Affordable Pressure Ulcer Prevention: Device, System, and Algorithm

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Motivation

Fig. 1. Healing of pressure ulcer over several months

Painful; wound healing takes up to several months/years. Adds $11B annually to US health care costs.

Cause: External pressure > 30mmHg restricts blood flow.
- Tissue deprived of oxygen.
- Can lead to ischemia, tissue necrosis.

Need: Compact, low cost prevention methods:
- In hospital and home setting.
- During surgery.
- In a long term care facility.

Long Term Vision

Autonomous sensor:
- Wireless communication
- Disposable
- Self powered
- Comfortably wearable for up to 7 days.

Measure data from multiple at-risk sites on body

System allows input of patient-specific characteristics:
- Age; Tissue quality; Other conditions
- Alert threshold patient-specific

Multiple options for communication:
- Caregiver: Monitor (Reduces workload)
- Doctor: Cloud/Web (Detailed information)
- Patient: Smartphone (Improved Independence)

Alert only when intervention necessary

Preliminary Results

Pressure measurement: Polymer force sensor [1]

Challenges:
- Nonlinear F-R characteristic: Correction algorithm
- Part-to-part variability: 2-point calibration

Demonstrated +/-3% accuracy

Fig. 3. Force-conductance characteristics of FSR 402 Sensor

Wired prototype: Pressure, temperature measurement [2]

Data from multiple sites, 7 hour surgery, porcine animal model

Validated key aspects of approach:
- Sampling rate sufficient to resolve pressure relief events.
- Relief in pressure is much less pronounced, or absent, in the results for sensor 3 as compared to sensor 2:
- Importance of having multiple sensors for individual contact pressure measurements for each at-risk point on the body.

Fig. 4. Measurement results, before and after calibration

Fig. 5. Flexible Wired PCB Prototype

Fig. 6. Sites instrumented on pig

Fig. 7. Pressure & Temperature data

Current Work

ECE MQP: Wireless measurement pressure, temperature, humidity
BME MQP: Biocompatible bandage, adhesive materials

Fig. 8. Wireless sensor patch block diagram

Fig. 9. PCB layout

Near Term Goals

Dec 2016
- Rigid PCB prototype

April 2017
- Flexible PCB prototype complete
- Integrate with bandage, adhesive

June 2017
- Integration of multiple sensors and communication with base station complete

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