‘Keeping Cool under Pressure’ – Performance Investigation of a Microclimate Coverlet

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Background

Sustained pressure is considered the major cause of pressure injuries (PI), hence support surface design has been primarily focused on lowering interface pressure. Yet in recent years, research has been targeted into investigating the effects of microclimate (moisture and heat at the skin interface), its interrelation with support surface technology and the risk factor for pressure injury development. [1]

The body generates a continuous supply of heat from its metabolic activity [2] and the skin serves a primary role in achieving thermoregulation. Skin temperature can vary depending on the body’s core temperature as well as the insulating properties of any contacting material such as a support surface.

The skin loses heat though evaporation, conduction, radiation and convection whereas moisture loss is due to transepidermal water loss (TEWL) and sweating. The material characteristics and design of a support surface will influence the movement of moisture and heat at the patient interface.

Immobility, such as supine positioning while on a support surface, can further lead to heat and moisture accumulation [3] at the skin interface causing localized issues.
This lack of movement prevents heat and moisture transfer, hence the importance of the support surface in providing a mechanism to dissipate this buildup.

Purpose

A laboratory-based study was performed on a powered microclimate management coverlet to explore its heat and moisture characteristics at the surface interface.
The study also reviewed the relationship between various factors associated with the operation and performance of the microclimate coverlet and mapped the effects on risk factors associated with pressure injuries.

Figure 1. Example of the microclimate coverlet as evaluated for use with a range of support surfaces

Scan this code for coverlet information.

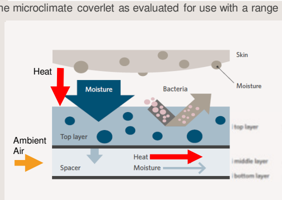

Figure 2. Schematic of the microclimate coverlet

Methodology

A powered microclimate coverlet, intended for use with any support surface, was evaluated by an independent test facility using the ANSI / RESNA S3I SS-1:2019 test standard Section 3 Body Analog. The tests measured the performance of a sample viscoelastic foam support surface with and without the powered microclimate coverlet to identify its effect.
The investigation involved multiple test runs measuring the maximum quantitative limits of heat removal (in both temperature °C and Watts/hr) and relative humidity using a standardized alternative to a human body. The indenter shown in Figure 3 provides a source of continuous heat and moisture to the support surface. The test duration averages 196 minutes, intended to represent the typical time between manual repositioning. At 180 minutes a simulated repositioning event occurs to allow the heat and moisture to dissipate. Additionally, the coverlet was repeatedly tested to SS-1:2019 Section 4 Sweating Guarded Hot Plate (SGHP) method using various surfaces to characterize the moisture removal ability in terms of evaporative capacity.

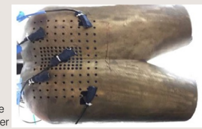

Figure 3. Example of the microclimate test indenter

Results

Body Analog testing [4] showed the coverlet achieved a reduction in temperature at the surface interface of 1.8 °C ±0.2°C (Figure 4) while also reducing the relative humidity (RH %) level by 15.5% (Figure 5). Further measurements indicated the coverlet achieved significant levels of moisture removal in terms of its evaporative capacity (g/m²/hr) and heat energy removal (measured in W/hr) (Figure 6).

The thermal performance of the powered coverlet identified a measurement limitation of the Body Analog test method. This is reported separately with proposed test improvements [4].

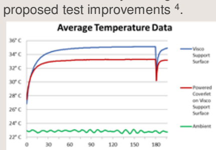

Figure 4. Example of the temperature difference due to the microclimate coverlet

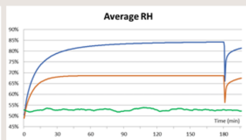

Figure 5. Example of the humidity difference due to the microclimate coverlet

Parameter	Value	Units
Coverlet Heat Removal	3.59	W/hr
Evaporative Capacity (using various surfaces)	>200	g/m²/ hr

Figure 6. Moisture and Heat Removal of the powered coverlet

Discussion

The comparative test results clearly demonstrate the ability of the powered microclimate coverlet to continually remove substantial heat and moisture present at the interface. This improvement in the microclimate condition is particularly important for patients who are unable to independently reposition themselves in bed. Immobility during supine positioning can limit the natural transfer of trapped heat and moisture to the environment which can be addressed by the powered coverlet moving ambient air under the patient. This air movement removes heat and moisture from the interface preventing an undesirable microclimate situation. The effect of repositioning is clearly shown in Figures 4 and 5 during the simulated lift (at t =180 mins) where the microclimate environment is returned to a lower level.

The microclimate situation is represented visually in the form of a conceptual model encompassing known factors as shown in the postulated schematic of a ‘microclimate cascade effect’ (Figure 8). This identifies the interrelationship of key factors, when combined at the interface, result in a cascade of negative effects. The described pathways originate from heat and moisture build up ultimately resulting in an increased susceptibility to pressure injury. The powered coverlet addresses a number of these pathways through its heat and moisture removal capability which works on the microclimate situation created by the patient at the surface interface. This can be particularly beneficial where the moisture level is not immediately obvious until a patient is rolled on to their side and moisture is noticed on their back and the bed linen. Higher levels or increases in TEWL are often not as perceptible as extreme levels of moisture such as profuse sweating.

Adverse effects can result from the accumulation of heat and moisture at the support surface interface as detailed below and depicted in the microclimate cascade model (Figure 8).

- As temperature and moisture increase, the stratum corneum layer of the skin becomes significantly weaker [5,6] thereby increasing susceptibility to the effects of pressure, friction and shear.
- It is known that metabolic demand increases as body temperature rises, with the average 6-13% increase for each 1 °C elevation. [2] By helping to maintain a normal temperature, the coverlet can assist the skin’s natural thermoregulation properties hence limit increases in metabolic demand.
- By assisting in maintaining a normal skin temperature, it is possible to mitigate the dehydration effects from an increase in TEWL and sweating.

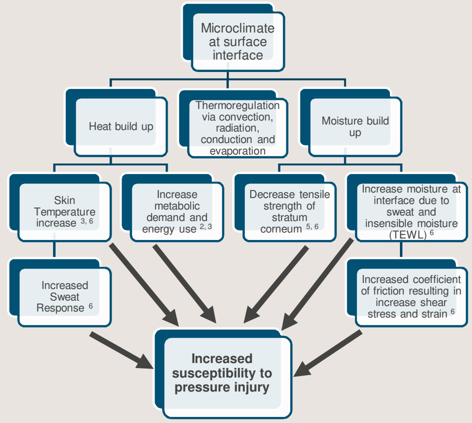

Figure 8. Schematic representation of the proposed Microclimate Cascade

Microclimate at the skin interface is typically assessed but is unmeasured in clinical practice and may vary significantly between individuals. Having a high ability to remove heat and moisture present at the interface provides for a flexible care solution that can be used with a range of patients.

Practical examples where this improvement in microclimate management may be clinically relevant include patients experiencing pyrexia (e.g. oncology, infection), moisture management issues (e.g. draining wounds, fistulas, autonomic dysfunction, menopausal hyperhidrosis, hyperthyroidism) or have other immobility related challenges (e.g. obesity, paralysis, dementia, multi-trauma, some post-operative patients, hemodynamically unstable patients).

Conclusion

The test results clearly demonstrated a continuous and high level of performance in the microclimate coverlet’s ability to dissipate heat and moisture at the surface interface. The level of heat removal achieved by the coverlet actually challenged the capabilities of the standardized test measurement technique.

The microclimate coverlet’s performance results demonstrated the potential benefits in controlling risk factors depicted in the microclimate cascade mapped in Figure 8. The significant moisture and temperature reduction achieved at the surface interface by the powered coverlet offers potential clinical benefits including decreased sweat response and interface moisture as well as improving patient comfort. The significant level of heat removal could be beneficial for patients with decreased thermoregulation capabilities or exhibiting symptoms of pyrexia. Further studies into the clinical benefits of thermal management effects are warranted.

Managing the surface interface microclimate allows clinicians the ability to help keep the patient ‘Cool under Pressure’.

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