You Got To Move It, Move It!
Pressure Relief Behaviors and Weight Shifting Activities to Prevent Pressure Ulcers in Persons with SCI

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March 3rd, 2016
“I Like to Move It, Move It!”

I like to move it move it, Madagascar
HD
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Disclosures

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Trevor Dyson-Hudson has no financial interest to disclose.
Objectives

At the end of this session, you should be able to:

1. Recognize how dedicated pressure reliefs and other weight-shift activities have a protective influence on skin in persons with SCI.
2. Describe different ways in which full-time manual wheelchair users with SCI move in their wheelchairs.
3. Discuss the impact and role functional movements can have on developing clinical interventions to prevent pressure ulcers in persons with SCI.
Let’s consider groups of Pressure Ulcer causation

- **Sustained** violation of load-duration thresholds
  - We do not know this threshold for individuals
    - Individualistic factors are in play
  - *Equipment & equipment fit are often culprits*

- **Episodic** events
  - Bump in transfer
  - Stuck in a poor surface or position
  - Absence of attendant care
  - Equipment problem

- Combination of the two

Evaluation & training are interventions used for both categories
Sustained violation of load-duration thresholds

• Addressed by equipment and training
  – Reduce magnitude of loading
    • Posture & seating system
  – Reduce duration of loading
    • Weight shifting activities
Weight Shifting & Pressure Reliefs

- Guidelines vary
  - 30 second weight shift every 30 minutes
  - 60 sec weight shift every hour
  - 30 sec weight shift every 15 minutes
- The wide range indicates lack of supporting evidence
- No published studies have identified pressure reliefs as factors in preventing ulcers
  - Based upon self-report
  - Functional movements aren’t considered
- Controlled studies suggests >60 secs for perfusion to return
  - Coggrave & Rose 2003

Consortium for Spinal Cord Medicine; PVA 2000
O’Connor & Salcido, in Spinal Cord Medicine, 2002
Each of these tasks are equally feasible

• Holding a push-up pressure relief for 60 secs
• Juggling a chain saw, M&M and bottle of beer
• Getting 3 children $\leq 5$yo to share 1 toy.
Pressure Reliefs and Weight Shifts

Pressure Reliefs
• Functional constraints limit options for independent pressure reliefs

Weight Shifts
• In-seat activity (e.g., shifting the center of mass) redistributes loading on the buttocks
Study 1: Effect of weight shifting maneuvers

• Hypothesis:
  – Weight-shifts, other than full push-ups, significantly alter ischial pressure and blood flow

• Weight-shifts include
  – Reaching- leaning- and other functional activities

• Approach:
  – measure interface pressure and blood flow during weight shifts
  – Compare cushion’s influence
Effects of wheelchair cushions and pressure relief maneuvers on ischial interface pressure and blood flow

- 6 seated postures
- 3 cushions
- 19 persons with spinal cord injuries

![Diagram of sensor and transducer with 7.5 cm measurement]
Changes in ischial pressure and bloodflow compared to upright sitting

Decrease in pressure
-7%
-29%
-80%
-46%
-72%
Increase in Blood flow
30%
95%
320%
330%
450%
Small frontward lean
Intermediate frontward lean
Full frontward lean
Intermediate sideward lean
Full sideward lean


Positions in red were significantly different from upright posture
Ischial Pressures across cushions

Matrix Vi  Jay2  Roho

![Graph showing the comparison of ischial pressures across cushions for Matrix Vi, Jay2, and Roho in various postures. The graph indicates that Matrix Vi has significantly higher ischial pressures compared to others in an upright posture. In other postures, there is no significant difference.](image-url)
Clinical Implications

• Leaning can reduce loading and increase blood flow at the buttocks
  – Only ‘hands-on-knees’ did not have impact
• Interaction between posture and cushion
  – How cushion responds to weight shift differs across cushion
• During full weight shifts- cushions act similarly
Study 2: Does in-seat movement affect microclimate: heat and moisture

- Clear evidence that microclimate is important
  - Especially in populations with poor regulation
- Movement dissipates heat and humidity
Monitoring temperature and humidity over a day

Long bouts of sitting
Monitoring temperature and humidity over a day

Frequent weight shifting activity
Clinical Implications: Microclimate

• Movement dissipates heat and humidity
  – Put people in a system that permits activity
  – Educate people to move

• **Judicious approach:** if someone commonly sweats on a cushion- *change it*
Studies 3 & 4: Monitoring Weight-shifting activities during everyday life

• Research questions:
  – How do wheelchair users move in their seats?
  – How does in-seat movement differ across wheelchair users?
    • Monitor new wheelchair users in their first months following discharge
    • Monitor people who have been using a wheelchair for more than 2 years
      – Compare behaviors across groups of people with and without a history of recurrent pressure ulcers
Seat monitor and data logger

- 4 force-sensing resistors located under wheelchair cushion
- Data-logger captures forces at 1 Hz
Raw data is a continuous signal of forces that are run through a classifier
Definitions

- **Out of Chair** – fully unloaded for > 2 minutes
- **Full Pressure Relief (PR)** – left and right sides fully unloaded for > 15 seconds and < 2 minutes
- **Weight Shift (WS)** – either side or both sides are partially unloaded (>30% pressure reduction) for > 15 seconds
Recent SCI

- 31 manual wheelchair users
- 359 complete days of data
- Recruited through Shepherd Center and Kessler Foundation
- Characteristics
  - Ages 19-63 (Average 32 yo)
  - 25-215 days post injury (Average 97 days)
  - 22 men, 9 women
  - LOI split: 8 cervical, 10 upper thoracic, 13 lower thoracic or lumbar
In and Out of the Chair

Histogram of Time In Chair (hrs)

7.0 (3.4) hours

Histogram of Num Transfers Out of Chair

8.6 (5.4) Transfers OUT

That’s a lot of transfers!!
Pressure Relief Training

**Shepherd**
- Every 30 minutes
- Hold for 1 minute
- Depression lift is possible, side leans to each side if not
- Timer

**Kessler**
- Every 20 – 30 minutes
- Hold for 3-5 minutes
- Forward lean for all manual users
- Sometimes iPhone timer or on the hour and half hour
Reality Poll:
How often do you think individuals do pressure reliefs when they go home from rehab?

A. They are over-achievers (1 PR every 15 minutes)
B. They are rule followers (1 PR every 30 minutes)
C. At least they are trying (1 PR per 60 minutes)
D. What’s a Pressure Relief? (1 PR every 2 hours, or less)
Actual In-Seat Movement

Pressure Reliefs (Full Unloading)

1.2 (1.7) Pressure Reliefs
~1 every 50 minutes

Weight Shifts (Partial Unloading)

3.8 (4.2) Weight Shifts
~1 every 16 minutes
Overview of In-Seat Behavior After Discharge

• 7 hours per day in wheelchair
  – 17 hours per day NOT in wheelchair
    • Where are they sitting?
    • Are the ischium still taking a beating?
    • What about the poor sacrum?

• 17 transfers daily

• Hourly pressure reliefs and more frequent weight shifts.
Chronic SCI Population

- 29 manual wheelchair users
- 225 complete days of data
- Recruited through Shepherd Center and Duke University / Durham VA
- Characteristics
  - Ages 21-66 (Average 41 yo)
  - 2-33 years post injury (Average 15 years)
  - 23 men, 6 women
  - LOI: mostly lower thoracic or lumbar (18), 7 upper thoracic and 3 cervical
  - 12 had a history of recurrent pressure ulcers
How long do full time users sit in their wheelchairs?

This study:

<table>
<thead>
<tr>
<th>Manual WC users</th>
<th>Mean</th>
<th>St Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>29 Manual WC users</td>
<td>10.1 hrs</td>
<td>3.8 (St Dev)</td>
</tr>
</tbody>
</table>

Prior studies

<table>
<thead>
<tr>
<th>WC users</th>
<th>Mean</th>
<th>St Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 Chronic Manual WC users</td>
<td>10.5 hrs</td>
<td>5.2</td>
</tr>
<tr>
<td>20 Chronic Power WC users</td>
<td>10.8 hrs</td>
<td>2.9</td>
</tr>
</tbody>
</table>

For full time users, the wheelchair is not merely a means of conveyance, it is an extension of their functional being.


Sonenblum, et al., *Arch Phys Med Rehabil, 2008. 89(3).*
Many full time wheelchair users transfer a lot

Median = 8 xfers
Reality Poll:
How often do you think individuals do pressure reliefs when they are years out from rehab?

A. They are over-achievers (1 PR every 15 minutes)
B. They are rule followers (1 PR every 30 minutes)
C. At least they are trying (1 PR per 60 minutes)
D. What’s a Pressure Relief? (1 PR every 2 hours, or less)
Full Pressure Reliefs and Weight Shifts
Daily Frequencies per Occupancy-hour

Pressure Reliefs (Full Unloading)

- 0.5 (0.8) Pressure Reliefs / hour
- ~ 1 PR every 2 hours

Weight Shifts (Partial Unloading)

- 2.3 (2.3) Weight Shifts / hour
- ~ 1 WS every 26 minutes
Maximum Time Between Weight Shifts Daily
So what happens over time?

Pressure Reliefs
95% CI for the Mean

Weight Shifts
95% CI for the Mean

Frequency Per Hour in Chair

1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0

Acute
Chronic

So what happens over time?
What about Pressure Ulcers?

Nobody does them regularly!
What about Pressure Ulcers?

Weight shifting behavior IS different!
Vastly different in-seat movement of 3 persons

COP of in-seat movement

Pressure reliefs

Weight shifts

Subject A

Activity Freq = 46.3

Subject B

Activity Freq = 82.6

Subject C

Activity Freq = 102.9
Studies 5 & 6: Everyday Use and Biomechanical Effects of Power Tilt

For people at high risk, powered tilt and tilt/recline systems are available.
The impact of tilting on blood flow

<table>
<thead>
<tr>
<th>Tilt Position</th>
<th>Increase in Mean Blood Flow Compared with Upright (SD)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>15°</td>
<td>8% (19%)</td>
<td>0.016</td>
</tr>
<tr>
<td>30°</td>
<td>24% (48%)</td>
<td>0.003</td>
</tr>
<tr>
<td>45°</td>
<td>84% (84%)</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Challenge lies in getting users to fully engage the functionality

“Pressure Relieving Tilts”
(Tilts > 30° lasting > 1 minute)

Use of tilt feature
(Angle change of 5° lasting > 20 sec)

Use of tilt feature per hour

## Putting It Together

<table>
<thead>
<tr>
<th></th>
<th>Power Tilt</th>
<th>Manual Weight Shifts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Position</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Small Movements</td>
<td>Angle change of 5° lasting &gt; 20 sec</td>
<td>3.0 (2.9)</td>
</tr>
<tr>
<td>Intermediate / Large</td>
<td>Tilts &gt; 30° lasting &gt; 1 minute</td>
<td>0.3 (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Position</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Weight Shift: Pressure Reduction &gt; 30%</td>
<td>2.4 (2.2)</td>
<td></td>
</tr>
<tr>
<td>Pressure Relief: Complete unloading of both buttocks lasting &gt; 15 seconds</td>
<td>0.4 (0.5)</td>
<td></td>
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</table>
If there’s time...

• Wheelchair use – bouts of mobility.
*How much* people move in wheelchairs

is a different question than

*How* people move in wheelchairs

We are concentrating on the latter
How people move in manual wheelchairs: Distance, time moving & bouts of mobility

• Distance & Time moving are commonly described

• Distance and time are very highly correlated
  – Therefore, do not offer unique information

• Bouts of movement
  – Represent transitions between activities

  **START**
  • Travel at 0.12 m/s (0.27 mph) for at least 5 seconds
  • Traverse at least 0.61 m

  **STOP**
  • Travel less than 0.76 m over 15 seconds
# Manual Wheelchair Use

<table>
<thead>
<tr>
<th>Wheelchair Movement</th>
<th>Acute</th>
<th>Chronic</th>
<th>P value</th>
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<tr>
<td>Distance Wheeled (km)</td>
<td>1.2 (1.1)</td>
<td>1.5 (1.2)</td>
<td>0.010</td>
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<tr>
<td># Bouts</td>
<td>55 (32)</td>
<td>84 (41)</td>
<td>&lt;0.01</td>
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## Manual Wheelchair Use

### Wheelchair Movement

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<td>55 (32)</td>
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</tr>
<tr>
<td><strong>% Mobile</strong></td>
<td>9.7 (8.5)</td>
<td>8.5 (5.8)</td>
<td>0.122</td>
</tr>
</tbody>
</table>
Manual Wheelchair Bouts of Mobility

69 Full time manual wheelchair users
All K0005 wheelchairs
59,027 bouts of activity
566 subject-days

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bout Distance (m)</td>
<td>8.3</td>
<td>0.8</td>
<td>3,891</td>
</tr>
<tr>
<td>Bout Duration (sec)</td>
<td>20</td>
<td>5</td>
<td>2,419</td>
</tr>
<tr>
<td>Bout Speed (m/s)</td>
<td>0.44</td>
<td>0.09</td>
<td>2.65</td>
</tr>
</tbody>
</table>
Other tidbits of manual wheelchair use

• **Long bouts > 5 minutes?**
  – 344 bouts out of 59,151 bouts (<1% bouts)
  – 2/3 of the subjects had at least 1 long bout
  – 15 subjects had > 5 long bouts
    • representing > 80% of bouts longer than 5 minutes

• **Fast bouts > 1 m/s?**
  – 1870 bouts out of 59,151 (3%)
  – Every subject has at least 1 fast bout
  – 41 subjects had at least 10 fast bouts
Clinical Implications

• Transfers
  – Training
  – Possible (likely?) culprit in shoulder pain

• Change with time
  – After discharge, time in chair increases and propulsion increases, but protective behaviors decrease.
  – What does this mean about the AT prescribed to them while in inpatient? Does it still fit their needs?
Clinical implications

• **Wheelchair users do not demonstrate routine**
  – All were trained in PRs and to target a frequency
  – We cannot assume dedicated PRs are routine

• **Weight shifts are much more common, for tilt and manual**
  – Intermediate forward and side leans qualify
  – In-seat movement can have an impact so
    • Education should address these activities
    • IPM as an education tool, especially because amount of pressure relief for a weight shift might differ by cushion
    • Position people so they can move
Interface pressure mapping is useful when teaching pressure reliefs and weight shifts.
In summary

• Weight-shifts are based upon PU models linking time@pressure to necrosis

• Activity is good
  – put people in a position that they can do stuff
  – Seating systems and training to facilitate transfers
  – encourage activity-
    • leaning and reaching has positive tissue benefits
    • Weight shifts impact microclimate

• Most persons do not have a weight shift routine

• Behavior changes over time
Acknowledgements

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  – Helen Hoenig, MD

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Questions

I like to move it move it, Madagascar HD
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