We improve posture, we encourage comfort, but what about heat and moisture regulation?

Paul Moodey, Consolor Ltd.

Additional authors: Corien Staels, Susie Turnbull, Nienke Conijn - WheelAir

Summary
Custom contoured seating, due to it close fitting nature, often has thermal influences on the properties of the skin, such as the moisture content and temperature. This quantitative study aims to objectively validate the effectiveness of a WheelAir ventilation system when used as part of a custom contoured carved foam backrest solution and highlight prescribing considerations.

Aims and objectives
The project aim is to provide quantitative data to validate the placing of the WheelAir ventilation channels in a custom contoured carved foam backrest for reducing the increased heat retention experienced by users of this type of medical device, and obtaining the perfect balance of heat, moisture, and pressure relief. The project intends to evaluate what considerations should be made when prescribing this solution to users.

Background
While finding the correct postural and pressure relieving seating system is important, there's the risk of causing excessive heat and moisture build-up, and this should be considered too.

The thermal properties (heat absorption and dissipation) of seating clearly play a vital role in comfort, and could also have an influence on tissue viability, and consequently skin ulcer formation (Huizenga, 2001) (Andersen, 2008) (Freeto, 2016). Moisture from the skin has been shown to weaken the crosslinks between the collagen in the dermis, and soften the stratum corneum, while also possibly increasing the skin's coefficient of friction, leading to increased damage due to shear stress (Klaassen, 2016).

The combination of high pressure over bony prominences, and a decrease in skin tolerance due to the microenvironment makes the ischial tuberosity (IT) and sacral regions most prone to pressure ulcer development (Freeto, 2016). Some wheelchair users are at higher risk of thermal management issues than others, often because of medication, autonomic nervous system dysregulation, or a worsening of neurological symptoms (Coon, 2016). It is also necessary to highlight the importance of thermal comfort: the state of mind where one is satisfied with the thermal environment. Studies show that overall thermal comfort is often dictated by local comfort (Rønneset, 2018).

Previous research
A particularly poignant example is the case study presented at PMG 2019 (Curling, 2019). As a result of using the WheelAir, the client showed significant health improvements; he no longer scratched or rubbed his body due to skin irritation, no longer needed four T-shirts and two sling changes a day, and his skin was not saturated with sweat.

While the previous studies were case-study based, the aim of this study is to analyse objective quantitative data and exclude the influence of pre-existing medical conditions.

The Project

The project will test with four healthy, non-wheelchair users, in order to reduce the amount of variables. Using multiple test candidates should allow for any abnormalities within the data to be identified.

To reduce the number of variables, the same controlled environment will be used, i.e. controlled temperature and humidity. Equipment setup should be the same for each candidate and each test; for example, the same seat cushion, chair, and a constant fan setting on the WheelAir.

Below are the identified tests, where data will be captured on thermal and moisture change over time, as well as pressure/loading comparison between each test/backrest:

- Carved foam backrest without WheelAir
- Carved foam backrest with WheelAir fitted using anterior shallow depth channels
- Carved foam backrest with WheelAir fitted using anterior deep depth channels
- Carved foam backrest with WheelAir fitted using posterior channels

The following data capture methods will be used:

- Relative humidity & temperature iButton Sensors – to record the microclimate between the participant and the seat surface.
- Pressure mapping system - to analyse the effects integrating WheelAir has on the pressure, loading and support a user will experience.
- Thermal Comfort Scale - to record and analyse the thermal comfort of the participant while testing the various configurations.

Discussion

Testing without the WheelAir system installed will provide a baseline for analysis of the performance of the WheelAir system. These results can also be used to identify any abnormal readings/data, if experienced.

The purpose of testing the channel installation method into the carved foam backrest is to identify which is the best design to provide the user with thermal comfort, as well as the required level of pressure distribution and support. We may also consider the channel orientation, and how this affects the performance.

There are known limitations which affect optimal data capture. The temperature/relative humidity recording sensors measure the microclimate next to the skin surface. Due to the contact method needed for attachment it will prevent ventilation to the exact location the sensor uses to capture data, therefore limiting heat dissipation.

Another limitation is that the study uses only able bodied people, whereas those who typically use the product often have temperature regulation issues due to their medical condition.

The outcome of this project will provide guidance to prescribers on the benefits and compromises of using a WheelAir ventilation system. The goal is to demonstrate the effectiveness of its use and the design considerations that are required to make the system as effective as possible.

References

Andersen, E.S., Karlsmark, T. (2008) 'Evaluation of four non-invasive methods for examination and characterization of pressure ulcers', *Skin Res Technol,* 14:270e6.

Coon, E., Fealey, R., Sletten, D., Mandrekar, J., Benarroch, E., Sandroni, P., Low, P. and Singer, W. (2016) 'Anhidrosis in multiple system atrophy involves pre- and postganglionic sudomotor dysfunction' *Movement Disorders*, 32(3), pp.397-404.

Curling, V., Shari, S., Staels, C., (2019) ‘Feeling hot! hot! hot! Can ventilation improve posture?’, *presented at PMG 2019 FP2, NHS Guys & St Thomas Wheelchair Services (kings College Hospital).*

Freeto, T., Cypress, A., Amalraj, S., Yusufishaq, M. and Bogie, K. (2016) ‘Development of a Sitting MicroEnvironment Simulator for Wheelchair Cushion Assessment’, *Journal of Tissue Viability*, 25, pp.175-179.

Huizenga, C., Hui, Z., Arens, E. (2001) ‘A model of human physiology and comfort for assessing complex thermal environments’, *Build Environ*, 36:691e9.

Rønneset, Ø. (2018) ‘Personal Heating and Cooling Devices: Increasing User's Thermal Satisfaction’. *ZEN Research Centre*.