Enhancement of the SPPB with Mobile Accelerometry

Accepted for the FNN Conference

Agnes Köhler, Florian Winter and Steffen Schlapak

E-Mail: koehler.agnes@mytum.de, steffen.schlapak@tum.de, florian.winter@tum.de
Content

- Introduction – The SPPB
- Goal
- Methods and Results
  - 4 Meter Walk Test
  - Chair Rise Test
  - Timed Up and Go Test
- Future Work
- Discussion
Short Physical Performance Battery (SPPB)

Objective assessment tool for evaluating lower extremity functioning in older persons

Contains:

- 4 Meter Walk Test
- Chair Rise Test
- Balance Test

In addition: Timed Up And Go Test (TUG)

Tests used in research fields e.g. Parkinson:


http://www.grc.nia.nih.gov/branches/leps/sppb/aap_CDcover.jpg
The Goal

- enhancement of clinical tests with accelerometry
- more precise results
- cheaper methods
- additional data
- user-friendly application for clinical trials
The 4 Meter Walk Test

Extracted information:

- Number of Steps
- Average Step Length in cm/step
- Step Frequency in steps/min
- Speed in m/s
The 4 Meter Walk Test
Methods of the 4 Meter Walk Test
Preliminary Results

<table>
<thead>
<tr>
<th># Trial (meters walked)</th>
<th>Average step length actibelt (m)</th>
<th>Average step length measurement (m)</th>
<th>Age, Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (4 meter walk)</td>
<td>0.685</td>
<td>0.696</td>
<td>Female, 23</td>
</tr>
<tr>
<td>2 (10 meter walk)</td>
<td>0.878</td>
<td>0.903</td>
<td>Female, 38</td>
</tr>
<tr>
<td>3 (4 meter walk)</td>
<td>0.831</td>
<td>0.917</td>
<td>Female, 38</td>
</tr>
</tbody>
</table>
Result of the 4 Meter Walk Test

Male, 21

<table>
<thead>
<tr>
<th># Trial</th>
<th>Average step length actibelt (m)</th>
<th>Average step length measurement (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.960</td>
<td>0.878</td>
</tr>
<tr>
<td>2</td>
<td>0.910</td>
<td>0.835</td>
</tr>
<tr>
<td>3</td>
<td>0.570</td>
<td>0.540</td>
</tr>
</tbody>
</table>
Chair Rise Test
Chair Rise Test

- Duration
- Amplitude
- Stand/sit events

[1] Longitudinal Falls-Risk Estimation Using Triaxial Accelerometry
Methods of the Chair Rise Test

Male, 26

Female, 68

Time
Acceleration [g]
Experimental Subjects of the Chair Rise Test

26, male

18, female

46, female

23, female

68, female

15, male

23, female
Results of the Chair Rise Test

<table>
<thead>
<tr>
<th>#</th>
<th>Sex, age</th>
<th>Number of rises by algorithm</th>
<th>Actual number of rise up events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Female, 68</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Male, 26</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Female, 18</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Male, 15</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Female, 46</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Female, 23</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>Female, 23</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td><strong>Mean</strong></td>
<td><strong>2.29</strong></td>
<td><strong>5.00</strong></td>
</tr>
</tbody>
</table>
Timed Up and Go Test (TUG)

- Duration
- Amplitudes
- Number of steps
- Step length
- Stand up/sit down events

[1] Longitudinal Falls-Risk Estimation Using Triaxial Accelerometry
Methods of the TUG

Male, 26

Female, 68
Experimental Subjects of the TUG

26, male

18, female

46, female

23, female

68, female

15, male

23, female
## Results of the TUG

### Female, 68

<table>
<thead>
<tr>
<th>#</th>
<th>Sex, age</th>
<th>Number of steps counted by algorithm</th>
<th>Actual number of steps (counted from video)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Female, 68</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Male, 26</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>Female, 18</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>Male, 15</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Female, 46</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>Female, 23</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>Female, 23</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td><strong>Mean</strong></td>
<td><strong>12.00</strong></td>
<td><strong>11.86</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Variance</strong></td>
<td><strong>1.67</strong></td>
<td><strong>3.48</strong></td>
</tr>
</tbody>
</table>
Future Work

- concept verification (more data needed)
- video analysis
- extend application with instructions for clinician
- development of android cloud computing platform to be used in clinical trials & clinical practice
- find more points of interest
- evaluation of the points of interest:
  - thresholds
  - correlation with reference signal
  - linear least square model
  - artificial neural networks (e.g. multi-layer perceptron)
[1] Longitudinal Falls-Risk Estimation Using Triaxial Accelerometry. Michael R. Narayanan, Student Member, IEEE, Stephen J. Redmond, Member, IEEE, Maria Elena Scalzi, Stephen R. Lord, Branko G. Celler, Member, IEEE, and Nigel H. Lovell*, Senior Member, IEEE

