The SIGAM mobility grades: a new population-specific measure for lower limb amputees

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Abstract

Purpose: To develop a valid measure of lower limb amputee mobility suitable for routine clinical use, including monitoring change.

Methods: The Special Interest Group in Amputee Medicine (SIGAM) described a single-item scale comprising six clinical grades (A–F) of amputee mobility. A self-report questionnaire was developed and algorithm designed to facilitate grade assignment. Reproducibility of the questionnaire and grades were assessed in 62 amputees. Concurrent validity and sensitivity to change were investigated using the timed walking test (TWT). The mobility construct was examined in 200 amputees, using item response theory, by co-calibration with the Rivermead Mobility Index (RMI) on the same patients.

Results: Patients included 144 males and 66 females, aged 13–90. Intraclass correlation coefficients and reproducibility kappa values were satisfactory. Observers agreed 100% in using the algorithm. TWT improved as SIGAM grade increased. Examination of psychometric properties revealed the SIGAM item fitted within the RMI mobility matrix. Average measures for the six grades were ordered correctly. There was no local dependency or differential item functioning for clinically relevant patient subgroups. The SIGAM scale showed an effect size of 10.66.

Conclusions: The SIGAM mobility grades represent a novel, valid, clinically useful measure of amputee mobility which is also sensitive to change.

Introduction

Measuring the impact of treatment is now, more than ever, an integral part of health care both at the individual level and societal level. Rehabilitation of lower limb amputees focuses on return to walking. While clinical experience suggests limb-fitting centres are good at monitoring various aspects of mobility, such monitoring is often unstructured. Examination of an extensive medical (Medline, Embase, Cinahl) and prosthetic (RECAL) electronic literature database search was undertaken to examine methods of measuring amputee mobility. This highlighted the need for a well-defined, stand-alone, structured measure of mobility in lower limb deficiency. A recent review by Rommers et al. examined 35 mobility scales for lower limb amputees and highlighted a considerable range in measurement and lack of real consensus in the literature. They noted the need for a valid reliable one with a wide range of measurement, to actually measure differences over time.

In Britain, the former Amputee Medical Rehabilitation Society (now the Special Interest Group of Amputee Medicine (SIGAM) of the British Society of Rehabilitation Medicine) was keen to promote standardized robust outcome measurement. The group recognized there was a need to develop an easy to use valid method of measuring levels of mobility in lower limb amputees. As a result a working party of interested clinical experts developed a single-item scale, consisting of six categories, that described clinically useful levels of mobility in lower limb amputees (appendix, figure 1). These SIGAM mobility grades were clinically deemed to identify a natural order of difficulty in mobilization.

The SIGAM mobility grades were developed along similar lines to Harold Wood Stanmore (HWS) mobility grades. While the HWS scale was used in clinical practice in limb fitting centres around the UK, problems with grade assignment were reported. The SIGAM scale includes the first two grades and last grade from the HWS scale. The SIGAM scale differs with respect to the remaining three grades: a bench-
A mark distance of 50 metres is used to denote an improvement in mobility, as opposed to ability to walk indoors or outdoors. Previous studies examining the inter-rater reproducibility of the SIGAM has shown an acceptable Kappa value of 0.726. However, further validation of the SIGAM grades was not undertaken.

The aim of this study is to investigate whether the SIGAM mobility grades are practical to use, reliable, valid and sensitive to change in mobility, particularly important in those who have recently become amputees.

Methods

Two studies were undertaken. The first (study 1) examined reproducibility and validity of the SIGAM mobility grades in a stable lower limb deficient population and the second study (study 2) investigated whether the scale is sensitive to change.

STUDY 1

Further development of the SIGAM mobility grades

The SIGAM mobility grades as a self-reporting questionnaire. The SIGAM mobility grades were originally proposed as an observer-rated instrument. However, self-reporting by a patient has certain advantages in a clinic setting: (1) the patient can be allowed as much time as he/she wishes to complete the questionnaire; (2) opportunities for observer error are reduced; and (3) there is potential to use the questionnaire for larger scale study through postal survey. Therefore, it was decided to transform the SIGAM mobility grades into a patient self-reporting questionnaire, from which the clinician can assign the appropriate grade for each patient.

In developing this questionnaire, closed-ended questions were developed from the original SIGAM grades, such that patients could answer dichotomously, yes or no, to each question. The questionnaire was piloted in an outpatient setting in order to identify linguistic or other problems which might interfere with interpretation of the questions. Comments or suggestions were documented and included in the overall development of the questionnaire. Feedback was also given on questionnaire layout and on giving clear instructions. Five trials were performed asking five to ten amputees in each trial. After each trial changes were made before the next trial, until a final satisfactory version was achieved (appendix, figure 3).

Developing the SIGAM algorithm. In developing any scale, it is necessary to focus on the consistency of the answers across the range of items, and for the most part, disregarding the responses to individual questions that make no sense. For instance, a patient that affirms wearing a false leg for cosmesis only, yet also indicates that he/she walks indoors, outdoors and only occasionally needs a walking stick, has wrongly answered the question on cosmesis; therefore, this response needs to be disregarded in assigning a mobility grade. In order to disregard inappropriate responses to the questionnaire and help assign an appropriate mobility grade an algorithm was developed for use by practitioners.

Assessor A (NR) assigned mobility grades to each of the questionnaires completed by all patients in study 1, part A (please see below), of the study. In order to represent each grade of mobility, stratified randomization of the completed questionnaires was performed: the questionnaires were divided into groups according to the grades assigned by Assessor A; a computer then randomly selected four questionnaires from each SIGAM-assigned group. Twenty-four questionnaires were therefore selected and distributed to seven other health care professionals in Chapel Allerton Hospital Limb Fitting Centre, including two consultants in Rehabilitation Medicine, one clinical assistant general practitioner, one specialist amputee nurse, and three prosthetists. These observers were blinded to the identities of the patients, to each other’s assignments, and that there were four questionnaires representing each grade.
mobility grade. This whole process is outlined below in figure 1. Feedback on readability and ease of use was given.

Study design

Study 1 was performed in two parts, Parts A and B. As these studies were performed at the same time, on the same patients, as those completing the Rivermead Mobility Index (RMI) in order to analyse the underlying psychometric properties of the SIGAM—see below for further explanation and discussion), the reader is referred to reference 1 for details on subject recruitment, and inclusion and exclusion criteria are also outlined.

Part A. Part A was performed over two time points, times 1 and 2, 2 to 4 weeks apart, to check reproducibility, with the patients completing the SIGAM questionnaire at both time points. From these, assessor A assigned a mobility grade to each completed questionnaire at both time points.

The time taken to complete the SIGAM was recorded for all patients at time 1. Mean values and standard deviations (SD) were calculated. Each patient was asked for any additional comments they wished to make regarding the measure, particularly relating to readability and comprehension of the questions; all responses were documented.

The TWT was used to assess concurrent validity of the SIGAM grades. The TWT has been previously used to measure mobility in lower limb amputees. Only those patients who achieved grades C–F were able to perform the TWT. Similarly, details of how the TWT was performed is outlined in reference 1.

Part B. Rasch analysis was used to investigate the construct validity of the SIGAM mobility grades. Since single-item scales cannot be analysed using Rasch analysis (at least two items are needed in order for items to be put in context of difficulty of each other) the SIGAM could not be analysed on its own. Therefore, it was necessary to perform the SIGAM grades on the same patients, at the same time, as those that completed the RMI. Thus the RMI was used as a matrix of mobility into which the SIGAM item was inserted.

Therefore, as outlined in reference 1, in order to recruit a representative sample of lower limb amputees, from immobile to highly mobile, patients completed the SIGAM and the RMI with assessor A at time 1 only.

STUDY 2

Patients who had undergone surgical amputation within the last 6 months were recruited from those routinely attending the outpatient limb fitting clinics to assess sensitivity to change in mobility. Attempts were made to recruit patients at different stages of rehabilitation within the first 6 months. Other inclusion criteria were: amputation at or above ankle-disarticulation level; unilateral or bilateral amputee; 5 years of age and over; and appropriate informed consent. Exclusion criteria were: any concomitant, significant, progressive or non-progressive psychiatric/neurological/rheumatological/orthopaedic deficit impairing mobility which significantly impaired mobility more than the amputation or ability to take part in the study; and inadequate fluency in English to participate fully in the study.

Patients underwent at least two assessments. Following the first assessment at recruitment, subsequent assessments were performed when the patient was due to attend the next routine outpatient clinic. Such appointments, for recent amputees, occur 3 weeks, and then 6 weeks, after delivery of prosthesis, followed by a 3-month, 6-month and finally a 12 month appointment.

At each assessment patients were requested to complete a SIGAM mobility questionnaire. NR assigned a mobility grade to each completed questionnaire and measured the TWT (TWT1) on each patient. At follow-up they were then assessed by a rehabilitation physician who independently assigned whether the patient had improved, remained the same or deteriorated with regard to his/her mobility and in what manner any change occurred. Similarly, patients were asked to comment on how their mobility had changed. The doctor was asked to comment on any discrepancy between the patient’s assessment and the doctor’s. NR repeated the TWT (TWT2).

Statistical methods

All statistics were calculated using SPSS 9.0 for Windows programme.

STUDY 1

Part A

An overall intraclass correlation coefficient (ICC) and individual kappa coefficients were calculated for the reproducibility of responses to the SIGAM questions.
A kappa coefficient was also calculated for the reproducibility of grades assigned by assessor A.
Non-parametric Kruskal-Wallis H analysis was applied to four SIGAM grades, C–F, in relation to the TWT. Mann Whitney U analysis was applied to two SIGAM grades at a time, e.g. C and D, C and E, C and F, D and E, D and F, and E and F, to investigate if the TWT could distinguish if a relationship could be demonstrated between change in mobility grade and change in TWT. Reliability of measuring the TWT has been previously discussed.1

Part B

The WINSTEPS computer analysis programme for Rasch analysis11 was used in this study. With co-calibration of the SIGAM with the RMI the 16 items were analysed with respect to: item hierarchy, overall fit to the model, item/person separation, factor analysis, local independence and differential item functioning (DIF).

STUDY 2

Agreement between any change in mobility grade assigned by the physician and patient assessments were assessed, as was agreement between grades assigned by the physician and patient. Where discrepancies were found comments were examined for likely explanations.

Effect size for change in TWT times and SIGAM grades between initial and follow-up appointments were calculated.11 For those patients who scored grade A on initial assessment, and therefore could not walk, it was not possible to include these subjects in the calculations of effect size.

Results

SIGAM QUESTIONNAIRE

Following constructive feedback from patients in the initial trials on layout, instructions and phrasing of questions, the final version of the SIGAM questionnaire was generally accepted as ‘user-friendly’. Relevancy of questions to the target population was highlighted by patient responses to questions 1 and 2. As the majority of lower limb amputees use their prostheses functionally, some felt the first question unnecessary, ‘Do you wear a false leg(s)?’ as they presumed it was self-evident. Nevertheless, they had no difficulty answering it correctly as they could understand the question clearly. The second question, however, posed greater problems. Again, some patients queried the relevancy of the item but a greater number seemed to have problems understanding it. Some queried the word ‘cosmetic’, while others seemed to understand the question but affirmed the wrong answer, e.g. ‘of course, I don’t wear it for cosmetic reasons only’ but ticked ‘yes’. This difficulty is reflected in a low kappa score of 0.38.

SIGAM ALGORITHM

The algorithm (appendix, figure 2) received highly favourable feedback as logical, methodical, easy to read and follow, and quick. The observers clearly described a learning curve in using the algorithm. Though not strictly timed, the first few questionnaires took at most one to two minutes to complete. Thereafter, as they became familiar with the algorithm, the grading assignments were completed much faster, in several seconds to less than a minute. Observers reported that, with pattern recognition, they quickly became familiar enough with the process not to have to use the algorithm routinely except as a back up or reference; in other words they were able to assign a mobility grade based on the questionnaire alone.

Of the seven assessors (1–7), six agreed 100% with the original assessor A. The seventh differed significantly in six of the 24 (25%) grade assignments. For example, all other assessors assigned grade A to a patient who affirmed questions 1 and 2 only, i.e. he/she wears cosmetic limbs only and does not walk. Assessor 7 assigned this person a grade C, i.e. walks on level ground less than 50 metres. Assessor 7 could not account for such a level of variance with the others. Assessor 7 repeated the grade assignments on the same 24 questionnaires in a different order approximately 4 months later. On this occasion there was 100% agreement with the other seven observers.

STUDY 1

Part A

Sixty-two patients (42 male, 20 female) were recruited. Patient demographics, including age (means and SDs), diagnoses leading to amputation, amputation levels, and time since amputation, have been previously outlined in reference 1.

SIGAM mobility grades. Cohen’s kappa values for each SIGAM question ranged from 0.70–1.0, except for question 2 which had a kappa value of 0.38. There was an ICC z of 0.79. The mobility grades assigned by
assessor A are outlined in figure 2. There was an overall kappa coefficient of 0.86.

One highly mobile patient (SIGAM grade F) refused to do the TWT, leaving 51 patients who were assessed. Age range (mean ± SD), underlying diagnoses leading to amputation, and levels of amputation, range of time since amputation, are outlined in reference 1. Times for the TWT ranged from 8.1–44.9 seconds with a median of 12.4 seconds with an interquartile range (IQR) of 10.4–16.3 seconds.

Only those patients who achieved SIGAM grade C or above were able to do the TWT. For individual grades C–F the medians and IQRs were C: 17.81 (13.89–21.7) seconds; D: 13.61 (11.32–17.98) seconds; E: 11.14 (9.55–12.35) seconds; and F: 9.64 (8.79–11.0) seconds. Box plots of the relationship of TWT to each of the SIGAM grades are outlined in figure 3. Outlier (o) and extreme (*) values are indicated. Non-parametric Kruskall Wallis H analyses across all grades for the TWT were highly significantly different, with a p = 0.000. Mann Whitney U analyses Z scores (with statistical significance set at p = 0.01) between each two grades were C–D: 7.195 (0.053); C–E: −3.13 (0.001); C–F: −2.86 (0.003); D–E: −2.307 (0.02); D–F: −2.91 (0.003); E–F: −1.16 (0.277).

Part B

Two hundred patients (144 males, 56 females) were recruited. Ages ranged from 13–90 (mean 57.2 ± 17.7) (males: 16–87 (55.5 ± 17.3); females: 13–90 (61.4 ± 18.3)). Summaries of age ranges are outlined in figure 4. Underlying diagnoses leading to amputation included trauma (n = 79), PVD (n = 49), infection (n = 20), cancer (n = 16), DM (n = 15), congenital deficiency (n = 14) and others (n = 7). Levels of amputation are outlined in table 1. There were 175 unilateral amputees and 25 bilateral amputees (16 bilateral TT, 1 TT and ankle disarticulation, 2 TT and knee disarticulation, 3 TT and TF, 1 TT and hip disarticulation, 1 bilateral TF, 1 TF and hip disarticulation). Time since amputation ranged from 1–61 years (mean 18.1 ± 17.7 years). This varied slightly for right and left sided amputations, with right-sided 18.5 ± 17.7 years and left-sided 16.8 ± 17.4.

Table 1  WINSTEPS analysis of the RMI and SIGAM (16 items)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Measure (logits)</th>
<th>INFIT</th>
<th>OUTFIT</th>
<th>POINT</th>
<th>BISERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Running/fast walking</td>
<td>7.00</td>
<td>1.45</td>
<td>3.10</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Walk outside on uneven ground</td>
<td>2.82</td>
<td>1.09</td>
<td>1.40</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Up &amp; down four steps</td>
<td>2.28</td>
<td>1.07</td>
<td>0.82</td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>SIGAM item</td>
<td>1.91</td>
<td>0.74</td>
<td>0.80</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Walk inside with no aid</td>
<td>1.49</td>
<td>0.81</td>
<td>0.50</td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Bathing/showering</td>
<td>0.48</td>
<td>1.19</td>
<td>0.78</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Stairs</td>
<td>0.42</td>
<td>0.80</td>
<td>0.48</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Walk outside on even ground</td>
<td>−0.15</td>
<td>0.90</td>
<td>0.99</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Picking off floor</td>
<td>−0.47</td>
<td>0.84</td>
<td>0.69</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Standing unsupported</td>
<td>−0.90</td>
<td>0.90</td>
<td>0.39</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Sitting to standing</td>
<td>−1.38</td>
<td>1.42</td>
<td>0.93</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Sitting balance</td>
<td>−1.86</td>
<td>1.19</td>
<td>0.78</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Walk inside with aid if needed</td>
<td>−1.86</td>
<td>0.59</td>
<td>0.18</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Turn over in bed</td>
<td>−2.93</td>
<td>1.53</td>
<td>0.52</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Lying to sitting</td>
<td>−3.31</td>
<td>1.04</td>
<td>0.28</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Transfer</td>
<td>−3.53</td>
<td>0.83</td>
<td>0.18</td>
<td>0.35</td>
<td></td>
</tr>
</tbody>
</table>

Note: Figures outside the accepted normal range are in bold
Assessor A assigned seven patients to each of both grades A and B, with 68 to each of C and D, and 20 and 30 to E and F respectively.

RASCH ANALYSIS OF THE SIGAM MOBILITY GRADES

With co-calibration of the SIGAM with the RMI, the SIGAM item became ‘item 1’ and all the RMI items 1–15 corresponding to item numbers ‘2–16’ respectively in the compiled scale. Results of 187 persons were analysed as 13 patients were found to have either ceiling or floor effects that could not be analysed.

For a detailed discussion on the basic principles and understanding of Rasch analysis, please refer to reference 1. Item hierarchy is outlined in table 1. This shows the SIGAM item fitted within the RMI hierarchy. The item threshold imprint for each of the six SIGAM categories within the RMI can be seen in figure 5. Average measures for the six SIGAM categories A–F were also in correct order as seen from table 2, however, step calibrations were out of order for categories B and C.

Infit and outfit values, and point biserials are also outlined in table 1 for the RMI-SIGAM co-calibrated scale. SIGAM category fit statistics are shown on table 2. The overall SIGAM item had acceptable infit and outfit values (required range 0.7–1.3). Categories A, E and F all had infit and outfit values below the required range, with category B having an outfit value below 0.7. The overall SIGAM item point biserial of 0.86 was above the lower acceptable limit of 0.2. There was no evidence of local dependency between the SIGAM item and any RMI items.

A factor analysis of all responses revealed the first/main factor accounted for 37.3% of variance with the next/second factor accounting for only 7.33% of variance in the data.

T-tests of the residuals suggested some degree of differential item functioning (DIF) for level of amputation on the left ($p = 0.49$), when considering comparison of the two groups ‘TT and below’ versus ‘through knee and above’.

Person separation was 2.6, greater than the required 2.0. The reliability with which the test separated people was greater than 0.8 (0.87). Item separation was 7.99. Item reliability (0.98) was greater than 0.9.

STUDY 2

Thirty-three patients were recruited, 20 of whom had two assessments and 13 of whom had three assessments, giving 46 patient-episodes for which any change in mobility could be calculated. There were 22 males and 11 females aged 21–85 (mean ± SD: 60.7 ± 14.5) years. Underlying diagnoses included DM ($n = 12$), peripheral vascular disease ($n = 9$), infection ($n = 5$), trauma.

![Figure 4](image_url)  
Age ranges, part B.

![Figure 5](image_url)  
RMI and SIGAM mobility grades item threshold imprint.
(n = 4), and cancer (n = 3). All patients had unilateral amputations (16 TT, 1 knee disarticulation and 16 TF). Fourteen patients had their first assessment within 3 weeks of delivery of prosthesis, six within 6 weeks, three within 3 months, and nine within 6 months.

Kappa values between physician and patient, physician and SIGAM scale, and patient and SIGAM scale were 0.87, 0.42, and 0.53 respectively. However, the data included 12 episodes where discrepancies occurred; in nine cases both physicians and patients were marking improvement/deterioration in mobility where the SIGAM scale could not, such as ability to climb stairs or gait pattern changing. Therefore, if these episodes are excluded the kappa values of agreement changed to 0.93, 0.74 and 0.81.

It was possible to estimate effect size in 38 patient-episodes (25 patients). Calculated effect size for the TWT was 8.56 while that for the SIGAM mobility scale was 10.66.

Discussion

SIGAM QUESTIONNAIRE

In developing any measurement tool, it is important to reduce the risk of error in each response: the person may misinterpret the item, respond in a biased manner, or make a mistake in transcribing his/her reply. Ways this can be achieved include: making each question concise; avoiding unnecessary length to the overall questionnaire to reduce patient fatigue and hence increase compliance of completing the questionnaire; minimizing ambiguity by making the items readable and understandable; making items relevant to the target population; and giving clear instructions on how to answer the questions correctly.12

Both questions 1 and 2 are relevant to the small population of amputees who do wear non-functioning prostheses. Therefore, despite difficulties with patient acceptability it was felt necessary to keep them in the overall questionnaire. Furthermore, question 2 is highly relevant to new amputees.

SIGAM ALGORITHM

Anything less than 100% total agreement in the algorithm would not be acceptable as this would be another source of error in the SIGAM grades. Complete agreement highlights the importance of achieving readable, understandable instructions and framework, which is also logical with clearly defined end-points.

STUDY 1

Part A

For discussion on patient demographics please refer to reference 1. High levels of agreement were found for all 21 questions (kappa coefficient’s >0.7) except for question 2 as discussed above. In this instance, three patients answered ‘yes’ as time 1 and ‘no’ at time 2. These patients answered incorrectly, subsequently achieving grades B, C and E respectively. This highlights the problems some patients had in relation to understanding this question and its relevancy to them. However, it was felt necessary to keep this question in the questionnaire in order to capture the small number of patients who do wear non-functioning prostheses. The ICC shows that 79% of the variance in the questionnaire is due to true variance among patients. Reproducibility of the assigned grades was high with a kappa of 0.86. The variability within this is accounted for by the variability within the patients’ answers as reliability of assigning grades was 100%.

Validation of the SIGAM grades by comparison with another valid mobility measure is limited by using the TWT only (walkers only). Other limitations of using the TWT has been previously discussed.1 Unfortunately, there is no means of concurrently validating the first two SIGAM questions other than by clinical observation and this was not possible in all circumstances. Nevertheless, despite the limitations, the TWT is useful. Patients found it simple, quick and easy to understand. As the TWT is a continuous variable it was not unexpected that there was overlap between the TWT times and the SIGAM grades. The general trend was for TWT times to get faster as the SIGAM grades improved. Non-parametric analysis showed the TWT times are not significantly different between each corresponding grade C to D, D to E and E to F, but were significantly different between grades not adjacent to each other, e.g. C to E, C to F, D to F.

Part B

For discussion on patient demographics please refer to reference 1. The numbers of patients assigned to each category reflects the wider population of amputees’ levels of mobility: the majority of patients are able to walk restricted distances or need walking aids, a smaller number have normal mobility or only occasionally require walking aids and very small numbers abandon limb-wearing or wear non-functioning prostheses.
Since single-item scales cannot be analysed using Rasch analysis the SIGAM could not be analysed on its own. There are two possible approaches to overcoming this difficulty. Firstly, to collect data on the SIGAM over two time points, using the same patients. However, it was felt a representative sample of enough patients spanning all mobility levels would not have been recruited. The second approach is to use another matrix of mobility, such as the RMI, into which the SIGAM item is inserted.

Such co-calibration allows us to ascertain whether the SIGAM and RMI scales are measuring the same construct. This is possible as the same patients are being examined at the same time. The new ‘16-item scale’ then undergoes Rasch analysis. Any changes in the results would therefore be due to the influence of the SIGAM scale, as both were performed on the same population of patients at the same time. This procedure was used here as it has been accepted as the best approach for examination of the underlying psychometric properties of single-item scales at a European meeting of Rasch analysis experts in Göteborg, May 2000.13

The SIGAM ‘item’ fitted within the RMI hierarchy; otherwise the mobility hierarchy is essentially the same as the RMI alone in amputees.1 Examination of the six categories, A–F, within the SIGAM item, showed the logit measures were in the correct order but were out of order for the step calibrations between categories B and C. These step calibrations are the thresholds, measured on the logit scale, at which a patient is more likely to be assigned to a higher grade than a lower one, e.g. F rather than E. Therefore, there is no step calibration for category A. For the B–C threshold, the order suggests patients are more likely to be graded C rather than B. However, as there were only seven patients in category B compared with 68 in category C this result is not reliable.

The overall SIGAM item fits within the RMI model. Categories A, B, E and F showed evidence of overfitting, however in the case of categories A and B the numbers of patients involved (seven in each) are too small to give meaningful results. Unfortunately, for statistical purposes, the nature of amputee rehabilitation makes it difficult to recruit adequate numbers of these patients.

The only subgroup for which the SIGAM item showed DIF was for level of amputation on the left. However, as similar numbers of patients were in both groups and there is no clinical reason why the left side only should be affected it is not considered to be of significance.

With the added SIGAM item the model was able to reliably differentiate people into at least two groups. Item separation was similar to the RMI analysis alone.1

STUDY 2

Any mobility measure for amputees has to be able to respond to clinically important changes in mobility in order to be useful. The inability of the SIGAM grades to detect changes in ability to climb stairs, get onto buses or go shopping (all stated as improvements in gait by patient and physician), for instance, highlight problems in making sure such a measure is useful enough for clinical use while not being burdened down with too much detail as to make it too long or impracticable. Similarly, the scale should not be tested against that which it cannot measure and hence the amended kappa values show more realistically the levels of agreement found between patient/physician and SIGAM scale.

The effect size demonstrates change over time in a particular measurement. Because the TWT could not be measured in those who could not walk then it was not possible to calculate the effect size in those patients who change from being unable to walk to achieving mobility. Therefore, the true effect size of the SIGAM mobility grades is underestimated. Nevertheless, a value of 10.66 demonstrates the great ability of the SIGAM grades to pick up meaningful changes in mobility.

Conclusion

A well-defined, structured and clinically useful measure of mobility in lower limb deficiency is required. The SIGAM scale offers the clinical a simple, valid and reliable means of measuring mobility in lower limb amputees, while also being sensitive to change in mobility, making it useful to monitor mobility in both new and established amputees. However, the six grades are limited to defining mobility in terms of help required to mobilise, distance, use of aids and ability to negotiate difficult terrain and weather conditions. It must be emphasized that the SIGAM mobility grades should not be compared to more detailed assessments of mobility. Instead they were designed to describe simple clinically meaningful functional levels of mobility and this is their primary purpose.
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References


Appendix

Figure 1 SIGMA mobility grades

A Limb wearing abandoned or use of cosmetic limb only.
B Therapeutic wearer wears prosthesis only for transfers, to assist nursing, walking with the physical aid of another or during therapy.
C Walks on level ground only, ≤ 50 metres, with or without use of walking aids: a= frame, b=crutches/sticks, c= 1 crutch/stick, d= no stick.
D Walks outdoors on level ground only and in good weather, more than 50 metres, with or without use of walking aids: a= frame, b=crutches/sticks, c= 1 crutch/stick.
E Walks more than 50 metres. Independent of walking aids except occasionally for confidence to or improve confidence in adverse terrain or weather.
F Normal or near normal gait.

Figure 2 SIGMA algorithm

Guidelines for use of SIGMA algorithm

1. Start at the top of page at question 1. The number beside each box corresponds to the same numbered question.
2. Depending on the answer ‘Yes’ or ‘No’ follow the arrows to assign one of Grade A – E.
3. Once you reach [Grade ...], then that is the grade to be assigned. You do not need to proceed, except for Grades C & D to assign a sub-grade.
4. Sub-grades (a)–(d) apply depending on what walking aid is used to assist walking. If a patient ticks ‘Yes’ to more than one aid then he/she is graded based upon that which provides most support: frame > 2 crutches/sticks > 1 crutch/stick > none.
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SIGAM Algorithm

1. Wear a false leg?  
   - No → Grade A
   - Yes

2. Cosmetic appearances only?  
   - Yes → All remaining answers ‘No’ → Grade A
   - No → Any remaining answers ‘Yes’

3. Short distances?  
4. Nursing care?  
5. In therapy?  
   - If any ‘Yes’ → Grade B
   - If Q.6 and Q.14 are ‘No’
     - If Q.6 is ‘No’ and Q.14 is ‘Yes’
     - If Q.6 is ‘Yes’

6. Walk indoors?  
   - No → Grade B
   - If Q.14 is ‘No’
   - If Q.14 is ‘Yes’

7. Help from another person indoors?  
   - Yes → Grade B Regardless of subsequent answers
   - No

13. Walk > 50 metres?  
   - No → Grade C
   - Yes

14. Walk outdoors?  
   - No → Grade C
   - Yes

15. Level ground only?  
   - Yes → Grade D
   - No

20. Occasional aid only?  
   - Yes → Grade E
   - No

21. Walk anywhere, any weather?  
   - Yes → Grade F
   - No → Grade D

8. Frame?  
   - a

9. 2 crutches?  
   - b

10. 2 sticks?  
   - b

11. 1 crutch/stick?  
   - c

12. any aid? – ‘No’  
   - d

Now assign a sub-grade

16. Frame?  
   - a

17. 2 crutches?  
   - b

18. 2 sticks?  
   - b

19. 1 crutch/stick?  
   - c
Figure 3  SIGMA mobility grades questionnaire.

This questionnaire asks you about how you usually get around, using any walking aid if needed.

Please tick  \(\sqrt{\text{YES}}\) or \(\text{NO}\) after each question, as is most true for you.

1. Do you wear a false leg(s)?

2. Do you wear your false leg(s) for cosmetic appearances only? i.e. you do not walk on it / them.

3. Do you wear your false leg(s) to help you move very short distances? (e.g. move from bed to chair or chair to toilet)

4a. Are you receiving any nursing care at present?

\[\text{If ‘YES’ please read on if ‘NO’ skip to question 5a.}\]

4b. Do you wear your false leg(s) to help you with any nursing care you may be receiving?

5a. Are you receiving any physiotherapy or occupational therapy at present?

\[\text{If ‘YES’ please read on if ‘NO’ skip to question 6.}\]

5b. Do you wear your false leg(s) to help you with any therapy you may be receiving?

6. Do you usually walk indoors at all, wearing your false leg(s)?

7. Do you usually need the physical help of another person to help you walk indoors, if you wear your false leg(s)?

8. Indoors, wearing your false leg(s), do you usually need the help of a walking frame to walk?

9. Indoors, wearing your false leg(s), do you usually need the help of 2 crutches to walk?

10. Indoors, wearing your false leg(s), do you usually need the help of 2 sticks to walk?

11. Indoors, wearing your false leg(s), do you usually need the help of 1 crutch or 1 stick to help you walk?

12. Indoors, do you usually use any walking aid at all?

Please turn to the next page
13. Do you usually manage to walk more than 50 metres (55 yards) at a time?  

14. Do you usually walk outdoors at all, wearing your false leg(s)?  

15. Do you usually walk on level ground only?  

16. Outdoors, do you usually need the help of a frame to walk?  

17. Outdoors, do you usually need the help of 2 crutches to walk?  

18. Outdoors, do you usually need the help of 2 sticks to walk?  

19. Outdoors, do you usually need the help of 1 crutch or 1 stick to walk?  

20. Outdoors, do you just occasionally use a walking aid, such to increase your confidence in adverse weather conditions or on uneven ground?  

21. Outdoors, wearing your false leg(s), do you walk anywhere, in any weather conditions, without using any walking aid at all?  

The End. Thank you very much for your help.