FEASIBILITY OF A NOVEL SMART SENSOR PLATFORM FOR MONITORING PATIENTS AT RISK OF PRESSURE INJURY IN A POST-ACUTE CARE FACILITY

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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 8-hour period (time point T0). Following the same protocol at 3-hourly intervals (time to coincide with manual turns where applicable), any changes from baseline (T1) or the previous assessment (T1-T5) were noted.

Results
A total of 104-patients met the inclusion criteria and participated in the study. Mean age was 59 years (range 21-92, ± 19.15). Nurse observations totalled 511. The 1,407 sensor monitoring hours generated 1,101,790 frames of surface data.

Discussion
The study results demonstrate the smart sensor platform’s ability to collect (IP and microclimate data that correlate with nurse assessment data. The preliminary analysis shows the potential for continuous monitoring to simultaneously identify events including self-turns, urinary incontinence and patient temperature changes remotely. The large volume of data collected forms a basis for artificial intelligence applications (e.g., IP visualization to train machine learning algorithms to detect self-turns). Existing PI prevention protocols that rely on intermittent physical assessment of mobility, temperature and humidity limit care providers’ ability to identify risks, deliver personalized care and measure the effectiveness of interventions. This technology has the potential to improve the allocation of limited nursing resources. It can decrease unnecessary interventions and inform targeted management strategies.

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 bed sheet. It is not in direct contact with the patient.

Figure 2: Interface pressure (PSI), relative humidity (% RH), and temperature (°C) visualizations of a patient in right lateral position. Generated from Smart Surface Platform sensor data.

Table: Overview of trial results. All tests of equal or given proportions between smart surface inter-rater reliability and naïve model inter-rater reliability

<table>
<thead>
<tr>
<th>Interface pressure visualization</th>
<th>Nurse recorded events selected for analysis</th>
<th>Number of events identified using smart surface platform data</th>
<th>Inter-rater reliability</th>
<th>Naïve model inter-rater reliability</th>
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<tbody>
<tr>
<td>Total patient positions recorded</td>
<td>n=630</td>
<td>Patient positions correctly identified by raters n=603</td>
<td>95.7 % (95% CI=94%,97%)</td>
<td>61.1%</td>
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<tr>
<td>Humidity</td>
<td>Total events recorded n=132</td>
<td>Events identified using sensor humidity data n=125</td>
<td>94.6 % (95% CI=93%,98%)</td>
<td>70.5%</td>
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<tr>
<td>Temperature</td>
<td>Total events recorded n=132</td>
<td>Events identified using sensor temperature data n=115</td>
<td>87.1% (95% CI=80%,92%)</td>
<td>70.5%</td>
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Sensors gathered data from the subject’s bedding surface in the form of interface pressure (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 inter-rater reliability (IRR) of IP data, classifications of sensor data by three independent raters were compared to patient position(s) recorded by nurses. For microclimate (temperature and humidity), IRR was established by comparing results of a model that classifies whether given data represented wellness event and comparing it to the classification inferred from nurse recorded moisture comments. A naïve model was employed that used the most common nurse observation as a prediction. 9

Table: Feasibility of a novel smart sensor platform for monitoring patients at risk of pressure injury in a post-acute care facility

<table>
<thead>
<tr>
<th>Objective</th>
<th>Methods</th>
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<td>To evaluate the ability of a smart surface platform to measure clinical data on patient mobility and skin microclimate simultaneously and to compare data generated to scheduled nursing observations in line with clinical protocols.</td>
<td>This prospective trial was conducted at a single tertiary care facility and sensor-generated data of both patient mobility (IP) and skin microclimate (humidity and temperature). The novel smart sensor platform can continuously measure PI risk factors accurately. This has the potential to enhance PI prevention approaches.</td>
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References

Keywords: Pressure ulcer, pressure injury, sensor technology, artificial intelligence, machine learning.