SmartSense: An Improved Method for Hospital Acquired Pressure Ulcer (HAPU) Prevention

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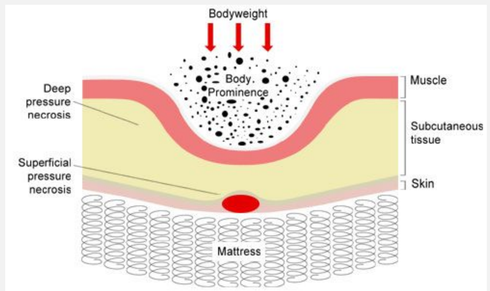
Biomedical Engineering Capstone Design

Background

Hospital Acquired Pressure Ulcers (HAPUs):

- Damage to the skin and/or underlying tissue due to prolonged pressure on the bony areas of the body
- 2.5 million occurrences of HAPUs costing hospitals $9.1-$11.6 billion per year in the US with around 60,000 deaths per year
- Current Prevention Method: manual repositioning of patients every 1-2 hours arbitrarily by nurses and assessing patient's risk factors with the Braden Scale

Problem	HAPUs Occurring at the Heels
Population	Low mobility patients
Outcome	Faster recovery time Decrease overall cost of treatment Decreased burden on nurses



Objectives

- Accurate
- Simple
- Affordable
- Comfortable
- Biocompatible

Functions

- Detect pressure and Braden Scale values
- Track pressure over time
- Categorize pressure ulceration risk
- Display pressure over time visual

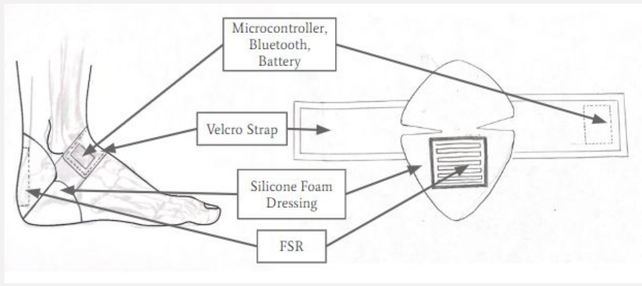
Form Factor

Force Sensitive Resistor (FSR) embedded within a silicone foam heel dressing with adjustable Velcro strap containing Bluetooth electronics

(a)

(b)

(c)



(a) Silicone foam dressing functions as form factor material to reduce shear and provide layer of cushioning; angle shows electronic components located on Velcro strap

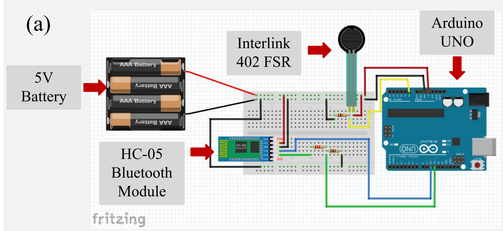
(b) Velcro strap holds the silicone foam dressing to the heel to allow for variations in level of mobility

(c) Diagram detailing form factor

Risk Algorithm & Sensor System

Risk algorithm evaluates patient risk level using real time pressure data wirelessly transmitted from FSR using Bluetooth, and individual patient risk, determined by Braden Scale values

(a)



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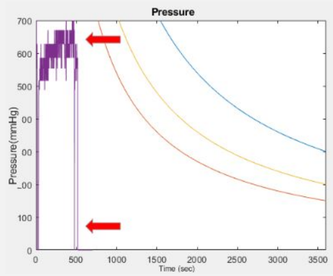
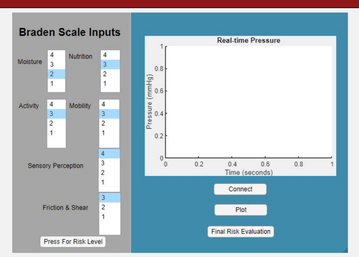


(a) Circuit diagram shows current electrical components

(b) Pressure vs. Time graph from force data, with imposed Reswick and Rogers curve. Top arrow indicates prolonged pressure over a duration of 8 minutes, bottom arrow shows a drop in pressure to zero mmHg after repositioning

User Interface

- MATLAB app
- Easy integration into the hospital setting and nurse workflow
- Allows nurses to quickly assess patient risk level to determine whether intervention is necessary



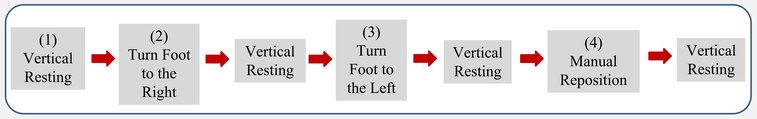
Validation Results

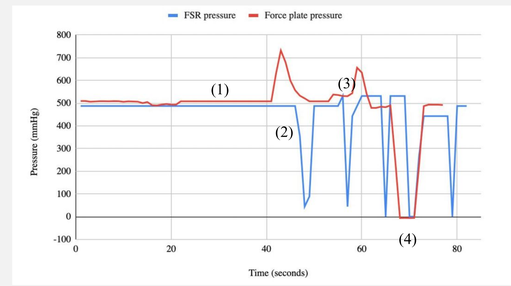
Sensor Validation (Weights Testing)

- FSR error percentage: ~1 to ~10%

Union College Ethics Board Exempt Validation Testing

- Measured heel pressures with Pasco Force Plate in 7 subjects and compared to pressures from FSR
- FSR senses changes in pressure over time
- Protocol:





Testing protocol performed on Pasco Force Plate (red) and FSR (blue). Both show comparable pressure at heel when subject is vertically resting, and significant changes in force during periods of turning and repositioning.

Practically Assessment: AMC feedback

- Approved of design and thought product would integrate well into a clinical setting

Conclusions & Future Directions

Conclusions:

- Developed a low-cost individual pressure ulceration risk system
- Used existing hospital procedures to develop an easy to interpret user interface and a form factor with simple implementation

Future Directions:

- Miniaturization of electrical components
- Modularization of design
- User Interface App Improvement
- Human trials to assess validity of risk algorithm

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