Cushion use and performance in everyday life

Stephen Sprigle
• Surveying used cushions
• Documenting degradation
• Temperature and humidity
  – Controlled tests
  – Within everyday use
Surveying used cushions

• Survey developed to document cushion status
  – Descriptions of cushion and cover;
  – Reasons for replacement
• Sent to Robert Bingham in Australia
• 209 surveys completed
• Flat and contoured foam
Age of foam cushions

Cushion age - dataset

Cushion age - collapsed

Cushion surface by age

Cushions replacement: age &/or prophylactic

Percent within levels of agecode2.
### Cleanliness of foam

- **0-6 mo**: 100% clean
- **7-12**: 88% clean, 12% slightly soiled
- **13+**: 38% clean, 62% heavily soiled

### Cover cleanliness

- **0-6 mo**: 100% clean
- **7-12**: 100% clean
- **13+**: 33% clean, 67% heavily soiled

Legend:
- 0 = clean
- 1 = slightly soiled
- 2 = 3 = 4 = heavily soiled

Panel variable: agecode2
Physical and clinical signs of fatigue

After 6 months, 70% showed physical signs of fatigue.

40% of cushions 7-12 mo of age showed clinical sign of fatigue.

>12 months, >60% showed a clinical sign.
Why we should care

• Nice size data set on foam cushions
• Insight into a different delivery model
• Compression set occurs before clinical indicators of fatigue
  – High pressures or discomfort noted for 33% of cushions ≤12 mo
  – Compression set noted in 70% of cushions ≤12 mo
• Foam is in pretty good shape after 12 months of use
• Certain temporary wheelchair users may benefit from a foam cushion
  – i.e., stroke survivors are often d/c’d with orders for only a wheelchair; minimal cost might meet needs
Documenting degradation
a collaborative project between

• Objectives
  – Identify the expected lifespan of cushions and the significant predictors of cushion failure
  – Develop and validate a clinical measure of seat cushion degradation
• 138 different cushions studied (24 measured >1x)
  – Most common: 32 Jay2; 26 Roho HP; 14 Evolution
• Client eval, visual inspection & performance measures
• Mean age: 24 months (range: 1 day to 168 months)
Testing cushions over time

Interview & physical exam

IPM with user

IPM using model

Visual inspection & dimensioning

Loaded contour depth

Impact dampening
Model and Human IPM

Metrics cover:
- magnitude
- asymmetry
- dispersion
DI = ratio of IT pressures to total pressure

PPI = measure of pressure magnitude
Pressure magnitudes-
ALL 162 cushions

Both model and subject pressures indicate NO relationship over time
A tale of 2 predictors

- **PPIassyrm**: asymmetry of R & L peak values
- **normPPI**: (normalized PPI) PPI divided by total pressure

![Graph of PPIassyrm vs cushion age](image1.png)

![Graph of PPIassyrm vs subj wgt](image2.png)
In fact....

- **Cushion age** has *not* been able to predict any IPM-related variable
  - For all cushions
  - Combining the 3 most tested cushions (Roho, Jay2, Evolution)

- Cushion age may predict certain performance in *Evolution*
  - *May be indicative of foam*
Looking only at FOAM-based cushions

Pressure magnitudes tend to rise over time
Huge variance in model testing
Why we should care

• Tracking performance changes over time is needed to better understand “useful life”
• Extensive data on 138 cushions (and 162 measurements) is overwhelming
• Evidence suggests that Roho and Jay 2 cushion performance appears independent of age
  – For the cohort studied
Temperature and humidity

- Humidity represents moisture
- Temperature represents temperature
Friction and Moisture

• As moisture increases, friction increases
  – ↑ softness → ↑ contact between surfaces
  – Want to learn more? - see cosmetics literature

• Excessive moisture weakens skin’s ability to withstand load
Temperature and it’s impact on tissue viability

• ↑ tissue temperature ↑ metabolic demand
  – Added demand coupled with reduced nutrient delivery leaves tissues vulnerable

• Evidence suggests that reduced temperature has protective influence
  – Patel (1999)

• Kokate: “At a given pressure, ... lower temperatures exert a significant protective influence with respect to the development of pressure ulcers”
Temperature and pressure

• Lachenbruch (2005)
  – 2nd analysis of published data
  – 8ºC decrease in skin temperature is equivalent to a 29% reduction in interface pressure
  – Rightly advocates attention to skin temperature
Controlled testing- Ferrarin & Ludwig, 2000

• Sequence of images taken
  – Before sitting (T0)
  – After 15 of sitting (T15)
  – 5 & 15 minutes after transfer (T20 & T35)
Roho heats the most and cools the quickest (*steepest slope*)
R. Medica gel retains heat the most (*lowest slopes*)

What’s one limitation of the study and conclusion
Logging temperature & humidity

Controlled testing
Monitoring daily life
• **Accuracy**
  - $\pm 0.1 \, ^\circ C$
  - $\pm 2\% \, RH$

• **Inserted temperature and humidity sensors at cushion interface under buttocks**
Controlled 45 min test - 4 cushions

*Same subject; same clothes, same room*

Predictions?

- Action Twister
- Hi Profile Roho
- Polyurethane foam
- Silicone-impregnated foam
Controlled interface temperature measurements

Same subject; same clothes, same room

Temperature Plot for different cushions (45 min bout)

- Urethane foam
- Silicone foam
- Twister
- Roho

NOTE: dash lines represent average ambient temperatures for each cushion according to color.
Predictions of RH responses?
Controlled interface humidity measurements

*Same subject; same clothes, same room*

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**Relative Humidity Plot for different cushions (45 min bout)**

- **Twister**
- **Roho**
- **Urethane foam**
- **Silicone foam**

**NOTE:** Dashed lines represent average RH (%) for each cushion according to color.
Monitoring in everyday life

• Attached logger and sensors
  – Everything fit within cover, on the side

• Monitor for 1 week
  – Occupancy switch and debriefing help contextualize data
One long bout
Up @ 10:30 - down at 11:30

Same person
Two different days

Long day, 3 bouts
No PRs
Up @ 8 am – down @ 1am

In both instances
Humidity hit 90%
Temperature peaked <30°C
BUT
Sitting bouts were very long
Data including many off-loading episodes

A 5-hour block

<table>
<thead>
<tr>
<th>day</th>
<th>average bout length (min)</th>
<th>total occupancy (min)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>34.51</td>
<td>483.17</td>
</tr>
<tr>
<td>2</td>
<td>39.60</td>
<td>712.75</td>
</tr>
<tr>
<td>3</td>
<td>34.53</td>
<td>552.42</td>
</tr>
<tr>
<td>4</td>
<td>33.03</td>
<td>495.50</td>
</tr>
</tbody>
</table>
Temperature variations by bouts of sitting

Roho Harmony
Tighter temperature range
(Of bouts >30 min, range 27.5 to 31.3 [outlier])
Rapid rise to max
This subject sat ≈12 hr/day
Sat for >6 hours in a row 1+ times daily

Note: different time scales

Jay 2
Wide temperature range
(Of bouts >30 min, range 29.5 to 35.2)
Slower rise to max
This subject sat ≈11 hr/day & got up frequently
Why should we care?

• Tissue microclimate is important
• Cushions vary widely in microclimate management just like they vary widely in pressure management
• Moving is a good thing
  – unweights tissue so dissipates heat & alters normal and shear loading
  – Facilitate movement via education, proper positioning, bribes, threats
• If client reports sweating, we should seek other solutions
  – Shear, friction and temperature implications
• Pressure reliefs have at least 2 purposes:
  – Alleviate pressure and dissipate heat