Wheelchair use in everyday life

Stephen Sprigle
Why understand wheelchair use in everyday environments?

• Clinicians and users
  – Relating a clients use (or anticipated use) relative to others may better inform decisions about models and configurations.

• Manufacturers and Suppliers
  – Better information about how products are used can inform design of their products and compare products.

• Payers
  – Any data that relates mobility to health or independence or secondary complications should inform policy. We can and should learn more about use to better distinguish users, and therefore coverage.
Characterizing Manual Wheelchair Use-
Study 1

• 6 manual wheelchair users
• Inpatients of rehab facility in UK
• Activity monitor mounted to wheel

# 7-day total & daily averages

<table>
<thead>
<tr>
<th>Subj #</th>
<th>Time moving (hr)</th>
<th>Distance (km)</th>
<th>Speed (m/sec)</th>
<th>Daily covariance (%)</th>
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<tbody>
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<table>
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<th>Avg Time moving/day (hr)</th>
<th>Avg distance/day (km)</th>
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<td>2.23</td>
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<td>7</td>
<td>0.58</td>
<td>1.06</td>
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</table>
Characterizing Manual Wheelchair Use - Study 2

• 52 Athletes from VA Games
• 2.457 Km (sd= 1.20 km) over 47.9 min (sd=21.4)
• Employed subjects
  – 3.4 km

Tolerico, M, et., al ; Assessing mobility characteristics and activity levels of manual wheelchair users. JRRD 2007
Characterizing Manual Wheelchair Use- Study 3

- 6 full time users living in the community
- Seat occupancy switch
- Accelerometer-based data logger on wheel
Distance, time moving & bouts of mobility

• Three constructs, 2 are commonly described
• Bouts of movement
  – Represent transitions between activities
  – Technical definition
    • Movement that is < 5 ft in < 5 sec
• Distance and time are very highly correlated
• Bouts are least correlated to the others in MWC and PWC data
• Data varies widely within and across subjects
Mean vs median

• Why look at median versus mean?

• Example: Income in the US
  – Normal or skewed?
  – What is the mean? median?

Median = 46,300  
Mean = 63,300

20% < $29,200  
40% < $36,000  
60% < $57,700  
80% < $91,700  
95% < $166,000  
98% < $250,000
# Median and ranges of movement

<table>
<thead>
<tr>
<th>Subject</th>
<th>Distance (m)</th>
<th>Time (min)</th>
<th>Number Bouts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>2295 (1710 - 3062)</td>
<td>95 (80 - 133)</td>
<td>113 (88 - 151)</td>
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<tr>
<td><strong>B</strong></td>
<td>1153 (523 - 2605)</td>
<td>61 (42 - 75)</td>
<td>81 (63 - 93)</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>1167 (875 - 1233)</td>
<td>87 (84 - 88)</td>
<td>119 (118 - 133)</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>676 (103 - 1150)</td>
<td>35 (7 - 46)</td>
<td>46 (14 - 60)</td>
</tr>
<tr>
<td><strong>E</strong></td>
<td>1375 (700 - 1731)</td>
<td>71 (39 - 91)</td>
<td>92 (58 - 112)</td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>3596 (1577 - 4694)</td>
<td>134 (82 - 153)</td>
<td>136 (114 - 178)</td>
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</tbody>
</table>

* Subjects A, E & F are employed
Characterization of Power Wheelchair Use in the Home and Community

• 25 full-time power users
• Monitored for 2 weeks
  – Seat occupancy
  – Wheel movement
  – GPS
• Prompted recall used to add context & detail

<table>
<thead>
<tr>
<th>Environment</th>
<th>Variable</th>
<th>Median</th>
<th>Mean</th>
<th>SD</th>
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<tr>
<td><strong>Home</strong></td>
<td>% Distance</td>
<td>59</td>
<td>57</td>
<td>30</td>
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<tr>
<td></td>
<td>% # Bouts</td>
<td>75</td>
<td>71</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>% Time</td>
<td>64</td>
<td>63</td>
<td>27</td>
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<tr>
<td><strong>Not Home</strong></td>
<td>% Distance</td>
<td>13</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>Indoors</td>
<td>% # Bouts</td>
<td>13</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>% Time</td>
<td>11</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td><strong>Not Home</strong></td>
<td>% Distance</td>
<td>2</td>
<td>19</td>
<td>29</td>
</tr>
<tr>
<td>Outdoors</td>
<td>% # Bouts</td>
<td>2</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>% Time</td>
<td>2</td>
<td>15</td>
<td>22</td>
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</tbody>
</table>
Median bout characteristics differ based on environment.

<table>
<thead>
<tr>
<th></th>
<th>Distance (m)</th>
<th>Duration (sec)</th>
<th>Speed (km/hr)</th>
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</thead>
<tbody>
<tr>
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<td>3.7</td>
<td>18</td>
<td>0.8</td>
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<td>Not Home Indoors</td>
<td>4.2</td>
<td>18</td>
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<tr>
<td>Not Home Outdoors</td>
<td>11.3</td>
<td>34</td>
<td>1.6</td>
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</table>
Comparing two users

Subject A

Subject B

- In The Home
- NotHome - Inside
- NotHome - Outside
10 vs 14” wheels

Can and should we try to discuss this?
Comparing usage

• PWC study- the median user
  – spent 10.6 hours in his/her wheelchair daily
  – wheeled 1.085 km over 58 minutes
  – 110 bouts
• MWC study- the median inpatient
  – Wheeled 2.0 km over 67 minutes
• MWC study- mean of Veterans Games participants
  – 2.457 Km over 47.9 min
• MWC study- the median community user
  – 1.33 km over 77 min
  – 101 bouts
How far do people walk?

• The role of free-living daily walking in human weight-gain and obesity. Levine, JA, et. al; Diabetes. 2008
  – “walking comprises many short-duration, low-velocity walking bouts”
  – On average, a participant took 47 (range 46-62) walks per day: 85% were <15 min in duration, and 88% occurred at <2 mph;
  – On average, people walked about 11.25 km/day (7 miles)

  – Average: 4.17 +/- 1.61 km

  – <5000 steps: sedentary (2.25 to 3 km)
  – 5000-7500: typical (3.4-4.5 km)
Why we should care

- Daily use varies widely within a person
- Use varies widely across people
- Movement is characterized by short bouts of movement
  - For PWC, this indicates need for maneuverability more than top speed
  - For MWC, this indicates that starts, stops and turns dominate propulsion
- Even if one considers only ITH, disparity of use can inform prescription (10” wheel vs 14”)
- Repair and replacement frequency is impacted by wheelchair usage
Why we should care- MWCs

• Research has not defined a dose-response relationship between time of MWC use and UE overuse injury
  – The disparity in propulsion might have masked this relationship
  – Documenting bouts of mobility and time moving might be a better measure
Why we should care - MWCs

• Can comparing average speed data to our clients’ speeds inform prescription?
  – A client unable to reach the average speed necessary for ‘everyday mobility’ may form basis for different MWC or need for PWC

• Should research into propulsion reflect speeds used in everyday mobility?

• Endurance – total time propelling leads to 2 considerations
  – Enough ‘umph’ at end of the day
  – Able to get to point B from Point A (longest trek)
Comparing wheelchair use to walking

- Studies of both produce disparate results
- However, wheelchair movement is quite low, comparatively
- Can we infer walking data reflects typical ADL needs?
- Can we use this comparison to
  - judge ‘mobility limitation’?
  - make an argument that mobility devices should facilitate equal movement?
Use of tilt-in-space

- Obtaining of specialized wheelchair features can be problematic
- Understanding use of TIS
  - Better document indications
  - Inform ways to optimize usage
  - Better match devices to users
- Recent publications: very consistent results
  - Ding D, et. Al; Usage of tilt-in-space, recline, and elevation seating functions in natural environment of wheelchair users, JRRD, 2008
Tilt feature use

Tilt Feature Use

Subject

Hours Spent in Range

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

small medium large large extreme
<table>
<thead>
<tr>
<th>Subject</th>
<th>Typical Position</th>
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<th>% Time</th>
<th>% Time</th>
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<td>15 -29</td>
<td>30 -44</td>
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<td>93%</td>
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<td>30%</td>
<td>26%</td>
<td>10%</td>
<td>3%</td>
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</table>
Use of tilting per hour

Use of tilt feature

Tilting >30°

Pressure Relieving Tilt Frequency
Why should we care?

• People use their TIS feature frequently
  • May indicate that small changes in position increase comfort, stability and/or function
  • Regardless of the reason, use of feature should be encouraged during set-up and training

• Many people sit in some tilt for extended periods
  – May indicate gravity-assisted positioning is sought
  – Perhaps we can investigate this during evaluation for and training of TIS systems
Can we increase tilt magnitudes?

• Few people use full ranges of TIS feature
  – We have no reason to obsess over small differences in maximum tilt magnitudes
  – Our obsession should be in increasing utilization

• Better training and education may be indicated
  – During delivery, all users should be brought through full tilt range
    • Reports of confidence issues
    • Lack or awareness of reason TIS was prescribed
  – Perhaps IPM can be used as a training tool
Done