Cushion use and performance in everyday life

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Understanding the State-of-Use and Performance

- Surveying used cushions
- Documenting degradation
- Temperature and humidity
  - Controlled tests
  - Within everyday use
Surveying used cushions

- Survey developed to document cushion status
  - Cushion construction
  - Reasons for replacement
  - Cushion & cover inspection
    - Damage, fatigue, failure
- Sent to Robert Bingham in Australia
- 209 surveys completed
- Flat and contoured foam
Age of foam cushions (n=209)

90% were <12 mo old

Majority of cushion replaced because of their age
All- but 1- was deemed ‘clean’ or ‘slightly soiled’

>60% of covers deemed ‘clean’ or ‘slightly soiled’
After 6 months, 70% showed **physical** signs of fatigue

**Compression set:** when a material fails to return to its unloaded state

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
  – *Opportunity to use peer pressure to collect more data*
    • Hopefully, on different types of 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
Conclusion

• Foam is in pretty good shape after 12 months of use
  – Australia should be commended for this model
• 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
Look only at ROHO and JAY2

$B =$ area outside of IT/sacrum

$A =$ IT/sacral region

$DI =$ 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.

Black: IPM using buttock model
Red: IPM using cushion user

Look at variability of red model data compared to variability of black subject data.
A tale of 2 predictors

Dispersion Index (DI)

- A = LL/sacral region
- B = area outside IT/sacrum

S1DI vs cushion age

S1DI vs subject weight
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)
- Regression reported cushion age has a weak performance relationship within *Evolution*
  - *May be indicative of foam*
Looking only at FOAM-based cushions

Subject & Model PPI vs age (cushions with some FOAM only)

No relationship with age
Huge variance in model testing
About \( \frac{3}{4} \) of cushion deemed ‘clean’
‘Unclean’ cushions ranged in age
Clinician’s perception of cushion adequacy
“is the cushion good enough for the client to use?”

• Clinician’s are 5 ½ times more likely to judge a foam cushion as *inadequate* compared to a non-foam cushion

• Clinician’s were 3 times more likely to judge a ‘clean’ cushion as ‘*adequate*’ than one judged ‘*moderately clean*’ or ‘*unclean*’
Why we should care

• Tracking performance changes over time is needed to better understand “useful life”
• We need a means to identify cushions that need to be replaced
• Extensive data on 138 cushions is overwhelming
• Evidence suggests that Roho and Jay 2 cushion performance appears independent of age
  – For the cohort studied
• Cushion usage is individualistic so identifying a global measure of fatigue is very difficult
  – As always, individualistic evaluation is indicated
Temperature and humidity

- Humidity represents moisture
- Temperature represents temperature

Both have impacts on tissue integrity
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*)

![Graph showing temperature changes](image)

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
1st question?:

Do skin interface temperatures equal cushion interface temperatures?

No, they don’t, but they are highly correlated.
Does RH at skin interface equal cushion interface RH?

No, and they have poor correlation, although many converge.
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)
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>
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<td>3</td>
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<tr>
<td>4</td>
<td>33.03</td>
<td>495.50</td>
</tr>
</tbody>
</table>
Single day: Long bout sandwiched between PR activities
Does movement matter?
Controlled testing- Action Exact cushion

Skin-mounted sensor

Graph 1: Normalized temperature
- Blue line: 60 minutes uninterrupted
- Red line: 60 sec PRs every 15 minutes
- Green line: partial PRs every 10 minutes (leaning)

Graph 2: Normalized relative humidity
- Blue line: 60 minutes uninterrupted
- Red line: 60 sec PRs every 15 minutes
- Green line: partial PRs every 10 minutes (leaning)
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
Thanks & questions