

# Challenging comparison of stroke scales

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Stroke scales can be classified as clinicometric scales and functional impairment, handicap scales. All studies describing stroke scales were reviewed by internet searching engines with the final search performed on January 1, 2013. The following string of keywords was entered into search engines; stroke, scale, score and disability. Despite advantages of modified National Institute of Health Stroke Scale and Scandinavian stroke scale comparing to the NIHSS, including their simplification and less inter-rater variability; most of the stroke neurologists around the world continue using the NIHSS. The modified Rankin scale (mRS) and Barthel index (BI) are widely used functional impairment and disability scales. Distinction between grades of mRS is poorly defined. The Asian stroke disability scale is a simplified functional impairment, handicap scale which is as valid as mRS and BI. At the present time, the NIHSS, mRS and BI are routine stroke scales because physicians have used to work with these scales for more than two decades, although it could not be an acceptable reason. On the other side, results of previous stroke trials, which are the basis of stroke management guidelines are driven using these scales.

**Key words:** Disability, scale, score, stroke

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## INTRODUCTION

A reproducible and valid method for quantification of the neurological deficit that occurs after stroke is essential for monitoring patients; many stroke scales have been proposed for this purpose.<sup>[1]</sup> Stroke scales represent a useful tool for estimating the severity of stroke at onset and for assessing prognostic information in hospital. In general, a stroke scale consists of several variables for observing the signs and symptoms and each variable is categorized for scoring.<sup>[1]</sup> In developing an ideal stroke scale, issues of simplicity, reliability, validity and popularity of use must be pursued, especially if a scale is to be used by a broad array of practitioners.<sup>[2]</sup> Reliability of a stroke scales could be improved with a personal and videotape training.<sup>[3]</sup> Simplicity and time taking is important in any outcome measure, especially for use in stroke patients with cognitive problems and feelings of tiredness.<sup>[4]</sup> Stroke scales can be classified as parametric or clinicometric scales on the basis of physical deficit and functional impairment, handicap scales.<sup>[1,5]</sup> Evaluating the impact of new treatments requires the use of reliable and valid outcome measures.<sup>[6]</sup> Development of stroke outcome classification systems is necessary because neurological deficits often lead to permanent impairments, disabilities and compromised quality-of-life.<sup>[7]</sup>

## METHODS

A retrospective review was performed about stroke scales. Medline, Ovid, PubMed, Google, Proquest, Scopus, Cochrane Library, Elsevier, Thompson, ISI, Index Medicus, Index Copernicus and Science Direct was used as search engines. The following string of keywords was selected (stroke) and (scale) and (score) and (disability) and (grade) with the final search performed on January, 1, 2013. At the other side, library archives of Mashhad University of Medical Sciences were searched for this purpose in paper journals published between 1970 and 2013.

### Comparison of clinicometric stroke scales

The National Institute of Health Stroke Scale (NIHSS) is the most frequently used stroke deficit scale in routine clinical practice and clinical trials.<sup>[8]</sup> In spite of its great success, there are problems with the NIHSS. It contains items with poor reliability and has been criticized for its redundancy and complexity.<sup>[9,10]</sup> The NIHSS overall reliability is clear, however assessments have consistently shown specific items that yield low inter-rater reliability.<sup>[10,11]</sup> These items with poorer NIHSS reliability included facial palsy, ataxia, dysarthria and level of consciousness.<sup>[12]</sup> Among over 15,000 individuals who have taken online NIHSS certification, the NIHSS items with poorer inter-rater reliability included facial palsy ( $k = 0.25$ ), ataxia ( $k = 0.15$ ), level of consciousness

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( $k = 0.43$ ), dysarthria ( $k = 0.46$ ) and gaze ( $k = 0.44$ ).<sup>[13]</sup> These NIHSS items with poor inter-rater reliability have also been identified in Spanish, Italian and Chinese versions of NIHSS.<sup>[14-16]</sup> These elements may contribute to difficulties in practitioner communication, incorrect hospital care patterns that are based on the NIHSS; e.g., decisions to give thrombolytics, variable trial enrollments and even possible difficulties with assessing patient outcome in clinical trials.<sup>[13]</sup> Given the unreliability of some of the NIHSS items, patients may score high on the NIHSS when they actually have mild strokes but questionable other findings. Alternatively, patients may score as mild even if they have more severe deficits, because unreliability may result in certain items being unscored.<sup>[13,17]</sup> Patient with severe stroke may not be able to receive NIHSS scores for ataxia or dysarthria because their arousal state may preclude testing these items. Because these items are not scored abnormal unless patients produce testable behaviors, these patients may be too sick to score on these items.<sup>[13,18]</sup> Though the patients may clinically improve, their NIHSS scores may artificially worsen since now items such as ataxia and dysarthria can receive the scores that were previously unscored.<sup>[13,19]</sup> Since these items have been removed from the modified NIHSS, this difficulty can be avoided or at least lessened. The NIHSS was modified, which maintains similar internal structure.<sup>[11,13,18]</sup> Level of consciousness was redundant and dropped from the new scale. Ataxia showed poor reliability, so it was excluded. Facial palsy and dysarthria showed poor reliability and were redundant, so they were eliminated.<sup>[11,13,18]</sup> The sensory item was simplified due to poor reliability.<sup>[11]</sup> With fewer items and simpler grading, the modified NIHSS was intended to be simpler and easier to administer.<sup>[11-13]</sup> The resulting modified NIHSS has shown significantly higher reliability and validity than NIHSS.<sup>[13,18]</sup> In the NIHSS, 7 of 42 points are related to language function, while only 2 of 42 points are attributed to neglect functions.<sup>[20,21]</sup> Redundant items are noted in the NIHSS have been deleted from the modified NIHSS, resulting in a more balanced clinical scale. Therefore, lateralization bias may be minimized.<sup>[13,20,21]</sup> The author suggests scoring 0-3 to language function and including mute or global aphasia in score 3 as severe aphasia. This scoring strategy improves hemisphere balance between language and neglect items in modified NIHSS. Both NIHSS and modified NIHSS failed to accurately or reliably detect stroke severity in patients with posterior circulation findings.<sup>[13,22]</sup> With the removal of the ataxia item, there may be a concern that the modified NIHSS would be even less able to assess brainstem strokes. However, since ataxia is a poorly reliable NIHSS item, the benefit of using a scale that inconsistently assesses the posterior circulation, may not outweigh the consistency of modified NIHSS.<sup>[12,13]</sup> Many clinical trials routinely include only anterior circulation strokes, so that there is less need to measure posterior circulation deficit

for this purpose. However, stroke severity scale specialized for posterior circulation strokes has been developed and validated in Israel.<sup>[22]</sup> The Scandinavian stroke scale (SSS) is easier than NIHSS for clinical practice in acute stroke patients and has been used in many clinical trials. The NIHSS,<sup>[9-21]</sup> Canadian neurological scale,<sup>[23,24]</sup> European stroke scale (designed for patients with middle cerebral artery stroke),<sup>[25]</sup> SSS,<sup>[26]</sup> Japan stroke scale,<sup>[1]</sup> Orpington prognostic scale,<sup>[27]</sup> Orgogozo scale<sup>[28]</sup> and numerous other scales developed for clinicometric assessment of acute stroke patients.<sup>[13]</sup> The Orpington prognostic scale is easier than NIHSS in clinical practice and additionally evaluates the cognitive function.<sup>[27]</sup> Despite advantages of modified NIHSS and SSS comparing to the NIHSS (including their simplification and less inter-rater variability), most of the stroke Neurologists around the world continue using the NIHSS because they have used to work with it for more than two decades, although it could not be an acceptable reason. At the other side, results of previous stroke trials, which are the basis of stroke management guidelines are driven using the initial NIHSS. The stroke outcome classification of the American Heart Association is too comprehensive and time consuming to be used in the routine clinical practice and did not enjoy the widespread acceptance around the world.<sup>[7]</sup>

### Comparison of functional impairment and handicap stroke scales

For quality-of-life and outcome measures after stroke, Duncan *et al.* in the US found that eight key areas (strength, hand function, activities of daily living, mobility, communication, memory, emotion and social participation) emerged as key areas from the patients perspective.<sup>[29]</sup> Similarly, Williams *et al.* reported that patients identified 12 key domains (mobility, energy, upper extremity function, work/productivity, mood, self-care, social roles, family roles, vision, language, thinking and personality).<sup>[30]</sup> The basic self-care tasks are feeding, grooming, dressing, bathing, toileting, including sphincter control and mobility, including transferring from place to place.<sup>[7]</sup> These are called basic activities of daily living. Independence in these activities could enable the stroke patient to live at home with the help from family or community providers for meals and other household tasks as needed.<sup>[7,29,30]</sup> More complex activities of daily living are called instrumental activities of daily living. These tasks are performed to maintain independence in the home and community and include shopping, using transportation, telephoning, preparing meals, handling finances and maintaining a household.<sup>[7,29,30]</sup> Other instrumental activities of daily living that affect quality-of-life are work skills, religious activities and leisure time and recreational activities.<sup>[7,29,30]</sup> Leisure activities are demonstrated as the strongest association to subject well-being.<sup>[31]</sup> The modified Rankin scale (mRS) and Barthel index (BI) are widely used functional impairment, disability

scales, which have been proven to be a valid and reliable for defining outcome in stroke patients.<sup>[32]</sup> Despite BI, distinction between grades of mRS are poorly defined.<sup>[33]</sup> Inter-rater variability introduces noise into trial outcome assessments and reduces the power of clinical trials to detect treatment outcome.<sup>[34]</sup> A variety of approaches to minimize inter-rater variation of mRS have been described or proposed, including: (1) Use of a formal structured interview, (2) training and certification programs using written and video case vignettes and (3) central panel adjudication of local site-recorded video assessments.<sup>[34]</sup> However, the instruments and approaches developed to date have not consistently been shown to reduce inter-rater variability for mRS.<sup>[33,34]</sup> However, there is little consensus on the optimal implementation of the BI and mRS as an outcome measure in acute stroke trials<sup>[32]</sup> and it is unclear which outcome scale is preferable.<sup>[32]</sup> The Japan stroke scale<sup>[1]</sup> and Kurashiki pre-hospital stroke scale are clinimetric stroke scales which are designed in Asia.<sup>[1,35]</sup> Chinese stroke scale is a comprehensive functional impairment scale designed in Asian continent.<sup>[36]</sup> The Asian stroke disability scale (ASDS) was provided as a simplified functional impairment, handicap scale and inter-rater reliability of ASDS compared with mRS and BI.<sup>[37,38]</sup> Development procedure for the ASDS is similar to method of making Japan stroke scale.<sup>[1,37]</sup> The procedure is summarized as following steps: (1) Select the variables, (2) categorize the variables, (3) evaluate the categorization for their distribution and sensitivity, (4) modify and re-evaluate the categorization, (5) repeat procedures 1 through 4 until the appropriate categorizations are obtained.<sup>[1,37]</sup> Three items including; self-care, mobility and daily activities were selected as variables for development of the ASDS based on the contribution of each item to the prognosis and a review of currently available stroke scales.<sup>[1,37]</sup> The variables were provisionally graded on a 2- to 4-point scale based on the importance of each item. Each of the variables was categorized into three categories.<sup>[37]</sup> The total score for a patient could be calculated from the sum of the scores for each of the variables ranging from 0 to 8.<sup>[37]</sup> Table 1 shows details of the ASDS. The ASDS is simple, requires less than 1 min to perform the test and is as valid as mRS and BI in assessment of functional impairment of stroke patients.<sup>[37,38]</sup> The quantitative and qualitative inter-rater variability of ASDS is similar to the mRS and BI.<sup>[36,37]</sup> The paired inter-rater variability of mRS, BI and ASDS scores based on qualitative categorization was not significant for the three methods,  $P > 0.05$ .<sup>[37,38]</sup> Inter-rater reliability of mRS was poor ( $k = 0.16$ ) in the study conducted by Quinn *et al.*<sup>[39]</sup> Comparing estimated scores between the paired assessors, there was again poor agreement in 30% and significant variability ( $k = 0.38$ ) of mRS score.<sup>[39]</sup> In the evaluation of Rankin focused assessment tool, rater's scores concurred fully in 47 of 50 patients and in the remaining three patients, scores differed by one level.<sup>[34]</sup> A review

of literature about inter-rater reliability of mRS revealed moderate inter-rater reliability, which improved with structured interviews.<sup>[40]</sup> The difference of disability scores based on the mRS, BI and SSS are small and these scores have excellent agreement with each other, whereas modified NIHSS has substantial agreement with mRS and BI in a UK study.<sup>[26]</sup> Another comparison study in UK was performed on 1400 patients.<sup>[19]</sup> When the mRS and BI scores were dichotomized at 95 and 1 respectively, the NIHSS appeared more sensitive than the BI or mRS.<sup>[41]</sup> Diagnostic accuracy of BI in serial assessments of ischemic stroke patients was performed in the Netherland.<sup>[42]</sup> Assessment of the BI in acute stroke showed good discriminative properties for the final outcome of BI at 6 months.<sup>[42]</sup> Another study in the Netherland compared with five stroke scales; the Orgogozo scale, the NIHSS, the Canadian neurological scale and the SSS with measures of disability and handicap and quality-of-life according to the mRS and BI.<sup>[28]</sup> The five stroke scales were highly related to one another but the correlation between stroke scales and functional scales was less than 0.70 and decreased from BI (47.5%) to mRS (36.5%).<sup>[28]</sup> Therefore, clinimetric stroke scales only partly explain functional health and impact of impairments on functional outcomes seems to be under estimated by the stroke scale weights.<sup>[28]</sup> The Frenchay stroke scale,<sup>[43,44]</sup> Canadian occupational performance measure,<sup>[45]</sup> stroke impact scale<sup>[46]</sup> and numerous other functional impairment scale have been developed for use in stroke patients by stroke specialists and occupational therapists.<sup>[1,5,6,47-49]</sup> Despite the development of better functional impairment scales, stroke neurologists around the world continue using the mRS and BI,<sup>[50]</sup> because they have used to work with these scales for decades, although it could not be an acceptable reason. At the other side, results of the previous stroke trials, which are the basis of stroke management guidelines are driven using the initial mRS and BI.

**Table 1: The Asian stroke disability scale\***

Mobility (chair to bed, walking, stairs)
0 – No problems, independent on all items
1 – Some problems, needs walker or help of another person
2 – Sever problems, wheelchair, immobile, bedridden
Self-care (feeding, toileting, dressing, bathing, grooming)
0 – No problems with self-care, independent on all items
1 – Some problems, needs help
2 – Unable or totally dependent
Daily activities (work, social, transport, family, leisure, sex, recreational activities)
0 – No problem with daily activities due to stroke
2 – Some problems
4 – Unable

Note: Scores are calculated based on difference between pre- and post-stroke

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## CONCLUSION

Despite advantages of modified NIHSS and SSS comparing to the NIHSS, most of the stroke neurologists around the world continue using the NIHSS. The mRS and BI are widely used functional impairment, disability scales and it is unclear, which outcome scale is preferable. The ASDS is a simplified functional impairment and disability scale, which is as valid as mRS and BI.

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