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.
Cleanness of foam

Percent within levels of agecode2.

Cover cleanness

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

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

![Graph 1](Model PPIasymm & Subject normPPI vs cushion age)

![Graph 2](Model PPIasymm & Subj normPPI vs subj wgt)
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)
Controlled testing- Ferrarin & Ludwig, 2000

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
  – ± 0.1 °C
  – ± 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)](image)

- Urethane foam
- Silicone foam
- Twister
- Roho

*NOTE: dashed 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
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

<table>
<thead>
<tr>
<th>day</th>
<th>average bout length (min)</th>
<th>total occupancy (min)</th>
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<tbody>
<tr>
<td>1</td>
<td>34.51</td>
<td>483.17</td>
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<tr>
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<tr>
<td>4</td>
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</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