A MEASURING SYSTEM TO EXAMINE WHEELCHAIR CUSHION FUNCTION IN HIGH HUMIDITY CONDITIONS

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Background

- The microclimate functions in skin are important to prevent pressure ulcers and to improve comfort in wheelchair sitting.
Thermodynamic rigid cushion loading indenter: A buttock-shaped temperature and humidity measurement system for cushioning surfaces under anatomical compression conditions

Martin Ferguson-Pell, Hideyuki Hirose, Graham Nicholson, Evan Call,

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An inner reservoir tank a controlled temperature 37.5 \( \times \) C (yellow). An outer shell according to the fabrication instructions specified in ISO 16840-2.

A microporous water vapor-permeable membrane GORE-TEX laminate (5l/24 h/m\(^2\)) be able to gradually diffuse across the water vapor-permeable membrane.
These humidity data were obtained below 100% rational humidity.
However, Japan and tropical countries may exceed 100% humidity in the summer.

Climate and geography in Tokorozawa

Tokorozawa is positioned in latitude 35° N and 139° E longitude.

Los Angeles 34, Barcelona 41.25, Tunis 36.493° N
Measuring temperature, humidity, and weight of clothes and cushion

Hioki Humidity Logger and Honeywell temp. and humidity sensor

On the cushion

Circumstance climate

Subjects put on these wears on undress.

Each weight including pants, shirt, towel and cushion is measured by the weight scale before and after exposure.
CASE 1
4th August, 2004    Fine, a gentle breeze, a little humid 34°C/47.2%
Male, L2 SCI, Sweat: much outside: 60min from 13:35 to 14:35

CASE 2
21st August, 2004    Fine, a gentle breeze, humid 33.5°C/51.8%
Male, 54 y, L2 SCI, Sweat: much outside: 60min from 12:50 to 13:50

<table>
<thead>
<tr>
<th></th>
<th>pants</th>
<th>shirt</th>
<th>cushion</th>
<th>Towel</th>
<th>Δ pants</th>
<th>Δ shirt</th>
<th>Δ cushion</th>
<th>Δ buttock</th>
<th>Δ body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>269.6</td>
<td>134.2</td>
<td>640.9</td>
<td>227.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After</td>
<td>279.2</td>
<td>137.3</td>
<td>642.4</td>
<td>227.8</td>
<td>9.6</td>
<td>3.1</td>
<td>1.5</td>
<td>11.1</td>
<td>3.1</td>
</tr>
<tr>
<td>Case2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>239.1</td>
<td>132.3</td>
<td>999.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After</td>
<td>248.7</td>
<td>136.6</td>
<td>999.1</td>
<td>9.6</td>
<td>4.3</td>
<td>-0.5</td>
<td>9.1</td>
<td>4.3</td>
<td></td>
</tr>
</tbody>
</table>
Results

The relative humidity increased to 100% between the subjects' buttock and the wheelchair cushion, and 10 ml of perspiration collected under the buttock over one hour.
The aim of this study to develop a system to measure high humidity conditions. Principal to discharge a simulated perspiration between a dummy and the test cushion and to measure the volume of perspiration over time.
The system has five functions:
1) Controlled temperature (23 degrees) and humidity (50% relative humidity), as established by the ISO,
2) Simulating the human buttocks using a dummy according to ISO 16840-2, and maintaining the surface temperature at 27 degree and the loading to 500N,
3) A 0.01 % NaCl solution was used to simulate perspiration and it was discharged from a hole (diameter 1mm) at the lowest point between the dummy and the test cushion.

4) The impedance was measured between two electrodes (diameter 10mm, stainless, distance 5mm) to measure the volume of solution (5cc).

From experiments of SCI, the results is 10cc/hour in buttonic.

From general result, 9cc/hour = (2400/24)*(0.3*0.3(buttock area)).

Hot weather or fever, active sweating : a water flow of 2400g/m2/day.

:International Comission on Radiological Protection No.23
**Methods**

1) With no weight on the dummy, the impedance was measured over one minute.

2) Weight was added, and, after one minute,

3) the solution was discharged into between the dummy and the cushion.

4) The impedance was measured for one hour at a sampling rate of one per second.
<table>
<thead>
<tr>
<th>Product</th>
<th>Cover</th>
<th>Body</th>
<th>Product country</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>AC</td>
<td>Gel: G</td>
<td>Block: BL</td>
</tr>
<tr>
<td>B</td>
<td>BC</td>
<td>Foam: F</td>
<td>Block: BL</td>
</tr>
<tr>
<td>C</td>
<td>CC</td>
<td>Air: A</td>
<td>Contour: CO</td>
</tr>
<tr>
<td>D</td>
<td>DC</td>
<td>Foam: F</td>
<td>Contour: CO</td>
</tr>
<tr>
<td>E</td>
<td>EC</td>
<td>Air: A</td>
<td>Block: BL</td>
</tr>
</tbody>
</table>

Product A is AC gel body block Germany.
Product B is BC foam body block Japan.
Product C is CC air body contour USA.
Product D is DC foam body contour USA.
Product E is EC air body block USA.
Results indicated different characteristics between the five available cushions. (AC+G,BL) cushion (>0.1) showed differences from the other cushions (0.1>)}
Impedance is affected by cushion cover
The reliability confirmed by a test-retest comparison was performed every 12 minutes over one hour (12, 24, 36, 48, and 60 minutes), and the re-test was every 12 minutes over one hour at one week after the initial test.

<table>
<thead>
<tr>
<th>In twelve minutes after start</th>
<th>0 day</th>
<th>After one week</th>
</tr>
</thead>
<tbody>
<tr>
<td>cloud</td>
<td>0.085</td>
<td>0.084</td>
</tr>
<tr>
<td>7.5cm Foam</td>
<td>0.037</td>
<td>0.029</td>
</tr>
<tr>
<td>proform</td>
<td>0.051</td>
<td>0.045</td>
</tr>
<tr>
<td>ride</td>
<td>0.731</td>
<td>0.518</td>
</tr>
<tr>
<td>roho</td>
<td>0.019</td>
<td>0.010</td>
</tr>
</tbody>
</table>

The results are reliable because the ICCs were greater than 0.9.
Conclusions

• We developed a measuring system to examine wheelchair cushion function in high humidity conditions, and confirmed the reliability using the test-retest comparison.

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