Clinical Application of the Dispersion Index

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Objectives:

1. Define “Dispersion Index” and relate to IPM and wheelchair cushion designs.
2. Calculate Dispersion Index using commercially available IPM systems.
3. List three ways to utilize Dispersion Index (and IPM) in the clinic.
Interface Pressure Mapping Overview

- Interface pressure mapping “mat” under client
- Data collected via computer
- Data processed via IPM system software
- For Research – post-process with Matlab GUI

Xsensor System pictured
Interface Pressure Mapping Overview

- Interface pressure mapping “mat” under client
- Data collected via computer
- Data processed via IPM system software
- For Research – post-process with Matlab GUI
Interface Pressure Mapping (IPM)

- **IS:**
  - A great clinical assessment tool and a great comparative tool.

- **IS NOT:**
  - A substitute for clinical decision making.
    (Best to use to *rule out* cushions vs. to select)
Cautions

- Snap shot
- Validity
  - Calibration
  - Alignment
Cautions: IPM provides a “snap shot” in time

- Not representative of client’s range of postures, activities (transfers), other surfaces, e.g. toileting, showering, transportation, etc.
- Using remote or movie mode can capture more representative IPM data.
- There is no substitute for skin inspection!
Cautions: Validity

- Does IPM measure tissue risk?
- Remember that it measures what’s happening between the body and the cushion, at the *interface*.
- We don’t know how well that correlates to what is happening inside the body.
- Current research focuses on internal tissue deformation.
Lower Risk
Cautions: Validity

(B) AB Male, 52 yo

(G) T12 SCI Male, 56 yo

Low Risk

High Risk
Calibration

- Correlates the load to the output readings.
- All systems must be re-calibrated periodically.
- Calibration minimizes error and effects of creep and hysteresis.
- While number between calibration is probably most telling, time between calibration is more clinically friendly.
- 1x per month minimum.
Alignment: Capture the butt

- The entire butt profile should be captured on the mat, versus hanging off the back edge, sides.
- Try to have rear row clear.
Error Identification: Common Sense Quick Checks

- Is the total load appropriate?
- Does it look like a butt?
- Buttocks do not impart a rectangular load profile

[Image of SpongeBob SquarePants]

Wheelchair cushions to prevent pressure ulcers

- What is the goal?
  - Redistribution of pressures
  OR
  - Offloading of critical areas
Reliable variables

- Peak Pressure Index
  - Peak and surrounding values
- Average Pressure
  - Harder to distinguish differences
  - Regional averages - asymmetry
- Contact Area
  - Requires calculation in some software
- Dispersion Index
  - Ratio of IT/Sacral loading to total loading

Peak Pressure Index (PPI)

- Average of the peak value + the surrounding cells which make up 9-10 cm\(^2\) (size of an IT or other bony prominence).
- This is 4 or 9 cells, depending on spatial resolution (# of sensors/mat area).
Reliable variables

- Peak Pressure Index
  - Peak and surrounding values
- Average Pressure
  - Harder to distinguish differences
  - Regional averages - asymmetry
- Contact Area
  - Requires calculation in some software
- Dispersion Index
  - Ratio of IT/Sacral loading to total loading

Dispersion Index

\[ \text{DI} = \frac{A}{A+B} \]

- Based upon the theory that redistributing load away from ITs is a good idea
- Clinical challenge: identification of areas
Our Challenge…

- How to answer clinical questions?
  - What does the picture tell us?
  - What do the metrics tell us?
- How do we compare cushions?
  - What parameters to use?
  - What comparators to use?
Using IPM to judge clinical effectiveness of cushions

- What is the goal?
  - Redistribution of pressures
  - Offloading of critical areas
- Interpretation of IPM parameters
- Areas of risk
- Matching pressures to anatomical locations
- Symmetry
- Answering the question: “is this cushion achieving the goal related to pressure management?”
Focus on areas of interest

- Bony prominences are at greatest risk
  - However, eval will inform specific risks

- Learn software’s capabilities to provide you with the data you desire
**Interpretation of Interface Pressures**

The hardest part

<table>
<thead>
<tr>
<th>Avg= 22</th>
<th>Peak = 110</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Avg= 16</th>
<th>Peak = 151</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15</td>
<td></td>
</tr>
</tbody>
</table>

![Pressure Map](image)
Cushion Design and IPM Variables

- Redistribution designs
  - PPI
  - Average Pressure
  - Contact area

- Offloading designs
  - Dispersion Index
  - PPI – location?
  - Contact Area
IPM Clinical Interpretation
Envelopment and Off-loading

- An enveloping cushion should have the ability to encompass and equalize pressure about irregularities in contour due to buttock shape, objects in pockets, clothing, etc.
- An off-loading cushion should safely shift the forces of support to low risk areas.
Typical IPM Images

<table>
<thead>
<tr>
<th>Envelopment</th>
<th>Off-Load</th>
</tr>
</thead>
</table>

| 21 29 15 28 27 23 9 4 9 16 26 28 29 11 45 0 | 
| 9 24 20 29 29 27 20 5 16 20 25 28 31 7 24 1 | 
| 33 35 32 26 37 31 32 16 34 24 36 37 38 16 31 4 | 
| 9 24 20 29 29 27 20 5 16 20 25 28 31 7 24 1 | 
| 33 35 32 26 37 31 32 16 34 24 36 37 38 16 31 4 | 
| 9 24 20 29 29 27 20 5 16 20 25 28 31 7 24 1 | 
| 33 35 32 26 37 31 32 16 34 24 36 37 38 16 31 4 | 
| 9 24 20 29 29 27 20 5 16 20 25 28 31 7 24 1 | 
| 33 35 32 26 37 31 32 16 34 24 36 37 38 16 31 4 | 
| 9 24 20 29 29 27 20 5 16 20 25 28 31 7 24 1 | 
| 33 35 32 26 37 31 32 16 34 24 36 37 38 16 31 4 | 
| 9 24 20 29 29 27 20 5 16 20 25 28 31 7 24 1 | 
| 33 35 32 26 37 31 32 16 34 24 36 37 38 16 31 4 | 
| 9 24 20 29 29 27 20 5 16 20 25 28 31 7 24 1 | 
| 33 35 32 26 37 31 32 16 34 24 36 37 38 16 31 4 | 
| 9 24 20 29 29 27 20 5 16 20 25 28 31 7 24 1 | 
| 33 35 32 26 37 31 32 16 34 24 36 37 38 16 31 4 | 
| 9 24 20 29 29 27 20 5 16 20 25 28 31 7 24 1 | 
| 33 35 32 26 37 31 32 16 34 24 36 37 38 16 31 4 |
IPM Clinical Interpretation surface area

- Envelopment:
  - Maximize surface contact area

- Offloading:
  - Make sure IPM reflects sites intended to be off-loaded (e.g. ITs)
  - Make sure off-loading to other areas is safe (not to other at-risk sites)

- Both
  - Skin inspection!
Interface pressure distribution

- IP should reflect intended cushion design

Envelopment

Off-Load
Interface Pressure (IP) System Parameters

- Peak Pressure (mmHg)
  - AKA “Maximum Pressure”
- Peak Pressure Index or PPI (mmHg)
- Average Pressure (mmHg)
- Contact Area (in² or cm²)

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum (mmHg)</td>
<td>200.00</td>
</tr>
<tr>
<td>Minimum (mmHg)</td>
<td>0.00</td>
</tr>
<tr>
<td>Average (mmHg)</td>
<td>64.21</td>
</tr>
<tr>
<td>Sensing area (in²)</td>
<td>217.19</td>
</tr>
<tr>
<td>Regional distribution (%)</td>
<td>100.00</td>
</tr>
<tr>
<td>Coefficient of variation (%)</td>
<td>70.95</td>
</tr>
<tr>
<td>Horizontal center (in)</td>
<td>8.45</td>
</tr>
<tr>
<td>Vertical center (in)</td>
<td>8.47</td>
</tr>
<tr>
<td>Standard deviation (mmHg)</td>
<td>45.56</td>
</tr>
<tr>
<td>Variance (mmHg²)</td>
<td>2075.55</td>
</tr>
</tbody>
</table>
Sample Xsensor Images

Unfavorable immersion
(> 30%)

Favorable immersion
(< 20%)

Favorable offload
(< 10%)
Dispersion Index: How?

- **Step 1:** Palpate bony prominences of interest through the mat
  - need to know specific sensor locations

- **Step 2:** Use IP Software to examine regional distributions

  Or

- **Export data into Microsoft Excel for further processing**
Dispersion Index: How?

- **Xsensor Software**
  - Sensor Groups
    - Up to 8 groups
    - # Sensors
    - Area (in²)
    - Maximum pressure
    - Minimum pressure
    - Average pressure

- **FSA Software**
  - “Regional Distribution” available
  - Select one or more regions on the map image
  - Multiple stats available
Dispersion Index: How?

- **Xsensor Software**
  - Sensor Groups
    - Average Pressure $X \#$ of sensors in each group = total pressure
  - Look at two groups:
    - IT/Sacrum Region
    - Full mat
  - DI = total pressure in IT/Sacrum Region/ total pressure in full mat

- **FSA Software**
  - “Regional Distribution” available
  - Provides a direct measure of percentage of pressure in each region
### Regional Pressures: FSA Sample

**Lavender = Dispersion Index**

<table>
<thead>
<tr>
<th>Sensing area (in²)</th>
<th>10.08</th>
<th>10.08</th>
<th>10.08</th>
<th>89.56</th>
<th>217.19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient of var</td>
<td>20.05</td>
<td>16.68</td>
<td>61.05</td>
<td>52.18</td>
<td>70.95</td>
</tr>
<tr>
<td>Average (mmHg)</td>
<td>148.65</td>
<td>168.09</td>
<td>55.96</td>
<td>94.68</td>
<td>64.21</td>
</tr>
<tr>
<td>Regional distribul</td>
<td>10.74</td>
<td>12.14</td>
<td>4.04</td>
<td>60.80</td>
<td>100.00</td>
</tr>
<tr>
<td>Standard deviat</td>
<td>29.80</td>
<td>28.04</td>
<td>34.16</td>
<td>49.40</td>
<td>45.56</td>
</tr>
<tr>
<td>Maximum (mmHg)</td>
<td>200.00</td>
<td>200.00</td>
<td>124.30</td>
<td>200.00</td>
<td>200.00</td>
</tr>
<tr>
<td>Horizontal center</td>
<td>11.14</td>
<td>5.88</td>
<td>7.86</td>
<td>8.24</td>
<td>8.45</td>
</tr>
<tr>
<td>Minimum (mmHg)</td>
<td>99.34</td>
<td>121.14</td>
<td>6.53</td>
<td>6.53</td>
<td>0.00</td>
</tr>
<tr>
<td>Vertical center (in)</td>
<td>8.94</td>
<td>9.00</td>
<td>12.78</td>
<td>9.79</td>
<td>8.47</td>
</tr>
<tr>
<td>Variance (mmHg²)</td>
<td>888.29</td>
<td>786.28</td>
<td>1167.19</td>
<td>2440.34</td>
<td>2075.55</td>
</tr>
</tbody>
</table>
Dispersion Index – How?

- With FSA or Boditrak system
  - Position patient on IP mat
  - Palpate the ITs and sacral regions “through” the mat
  - Note locations, use mouse to select appropriate sensor regions
  - Select one additional region, encompassing both IT’s and the sacral region
  - “Regional distribution” parameter reports the percentage of pressures present within each region
- Example:

| Regional distribution | 10.74 | 12.14 | 4.04  | 60.80 | 100.00 |
Dispersion Index – How?

- With Xsensor system and using Excel
  - Position patient on IP mat
  - Palpate the ITs and sacral regions “through” the mat
  - Note locations, use mouse to select appropriate sensor regions
  - Select one additional region, encompassing both IT’s and the sacral region
  - Export the data into a Microsoft Excel file
  - Select all sensor readings and use Excel to create a sum
  - Select the region around the IT and Sacrum locations (identified by palpation), and use Excel to sum these values
  - Divide the IT/sacrum region sum by the total mat sum and multiply by 100 for percent
<table>
<thead>
<tr>
<th>Name 57(18/17/14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvis Pressure</td>
</tr>
<tr>
<td>Mat Pressure</td>
</tr>
<tr>
<td>Disp Index</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tot Pelvis Pressure</th>
<th>=SUM(J101:V114)</th>
<th>mmHg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tot Mat Pressure</td>
<td>=SUMIF(A79:AJ114,&quot;&gt;5&quot;,A79:AJ114)</td>
<td>mmHg</td>
</tr>
<tr>
<td>Disp Index</td>
<td>=(AM88/AM89)*100</td>
<td>%</td>
</tr>
</tbody>
</table>
How do I use this information?

- Improved understanding of the pressures under the pelvis relative to total pressures on mat.
- Regardless of cushion choice, the goal is to reduce bias of supportive forces at high risk areas.
Clinical Application of DI in Offloading Environment

- Confirm offloading of existing pressure ulcer
  - PMI may indicate offloading, but how far is it offloaded?
    - Palpation/ skin inspection are key!
- Confirm offloading known risk areas –
  - ITs
  - Coccyx/sacrum
  - Perineum
  - Greater Trochanters
- Confirm adjustment of cushion to achieve the above.
- Confirm supporting pelvic alignment through safe loading of low risk anatomy, but what is safe?
  - Skin inspection
Clinical Application of DI in Immersion Environment

- Confirm distribute load over maximum contact area.
- Confirm reduced loading on ‘at-risk’ sites
- Confirm adjustment of cushion to achieve the above.
- Skin inspection
Consider

- The forces on the seat represent ~2/3 of total body weight (represents upper body weight).
- Accurate support of trunk, feet, UE’s, and head can all have a favorable impact on forces experienced at the seat
IPM as an Educational Tool

- Client and caregiver
- Effectiveness of pressure relief technique
- Effects of propulsion techniques
- Effects of postural changes
Remember, there is no substitute for skin checks!
References

