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**ABSTRACT**

**Purpose:** To assess the test–retest reliability of the Special Interest Group on Amputation Medicine Mobility Scale/Dutch Working Group on Amputations and Prosthetics, better known as SIGAM/WAP mobility scale, in persons with a lower-limb amputation.

**Method:** Longitudinal study at the outpatient departments of a rehabilitation center and a university medical center. Persons with a lower-limb amputation, wearing a prosthesis, were assessed at the end of their multidisciplinary rehabilitation treatment twice, with a 3-week interval, by the same practitioner. Test–retest reliability was quantified using the intraclass correlation coefficient for agreement.

**Results:** Eighty persons participated (mean age ± SD, 61 ± 15 years; 61% men; 76% vascular cause of amputation; 70% able to walk >50m). Fifty-one of them rated themselves to be stable with respect to their mobility and their intraclass correlation coefficient was 0.90 (95% confidence intervals 0.84–0.94).

**Conclusions:** The Special Interest Group on Amputation Medicine Mobility Scale/Dutch Working Group on Amputations and Prosthetics had, at the outpatient departments of a rehabilitation center and a university medical center, excellent test–retest reliability in persons wearing a prosthesis after a lower-limb amputation.

**IMPLICATIONS FOR REHABILITATION**

- The Special Interest Group on Amputation Medicine/Dutch Working Group on Amputations and Prosthetics Mobility Scale was developed to classify mobility after a lower-limb amputation and wearing a prosthesis.
- The Dutch translation of this mobility scale has excellent test–retest reliability.

**Introduction**

Mobility is one of the major determinants of quality of life in persons with a lower-limb amputation [1]. With prosthetic devices and after rehabilitation treatment, many amputees are able to restore their mobility as well as their participation in society [2].

Many scales are used to measure or classify mobility in persons with a lower-limb amputation, but a golden standard or a criterion standard test is still lacking [3,4]. The Amputee Mobility Predictor (AMPPro) [5], a physical assessment scale which has been recommended [3], takes 10–15 min per patient [5]. The Locomotor Capabilities Index (LCI) [6] is a recommended survey [3] and another way to assess mobility, but it has a high ceiling effect [7]. The Special Interest Group on Amputation Medicine Mobility Scale (SIGAM-MS) [8] is alternative recommended survey.

The SIGAM-MS has been developed to measure levels of mobility in persons with a lower-limb amputation [8]. The SIGAM-MS is a questionnaire, measuring getting around, using a prosthesis and any walking aid if needed. It contains 21 items with dichotomous response options (YES box marked/NO box marked). An algorithm was designed to calculate for six mobility grades (A to F). On the basis of the use of different walking aids, grade C is subdivided into four grades, and grade D is subdivided into three grades, resulting in a total of 11 grades. Table 1 presents all grades and sub-grades and Figure 1 the algorithm. Higher grades indicate better mobility. The conceptual framework of the SIGAM-MS has been well described [8]. The SIGAM-MS has proven feasible (simple questions, easy to assess, quick) and has good reliability and validity [8]. The original English version of the SIGAM-MS was therefore translated into Dutch. This Dutch translation of the SIGAM-MS has been named the SIGAM/WAP mobility scale [9].

The psychometric properties of the SIGAM/WAP mobility scale have not been studied yet. An important psychometric property is test–retest reliability. Test–retest reliability refers to the reproducibility of measurements with the same instrument over time [10]. The objective of the present study was to assess the test–retest reliability of the SIGAM/WAP mobility scale in persons with a lower-limb amputation.

**Methods**

**Participants**

Participants were recruited from two settings: the outpatient department in Rehabilitation center ‘Tolbrug’ in s-Hertogenbosch,
as part of a former study [11], and the outpatient rehabilitation department of the University Medical Centre of Groningen. Selection criteria were: persons with a lower-limb amputation, using a prosthesis, aged ≥18 years, and able to understand and fill in questionnaires. Recent standards recommend that at least 50 participants should be included in a test-retest reliability study [10]. Recruitment therefore aimed at selecting at least 50 participants who considered themselves stable with respect to their mobility. The study protocol was approved by the Research Ethics Committee of the Jeroen Bosch Hospital’s, Hertogenbosch. All participants gave informed consent.

Figure 1. SIGAM algorithm.
Table 2. Demographics and clinical characteristics of the study participants.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Stable patients rehab center (n = 22)</th>
<th>Stable patients university medical center (n = 29)</th>
<th>All stable patients (n = 51)</th>
<th>All patients (n = 80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>Mean ± SD 64 ± 14</td>
<td>60 ± 16</td>
<td>62 ± 16</td>
<td>61 ± 15</td>
</tr>
<tr>
<td></td>
<td>Range 37–86</td>
<td>27–91</td>
<td>27–91</td>
<td>24–91</td>
</tr>
<tr>
<td>Sex</td>
<td>Women 6 (27)</td>
<td>14 (48)</td>
<td>20 (39)</td>
<td>31 (39)</td>
</tr>
<tr>
<td></td>
<td>Men 16 (73)</td>
<td>15 (52)</td>
<td>31 (61)</td>
<td>49 (61)</td>
</tr>
<tr>
<td>Amputation etiology</td>
<td>Vascular 18 (82)</td>
<td>19 (66)</td>
<td>37 (73)</td>
<td>61 (76)</td>
</tr>
<tr>
<td></td>
<td>Non-vascular 4 (18)</td>
<td>10 (34)</td>
<td>14 (27)</td>
<td>19 (24)</td>
</tr>
<tr>
<td>Amputation level</td>
<td>Unilateral 21 (95)</td>
<td>24 (83)</td>
<td>45 (88)</td>
<td>70 (88)</td>
</tr>
<tr>
<td></td>
<td>Higher (TF or KD)</td>
<td>7 (32)</td>
<td>11 (38)</td>
<td>18 (35)</td>
</tr>
<tr>
<td></td>
<td>Lower (TT or Syme)</td>
<td>14 (63)</td>
<td>13 (45)</td>
<td>27 (53)</td>
</tr>
<tr>
<td></td>
<td>Bilateral 1 (5)</td>
<td>5 (17)</td>
<td>6 (12)</td>
<td>10 (12)</td>
</tr>
</tbody>
</table>

Values expressed as n (%) unless noted otherwise.

Measures

The SIGAM/WAP mobility scale questionnaire and a self-constructed global rating of change questionnaire (GRCQ) [12] were used. The GRCQ was used in order to study the test–retest reliability in participants who did and did not considered themselves stable with respect to their mobility. This GRCQ was designed according the criteria to have adequate reliability and validity [12]. In the GRCQ participants were asked: “How do you rate your ability to walk now, compared with the first time you filled in the questionnaire?”. The 15 response options were (7) extremely good; (6) very much better; (5) much better; (4) better; (3) somewhat better; (2) slightly better; (1) almost the same, marginally better; (0) no change; (−1) almost the same, marginally worse; (−2) slightly worse; (−3) somewhat worse; (−4) worse; (−5) much worse; (−6) very much worse; (−7) extremely bad. Participants were considered to be stable with respect to their perceived mobility if they rated themselves on the GRCQ in the range from (2) slightly better to (−2) slightly worse [11].

Procedure

Information about age, sex, and cause and level of amputation were collected from the medical record. Participants were assessed for the first time at the end of outpatient rehabilitation treatment by a trained independent physician (rehabilitation center) or physiotherapist (university medical center). Participants were assessed for the second time 3 weeks afterwards by the same physician or physiotherapist, respectively. The SIGAM/WAP mobility grades were assigned on both occasions using the algorithm. During the second assessment, participants also completed the GRCQ.

Analysis

The test–retest reliability was quantified per setting and for both settings combined in stable and non-stable patients with the intraclass correlation coefficient (ICC) for agreement, with 95% confidence intervals (95% CI) [13]. The ICC is considered to be the most suitable and most commonly used reliability parameter [10]. We used a two-way random effects model where both person effects and measures effects are random. ICCs ≥0.90 are considered to be appropriate for both group level and individual level comparisons, ICCs ≥0.75 are considered to be appropriate for group level comparisons [10,14]. In addition, we visualized for both settings combined the test–retest reliability of the stable patients with a modified scatter plot. All statistics were calculated in the SPSS 22.0 for Windows program (SPSS, Chicago, IL).

Results

Patient characteristics

Eighty-three patients fulfilling the selection criteria completed the outpatient rehabilitation treatment program. Eighty out of these 83 (96%) were willing to participate in the study. Fifty-one out of these 80 participants considered themselves as stable with respect to their mobility, whereas 26 considered themselves improved and three considered themselves worse. The characteristics of all and the stable participants are summarized in Table 2. The results of the SIGAM/WAP mobility score of the participants at first assessment are shown in Table 3.

Test–retest reliability

The ICC of the stable participants was 0.79 (95% CI 0.56–0.90) for the outpatient department of the rehabilitation center, 0.98 (95% CI 0.95–0.99) for the outpatient rehabilitation department of the University Medical Centre, and 0.90 (95% CI 0.84–0.94) for both settings combined, indicating an excellent reliability [15]. The ICC of the non-stable participants was 0.55 (95% CI 0.24–0.76), indicating a fair to good reliability only. Figure 2 visualizes the results of all stable participants of both settings combined.

Discussion

The objective of this study was to assess the test–retest reliability of the SIGAM/WAP mobility scale in persons wearing a prosthesis after a lower-limb amputation. Results indicate that the SIGAM/WAP mobility scale has an excellent reliability in stable persons after a lower-limb amputation [15]. The reliability in the non-stable participants was, as to be expected, fair to good only. Our study population was slightly different from other studies in The Netherlands [16]. Our study population was younger (61 ± 15 years versus 74 ± 11). This is probably due to the selection criteria that participants used a prosthesis and that they were sampled at the end of outpatient rehabilitation treatment period. Both may result in an overrepresentation of younger amputees.

The SIGAM/WAP mobility scores of our participants differed slightly from the scores presented in the paper about the development of the SIGAM-MS [8]. No participants in our study had a score A (no limb wearing) reflecting that we selected persons...
wearing a prosthesis only. No participants had a score Cd (walking level ground, < 50 m, without walking aids) and just one participant a score Da (walking outdoor on level ground, > 50 m, with a frame). Note that the hierarchy in the SIGAM-MS indicates that a person who is able to walk 49 m without a walking aid is more limited than a person who is able to walk 51 m with a frame. This reflects that the use of aids is simultaneously seen by the developers as an indication of activity limitations ([more] use of aid indicates [more] limitations) and as a compensation mechanism (walking less than 50 m indicates more limitations than walking more than 50 m [with or without an aid]).

The test–retest reliability we found in this study in stable patients was excellent for both settings and both setting combined, and was more or less comparable to the test-retest reliability that was found in some other studies [8,17]. Excellent test–retest reliability has been found for the original version of the SIGAM-MS [8] and other translations [17,18]. A study addressing the psychometric properties of the French translation of the SIGAM-MS found an excellent reliability [17]. The recent published Turkish version of the SIGAM mobility scale [18] had a repeatability of 0.82, comparable with our results. A study addressing the psychometric properties of the original SIGAM-MS showed a slightly lower ICC, of 0.79 [8]. This is probably because the test-retest reliability of the original SIGAM-MS was not studied in participants who considered their mobility stable. The ICCs for the outpatient department of the rehabilitation center, albeit excellent, was lower than the ICC for the outpatient department of the University Medical Centre. Probably, the SIGAM/WAP mobility scale has better reliability in an academic setting.

Table 3. SIGAM/WAP mobility scale of the study participants at first assessment.

<table>
<thead>
<tr>
<th>SIGAM/WAP scale</th>
<th>Stable patients rehab center (n = 22)</th>
<th>Stable patients university medical center (n = 29)</th>
<th>All stable patients (n = 51)</th>
<th>All patients (n = 80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A No limb</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B Transfers</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Ca &lt; 50 m, + frame</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Cb &lt; 50 m, + 2 crutches / rollator</td>
<td>4</td>
<td>9</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Cc &lt; 50 m, + 1 crutch</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Cd &lt; 50 m, no walking aids</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Da &gt; 50 m, + frame</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Db &gt; 50 m, + 2 crutches / rollator</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>Dc &gt; 50 m, + 1 crutch</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>E Occasional aid outside</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>F Near normal/normal</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>
The test–retest reliability we found in this study was in non-stable patients fair to good only. The finding that the test–retest reliability was worse in non-stable was to be expected. This might even be considered an aspect in favor of the construct validity of the SIGAM/WAP mobility scale.

Study limitations
This study addresses only the test–retest reliability of the SIGAM/WAP. Other important psychometric properties are validity and responsiveness [19]. The concurrent validity of the original SIGAM-MS has been investigated using the timed walking test: as the SIGAM-MS grade increased, the time to complete the timed walking test decreased [8]. We suggest further testing of the construct validity of the SIGAM/WAP, using questionnaires, such as the Prosthetic Limb Users Survey of Mobility (PLUS-M) [20], and other performance tests, such as the Timed Up and Go test [21]. We recommend study of the responsiveness and the longitudinal construct validity of the SIGAM/WAP mobility scale over a longer time period in a larger sample of participants who considered themselves as changed with respect to their mobility. In addition to the validity and the responsiveness, the interpretability of the scores is an issue. One study showed that physicians in The Netherlands understood the algorithm and its qualifications of the SIGAM/WAP mobility scale [9].

Conclusions
The Dutch translation of the SIGAM-MS, the SIGAM/WAP mobility scale, has excellent test-retest reliability in stable persons with a lower-limb amputation wearing a prosthesis. This enables group level comparisons as well as individual level comparisons.

Disclosure statement
No potential conflict of interest was reported by the authors.

References