WheelAir

Slingback Test Report

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Microclimatic test of the WheelAir Slingback

Abstract

If left unmanaged, heat and moisture can cause serious health complications for wheelchair users, such as pressure sores and heat stroke. Although it is common for wheelchair users to be affected by these symptoms, there is a lack of research and available solutions to the issue of microclimate management; that is, the regulation of temperature and relative humidity in the space between the skin and wheelchair seating surface. Common current standards of care include administering antibiotics, skin creams, making chair modifications and frequent supportive care. The WheelAir (WA) Slingback provides an innovative alternative to these solutions and helps wheelchair users manage their microclimate more effectively. Using a modified ISO 16840-11 testing standard, we tested 2 conditions, with the WheelAir Fanbox on (WA on) and with the Fanbox off (WA off). The mean measured changes for temperature was 8.7°C over a period of 2 hours and for relative humidity the mean change was 21.5% both in favour of WA on. In summary, the results show that the WheelAir Slingback with Fanbox on allows for an overall reduction in temperature and relative humidity over a two-hour period compared to the WA Slingback with Fanbox off. This suggests that using a WheelAir Slingback can help in heat and moisture management.

Introduction

There are many ways the body can maintain homeostasis when exposed to hot and humid climates. In general, people with no pre-existing medical conditions are able to sweat and regulate their temperature, avoiding any of the serious heat and moisture related complications. However, for wheelchair users who are unable to maintain adequate airflow around the body, it is far more difficult to regulate heat and moisture, especially if their condition, immobility or medication limits their heat loss capabilities. An inability to sweat or self-regulate temperature can lead to build-ups of heat and moisture in the most humid parts of the body, which, if left unmanaged, can seriously damage skin integrity. For instance, if the skin is heated past 33 degrees celsius, localized perspiration is increased; the skin becomes softer, and it becomes more susceptible to breakdown (Lachenbruch, 2005).

Sitting in a wheelchair for long periods, especially with a custom-fitted seating system, can exacerbate these heat and moisture complications. This is particularly acute for people with conditions such as spinal cord injury (SCI) who can experience dysregulation of the autonomic nervous system, an inability to perspire in parts of the body, and limited mobility. In such cases, the microclimate - the space between the skin and seating surface - can become unstable (too hot or humid), which makes the skin particularly vulnerable to the formation of pressure ulcers, moisture lesions and heat rashes. On top of skin microclimate issues, for people with conditions such as Multiple Sclerosis (MS), Cerebral Palsy (CP) or Epilepsy, unmanaged heat can cause heat exhaustion, heat stroke, agitated symptomatology and a general discomfort when engaging in social activities.

Current standard practices of care for wheelchair users to prevent overheating and over-sweating complications include administering antibiotics, skin creams, the use of fans, custom chair designs, frequent clothing changes, and other types of self-management. These interventions are often inconvenient, cumbersome and can severely limit the autonomy and life quality of wheelchair users. The WheelAir Slingback is designed specifically to help wheelchair users maintain a healthy microclimate and mitigate against heat and moisture build-up.

In previous testing, the WA Slingback V1 has consistently been shown to lower the microclimate temperature by at least 6 degrees celsius. However, relative humidity has never been evaluated. The aim of this test procedure is to measure the change in relative humidity, in combination with temperature, of the WheelAir Slingback V2, with and without the use of the Fanbox, to give indications about dissipating perspiration and moisture. If heat and moisture can be effectively managed by the easy-

to-use and convenient WA system, the burden of care and treatment for wheelchair users could be drastically decreased and result in more autonomy and confidence.

Methods

Test procedure

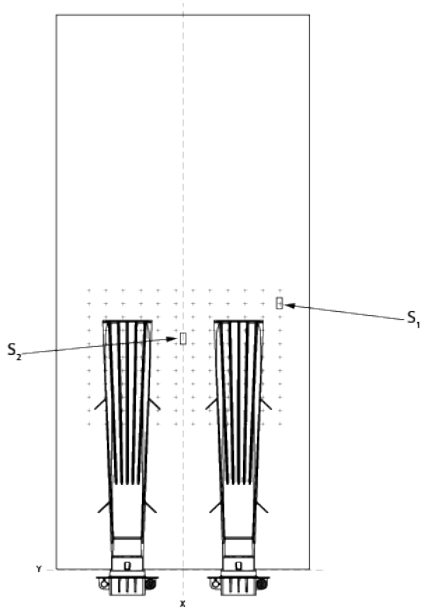
Testing was conducted in-house for WheelAir based on the ISO 16840-11 testing standards and procedures. The present test procedure deviated from the ISO 16840-11 test in that body loading on support surfaces was not simulated and instead the same female test participant was used for all testing. Take into account that the ISO 16840-11 test is not developed for testing wheelchair backrests, unfortunately there is no proper test method developed for testing backrests, that is why we choose to follow the same procedure as we did to test our WheelAir Cushion Cover.

Tests were performed with one female participant (29 years, 53kg) who is a daily wheelchair user, who completed the testing. She wore a shirt with short sleeves, which was made of 92% cotton. The participant was instructed not to perform any movements during the time of the measurement that would lead to a lifting of the back off the backrest. The participant was also instructed not to move around the room or perform any tasks that could influence her body temperature.

All testing was conducted in a small office room (25.25°C ± 0.75°C, 34.1 ± 4.8 % relative humidity) isolated from the rest of the office.

The production of relative humidity and temperature in the contact area between back and upholstery was observed over a two hour time span. Two measuring devices - DS1923 Temperature/Humidity logger iButtons - were stitched onto the outer surface of the slingback at two different points in the middle of the spine at the third lumbar vertebra. And more to the flank of the test subject, placed on the latissimus dorsi at the height of the third lumbar vertebra. Both iButtons were not directly placed on an air channel of the WA slingback. The iButtons were programmed to record temperature and relative humidity at intervals every 30 seconds, for a total period of 120 minutes.

For both tests a WheelAir fanbox was attached to the slingback as is required to produce an airflow when the fanbox is on. The fanbox was set to the highest fan speed for the entire two hour testing period, which produces 14.4m/s airflow per fan.



Sensor Number	X_{loc} (mm)	Y_{loc} (mm)	Sensor location by rows and columns of holes (from top left corner)
S1	105	350	Row 2, Column 12
S2	0	310	Row 4,5, Column 6,5

Figure 1. iButton location relative to the FluidFlowTM channels

Environmental Conditions

Ambient temperature and relative humidity were recorded at the start of testing and throughout the experiment using an RS Pro temperature and humidity datalogger. Values for temperature and relative humidity were measured at 30 minute intervals (0hr, .5hr, 1hr, 1.5hr, and 2hr), in line with ISO 16840-11 procedures.

Subjective Conditions

Every 30 minutes the participant also had to describe her heat related symptoms. To get inside in how the participant was coping with the heat. And whether this corresponds with the findings of the relative humidity and temperature that were measured.

Wheelchair specifications

The test was performed in an active rigid wheelchair which was fitted with a WA slingback V2 the slingback is made of 3D CoolMaxTM Spacer Fabric.

The wheelchair has an ILSA backrest to give more postural support to the user. And the wheelchair is equipped with a Vicair Vector O2 seat cushion. The seat cushion as well as the backrest can be categorized as contoured seating systems.

Results

Both iButton sensors showed similar results for temperature and humidity, for convenience we took the average of both sensors. All results displayed are therefore the average of the two sensors.

WA Slingback with Fanbox off

The environmental temperature ranged from 26°C at .5hr to 25.4°C at 1.5hr during the test. The environmental relative humidity ranged from 38.9% at the start to 32.6% at 1hr during the test.

Temperature

During a sitting time of two hours without in-between airing of the contact area, the temperature of the contact area increased from 30.5°C at the start to a peak temperature reading of 37.1°C, an increase of 6.6°C. The final temperature reading at the end of the two-hour test was 37.1°C.

The mean temperature of the contact area during the test was 35.9°C

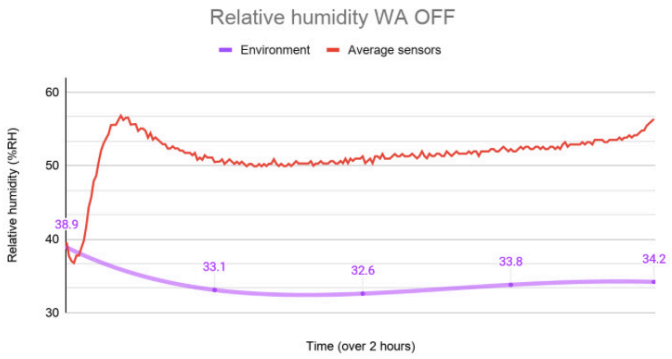
Relative Humidity

During a sitting time of two hours without in-between airing of the contact area, the relative humidity of the contact area increased from 39.6% at the start to a peak humidity reading of 56.8%, an increase of 17.2%. The final relative humidity reading at the end of the two-hour test was 56.3%.

The mean relative humidity of the contact area during the test was 51.5%.

Subjective Results

Already after 30 minutes the participant felt that her back was hot and a bit sweaty, which is in line with the results of the graphs. Also she started sweating under her armpits. After an hour she also had sweaty hands, felt light headed and noticed that she saw less clearly. She had some muscle spasms in one leg, but not very severe. After 90 minutes she continued to have muscle spasms in both legs which started to get unplassend, these muscle spasms stayed the rest of the remaining 30 minutes and also expanded to her buttock and abdomen.



Graph 1. Comparison between the average relative humidity of the iButton sensors when WA was OFF and the relative humidity of the environment. First the relative humidity of the iButton sensors increases fast, then in line with the decrease of environmental relative humidity the sensors record a small decline, which is made possible by the Spacer fabric of the slingback which also helps a little with moisture removal due to the open structure of the fabric. When time passes the humidity recorded by the sensors slowly increases due to the lack of air ventilation.

WA Slingback with Fanbox on full speed

The environmental temperature ranged from 24.5°C at the start to 25.6°C at 2hr during the test. The environmental relative humidity ranged from 33.8% at 0hr to 29.3% at 1.5hr during the test.

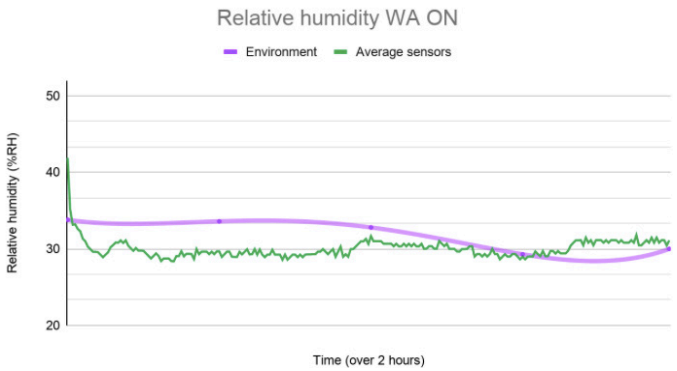
Temperature

During a sitting time of two hours without in-between airing of the contact area, the temperature of the contact area decreased from 29.8°C at 0hr to a lowest temperature reading of 25.8°C, an decrease of 4°C. The final temperature reading at the end of the two-hour test was 27.8°C.

Relative humidity

During a sitting time of two hours without in-between airing of the contact area, the relative humidity of the contact area decreased from 41.8% at the start to a lowest humidity reading of 28.4%, an decrease of 13.4%. The final relative humidity reading at the end of the two-hour test was 31.1%. Which results in an overall decrease of 10.7%.

The mean relative humidity of the contact area during the test was 30%.



Graph 2. Comparison between the average relative humidity of the iButton sensors when WA was ON and the relative humidity of the environment. As can be seen the relative humidity recorded by the sensors decreases fast with the WA ON. And then stabilizes around the environmental humidity.

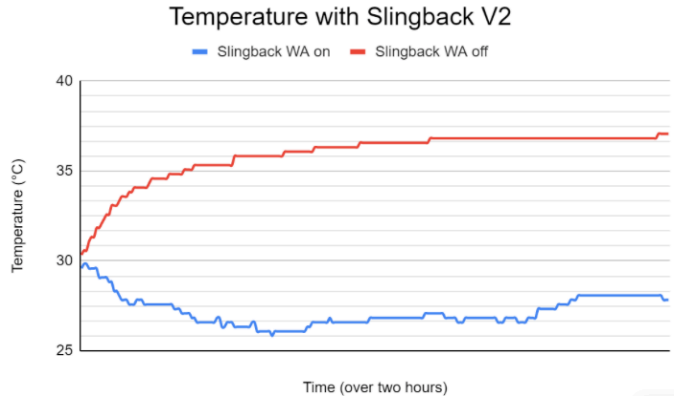
Subjective Results

Test subject did not complain about any heat related symptoms. She was feeling a bit hot after testing but could still perform well.

Comparison between WA ON and WA OFF

Temperature

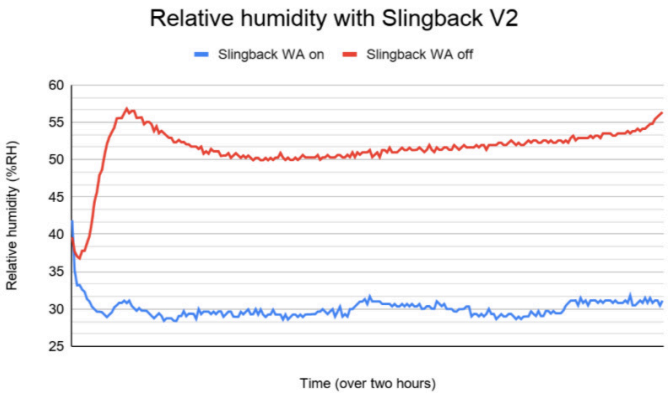
As can be seen in graph 3, both temperature lines start at the same temperature of 30°C. Over a time period of two hours the temperature of the sensor with WA off increases to 37.1°C, compared to 27.8°C with WA on. In a head to head comparison between WA on and WA off, it can be seen that there is a total difference in temperature of 9.3°C measured by the sensors after a two hour period. Already after 30 minutes there is a difference of 8.7°C in favour of WA on, this was also the mean difference.



Graph 3. Comparison graph for temperature with WA on (blue line) and WA off (red line)

Relative humidity

As can be seen in graph 4, both relative humidity lines start at almost the same humidity of 40%. Over a time period of two hours the humidity of WA off increases to 56.3%, compared to 31.1% with WA on. In a head to head comparison between WA on and WA off, it can be seen that there is a total difference in humidity of 25.2% measured by the sensors after a two hour period. Already after 30 minutes there is a difference of 20.8% in favour of WA on. The mean difference over the 2 hour span was 21.5%.



Graph 4. Comparison graph for relative humidity with WA on (blue line) and WA off (red line).

Conclusion

During the WA slingback trial with the fanbox off, the temperature of the contact area was on average 35.9°C and at the end of the test even 37.1°C. The relative humidity of the contact area was on average 51.5% and at the highest even 56.8%.
In comparison, for the WA slingback trial with the fanbox on, the temperature of the contact area was overall 27.2°C and at the lowest 25.8°C. The relative humidity of the contact area was on average 30% and at the lowest 28.4%. This is a difference of 8.7°C on average for the temperature and a difference of 21.5% on average for the humidity.

In general, the WheelAir slingback with the fanbox on full speed resulted in lower temperatures and lower relative humidity during the two-hour testing period.

Test subject complained more about heat related symptoms when WA was off. So also for comfort of the test subject and managing heat related symptoms the WheelAir was beneficial.

In sum, the results suggest that the WheelAir

slingback with fanbox on allows for an overall reduction in temperature and relative humidity over a two hour period compared to the WA slingback with the fanbox off. This suggests that using a WheelAir can help in heat and moisture management.

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