patient is lying on it. Additionally, visual observation is not a reliable measure of changes taking place under the skin. By the time a patient has been moved, tissue damage may already have occurred. Peterson et al., (2010) suggest that standard turning, even by experienced nurses, may not adequately unload all areas of high skin-bed IP. Further confounding this issue, frequent turning has been linked to detrimental physical and psychological impacts for patients and increased risk of musculoskeletal injury for care providers.

This study's results demonstrate high levels of accuracy in the smart surface system's ability to detect patient posture compared to observations made by nurses. This demonstrates the feasibility and potential for an intelligent system to continuously monitor patients' posture changes. Detecting and recording the patient's posture may help caregivers reposition more efficiently and reduce the risk of developing HAPIs.

Figure 2: Two examples of smart surface system-generated IP visualizations. The smart surface system recorded left fetal and supine, respectively.



Conclusions

The study shows statistically significant accuracy levels when comparing sensor-generated data of patient mobility to nurses' intermittent physical assessments. This has important implications as manual repositioning and visual inspection of skin require resources, especially time, that may be limited due to high patient acuity and competing demands.

Existing pressure injury prevention protocols that rely on intermittent physical assessment limit care providers' ability to identify risks, deliver personalized care, and measure interventions' effectiveness. The smart sensor platform's capacity to continuously and accurately measure pressure injury risk factors, including posture, offers the potential to decrease unnecessary interventions, inform targeted management strategies and improve the allocation of limited nursing resources. Having validated the smart sensor platform's ability to detect posture accurately, the next step is to teach the system to classify multiple factors related to patient positioning and other risk factors. The large volume of IP visualization data collected forms a basis for further artificial intelligence applications (e.g., machine learning algorithms to detect unobserved self-turns).

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Keywords: Pressure injury, posture detection, repositioning, sensor technology, artificial intelligence, machine learning.

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