Potential Utility of Sacral Skin Temperature to Detect Patients at High Risk for Pressure Injury
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Background and Objectives
Hospital-acquired pressure injuries (HAPIs) are a common & substantial burden on the health care system, with more than 2.5 million patients in acute-care hospitals treated in the US annually.\textsuperscript{1} While HAPIs are a known concern for hospitalized patients with vascular disease,\textsuperscript{1} it is unknown if all such patients are similarly at risk. To date, there is no noninvasive method in clinicians can use to expediently and efficiently determine which patients with vascular disease are most likely to develop a deep tissue pressure injury (DPI). Measuring skin temperature is one potential strategy that may allow health care providers the ability to prospectively determine if an area of intact discoloration will eventually progress into necrosis. Thermography is a noninvasive and objective technique to estimate local hemodynamic status based on skin temperature differentials between and among different sites. An underlying assumption is that tissue regions with blood flow deficits will render skin temperatures less than those in regions not affected. We hypothesized that such temperature differentials are more pronounced in persons with cardiovascular disease and related conditions resulting in diminished perfusion pressures due to regional vascular deficits or systemic hypotension. We hypothesized that patients with such conditions have a lower relative sacral skin temperature that can be detected via a rapidly obtained thermal image.

Methods
PATIENTS: The sample comprised 100 patients (58 men, 42 women) with mean \( \pm SD \) ages of 70.4 \( \pm 14.4 \) and 74.0 \( \pm 14.5 \) years, respectively, who were admitted to a cardiovascular ICU or a neurological ICU.

IMAGE ANALYSIS PROCEDURE: A commercially available thermal imaging system was used to obtain simultaneous standard photographic and infrared thermal images (11 \( \times \) 14 inches) that included the patient’s buttocks and a remote skin area after the patient was off-loaded for about 4 minutes. The analysis procedure was standardized as illustrated in Figure 1. Temperature differentials are expressed as \( \Delta T \) = sacral temperature – control temperature. The system software calculates the average temperature within the target sacral area and the control area. Examples of patients with different temperature profiles when compared to the distal (control) skin area are illustrated in Figure 2.

DATA ANALYSIS: Prior measurements of healthy subjects showed that sacral skin was on average 0.75 C° less than the remote skin site (\( \Delta T = -0.75 \) C°). A threshold (\( \Delta T_{\text{norm}} \)) of twice that amount (\( \Delta T = -1.5 \) C°) or more was considered to put a patient at greater than normal risk for PI based on the hypothesis that low sacral temperatures were associated with lowered blood perfusion issues of various clinical conditions. Comparisons of sacral to control area temperature differentials were used to categorize patients as either high risk for a PI (\( \Delta T \pm -1.5 \) C°) or low risk for a PI (\( \Delta T < -1.5 \) C°). In addition, 3 groups (Table 1) were identified to assess whether temperature differentials were significantly associated with conditions related to impaired blood perfusion to the skin. The potential consequence of vascular status and temperature differentials was examined by considering the number of patients within each group who had \( \Delta T \) of -1.5 or less compared to those with \( \Delta T \) of more than -1.5 using \( \chi^2 \) analysis.

Results
Of the 100 patients, the first group was comprised of patients with cardiovascular disease (CVD), which we operationally defined as any patient with a diagnosis of coronary artery disease (CAD), peripheral artery disease, or atherosclerotic heart disease (n = 74). The second group comprised patients who experienced a mean arterial blood pressure (MBP) of less than 60 mmHg at any time during their hospital stay (n = 58). A third group (CVD + MBP) comprised patients who had both CAD and MBP of less than 60 mmHg (n = 43). The Table summarizes the relationships between the presence or absence of these conditions and a \( \Delta T \) indicating a clinically relevant difference in perfusion. Analysis via \( \chi^2 \) indicated no statistically significant differences between the subgroups.

Table. Relationship Between Temperature and Selected Clinical Conditions Associated With Impaired Perfusion. Numeric entries are the number of patients with the specified condition and differential temperature range between target and control area.

Conclusions
Although infrared thermal screening may provide visually impressive and potentially useful images in some cases, temperature differentials to detect patients at particularly high risk related to vascular status is not supported by the current results.

References