Using Orthotic Design to Manage Wheelchair Cushion Microclimate

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Microclimate

The term microclimate refers to the skin surface temperature (heat) and skin surface humidity (moisture) at the body-support surface interface.
Heat and moisture at the sitting surface are believed to be the causative factor in superficial stage I and II pressure ulcers (Ferguson-Pell 2009).

Elevated temperature exacerbates ischemia related to sitting acquired ulcer development (Berlowitz and Brienza, 2007).

When there is an increase in temperature we can predict an increase in moisture (Ferguson-Pell 2009).

Superficial dermal injuries without deep underlying tissue damage results from moisture and shear (Berlowitz and Brienza, 2007).
Negative Effects of Heat

- Every 1°C raises metabolic demands by 10%
- Increased metabolic need = STRESSED OUT cells
- Ischemia occurs when tissue perfusion is insufficient to **meet the needs** of the tissue
- Elevated tissue temperature will cause ischemia and pressure ulcer development in a shorter period of time
- When there is an increase in temperature, we can predict an increase in moisture (Ferguson-Pell 2009)
Negative Effects of Moisture

- Softening of the stratum corneum at the epidermis
- Weakening of the collagen crosslinks in the dermis
- Causing increased risk for damage via micro-traumas
- Reduced natural skin barrier to outside toxin absorption, allowing more toxins into the cells
- Increased friction co-efficient
Microclimate Pilot Study

Objective:
- Compare sitting surface temperature and humidity on an air cell and orthotic-style wheelchair cushion

Methodology:
- Single-subject human test
- 6 mini temperature sensors and a temperature and humidity "logger"
- Data gathered over 24 hour period x 7 days each on air cushion and orthotic-style cushion

Primary Researcher: Evan Call, MS, CSM Weber State University, Ogden, UT
Microclimate Study Data

Temperature Date

Orthotic Cushion Day 4

Air Cushion Day 2
Microclimate Study Data

Humidity

Orthotic Cushion, Day 4

Air cushion, Day 3
Calculations

- Peak readings for RH and temperature indicating at risk occupancy times.
- Minimum readings indicating excursions from the cushion.
- Duration of readings indicating occupancy, time between repositioning/pressure relief.
Pilot Study Results

- The cushion/user interface on the orthotic style cushion was 1.6°C cooler (2.88°F) than the 4” air cushion.
- This can be equated to an average of 16 to 20% decrease in metabolic demands of the tissue (Call, 2015).
Microclimate & Immersive Cushion Design

Immersive designed cushions rely upon mechanical pressure relief for effective heat and moisture management.
Microclimate & Orthotic Designed Cushion

Airflow around high risk anatomy helps keep skin cool and dry.

Spacer mesh maintains air space at lower risk/loaded anatomy.
Study Limitations and Future Considerations

- Single subject test, should be 10 subjects
  - While significance statements and confidence intervals can be applied to the data, they would only suggest the confidence we have that the readings we gathered are not in error for this volunteer at this time.

- Better logging of activities to improve correlation with temperature and RH.
- The humidity data requires further analysis.
- Multiple climates
- Recording of core temp.
Conclusion

- Research shows Stage I & II pressure ulcers are caused by heat and moisture
- A wheelchair cushion utilizing orthotic-design principles, properly covered, has the ability to decrease heat at the sitting surface. This can assist in the prevention of sitting acquired pressure ulcers
- It is essential that a wheelchair cushion prescription address heat and moisture build-up at the wheelchair user sitting interface
- Further research needed
References:
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8. Dan R. Berlowitz, MD, MPH; and David M. Brienza, PhD, Are All Pressure Ulcers the Result of Deep Tissue Injury? A Review of the Literature,