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.

Literature & Research Review

- Superficial ulcerations constitute 58% of all pressure ulcers (Barberel et. al., 1977)
- Heat is a major non-pressure risk factor for pressure ulcers (Kokate 1995)
- Superficial dermal injuries without deep underlying tissue damage results from moisture and shear (Berlowitz and Brienza, 2007)
- Elevated temperature exacerbates ischemia related to pressure ulcer development (Berlowitz and Brienza, 2007)
- Heat and moisture at the sitting surface is believed to be the causative factor in superficial stage 1 and 2 pressure ulcers (Ferguson-Pell 2009)
- When there is an increase in temperature we can predict an increase in moisture (Ferguson-Pell 2009)
- Every 1 degree C raises metabolic demands by 10%.
**POP Quiz!**

- Absent documented tissue trauma, the leading causative factors of superficial skin breakdown are _______ and _______.
- Where there is heat, there is _______.
- Does heat and moisture help or hinder the healing of deep decubitus ulcers?
- For a seating system to help in the prevention and healing of sitting related tissue trauma, it must manage _______ and _______.

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**Current Cushion Design Principles**

- **Immersion (pressure redistribution)**
  - Full contact.
  - The greater the immersion, the greater the amount of contact, and the better distribution of forces.
  - Cushion and cover material influence microclimate, but general design relies upon mechanical pressure relief for effective heat and moisture management.

- **Orthotic design (Off-loading)**
  - Balance of safe loading of low risk areas with off-loading of high risk areas.
  - Air channels through areas of off-loading creates passive convection which aids in the management of heat and moisture.
  - Spacer fabric helps to manage heat and moisture on loaded areas.
  - Less dependent on movement of sitter for management of microclimate.

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**Microclimate & Java Cushion**

Airflow, i.e. passive convection, around high risk anatomy helps keep skin cool and dry.

Spacer mesh maintains air space at lower risk/loaded anatomy.
Pilot Microclimate Study on Java

- Methodology:
  - Single-subject human test
  - 6 mini temperature sensors and a temperature and humidity "logger"
  - Placed between the cushion & cover at the right IT and thigh, perineum, left IT and thigh, and ambient air
  - Data gathered over 24 hour period x 7 days each on high-profile ROHO and Java Cushion
- Objective:
  - Compare sitting surface temperature and humidity on an air cell and off-loading style wheelchair cushion.

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Microclimate Study Data

Temperature

Humidity
Pilot Study Results

- The cushion/user interface on the Java Cushion was 1.6°C cooler (2.88°F) than a 4 inch high profile ROHO.
- This can be equated to a 16 to 20% decrease in metabolic stress to tissue.
- The humidity data requires further analysis as it is heavily influenced by the temperature data.
- Encouraging, but is it conclusive?
  - Further studies
  - Multiple subjects
  - Multiple sites

Preliminary Findings

- Research shows Stage I & II pressure ulcers are caused by heat and moisture.
- It is essential that a wheelchair cushion prescription address heat and moisture build-up at the wheelchair user sitting interface.
- A wheelchair cushion utilizing orthotic-design principles, properly covered, has the ability to decrease heat at the sitting surface to assist in the prevention of sitting acquired pressure ulcers caused by heat and moisture build-up.
- Further research needed.

References: