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VALIDITY AND RESPONSIVENESS OF THE RIVERMEAD MOBILITY INDEX IN STROKE PATIENTS

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The Rivermead Mobility Index is used to measure mobility in patients with head injury or stroke. The purpose of the study was to examine construct validity, predictive validity, and the responsiveness of the Rivermead Mobility Index in stroke patients. Thirty-eight stroke inpatients participated in the study. The Rivermead Mobility Index, the Barthel Index, and the Berg Balance Scale were administered at admission to the rehabilitation ward and at discharge. The results showed that the Rivermead Mobility Index fulfilled the Guttman scaling criteria (coefficients of reproducibility > 0.9, coefficients of scalability > 0.7). The Rivermead Mobility Index scores were highly correlated with the Barthel Index scores (Spearman *rs* > 0.6) and the Berg Balance Scale scores (Spearman *rs* > = 0.8, all *ps* < 0.001). The Rivermead Mobility Index score at admission was closely correlated with the Barthel Index score at discharge (Spearman $r = 0.77$, $p < 0.001$). About 76% (29) of the subjects improved by more than 3 Rivermead Mobility Index points (median = 5) during their stay. The relationship between the change in score of the Rivermead Mobility Index and the Barthel Index was fair (Spearman $r = 0.6$, $p < 0.001$). These results indicate that the Rivermead Mobility Index is valid and sensitive to change over time. It is therefore a useful scale for the assessment of mobility in stroke patients.

Key words: cerebrovascular disorders, disability evaluation, inpatients.

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INTRODUCTION

Although improving mobility is one of the major goals of stroke rehabilitation, few simple outcome measures concentrate on mobility disability (1). The Rivermead Mobility Index (RMI) was developed to measure mobility in patients with head injury or stroke. The RMI is a Guttman scale comprising 14 questions and one direct observation, and covers a range of hierarchical activities, from turning over in bed to running.

The psychometric characteristics of the RMI have rarely been explored. Collen et al. (1) found that its inter-observer agreement is reliable to a limit of 2 points (out of 15) in patients with neurological deficits (head injury and stroke). They also tested its validity as a measure of mobility using concurrent measurements of gait speed and endurance, and standing balance and found the RMI to be valid (1).

However, generalization of the results requires caution. The subjects of Collen et al.'s study (1) were mainly patients with head injury and stroke. The broad scope of the subject's condition may obscure some specific characteristics of a particular disease. According to Collen et al. (1), further psychometric characteristics testing of the RMI is needed. The purpose of the study was to further examine the construct validity, predictive validity, and responsiveness of the RMI in stroke inpatients.

PATIENTS AND METHODS

Subjects were selected from consecutive stroke patients admitted to the Physical Medicine and Rehabilitation Department of National Taiwan University Hospital in Taipei, from February 1, 1998 to January 31, 1999. Patients were included in the study if they met the following criteria: (i) diagnosis (International Classification of Diseases, Ninth Revision Clinical Modification [ICD-9-CM] codes) of cerebral hemorrhage (431), cerebral infarction (434), or other diagnosis (430, 432, 433, 436, 437); (ii) first onset; (iii) stroke onset within 2 months prior to admission; (iv) ability to follow commands; (v) living in Taipei; and (vi) informed consent for participation obtained from the patient or a family member responsible for the patient's care. The clinical diagnosis of stroke was confirmed by neuroimaging examination (computed tomography or magnetic resonance imaging). Patients who had a diagnosis of non-vascular accident-related subarachnoid hemorrhage, transient ischemic attack (ICD-9-CM code 435) or late effects of cerebrovascular disease (ICD-9-CM code 438) were excluded.

Procedure

Assessment of validity requires standard measures that are used for comparison (2). The Berg Balance Scale (BBS) (3) and Barthel activities of daily living (ADL) index (BI) (4) were used as criteria of validity and were administered by an occupational therapist. The RMI was administered by another occupational therapist. All measures were administered within 48 hours after the patients' admission and before their hospital discharge. Both therapists were blind to the results of each other's assessments during the study period.

The BI is a measure of the severity of disability and is the most frequently used stroke outcome measure (5). The BI evaluates 10 basic ADL, and scores range from 0 to 100. It has been shown to be a reliable and valid measure of ADL (4, 6, 7). A recent study shows that the BI and the Functional Independence Measure (8) have a similar ability to detect change in disability in stroke patients (9).

The BBS (3) was selected to measure balance. The BBS consists of 14 items measuring daily movements. Each item is graded from 0 to 4. The maximum possible score on the BBS is 56 points. This instrument has a

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Table I. *Clinical and demographic characteristics of the study patients* (n = *38*)

Gender (Male/Female) (*n*)	22/16
Age (years, mean ± SD)	62.1 ± 9.8
Diagnosis (*n*)	
Cerebral hemorrhage	14
Cerebral infarction	19
Other	5
Side of hemiplegia (*n*)	
Left	26
Right	12
Days after onset at admission (median (range))	24 (7–53)
Days of rehabilitation stay (median (range))	38 (15–73)
Admission RMI score (median (mean ± SD))	3 (4 ± 3.6)
Admission BI scores (mean ± SD)	50.7 ± 17.6
Admission BBS (mean ± SD)	16.1 ± 15.1
Discharge RMI score (median (mean ± SD))	9 (8.6 ± 4.4)
Discharge BI scores (mean ± SD)	78.5 ± 17
Discharge BBS (mean ± SD)	31.2 ± 15.9

RMI = Rivermead Mobility Index; BI = Barthel Index; BBS = Berg Balance Scale.

high inter- and intra-rater reliability (3, 10), and good validity in stroke patients (3, 11).

Data analysis

The construct validity of the RMI was examined to determine whether the RMI would fit the Guttman scale model. The coefficient of reproducibility is a measure of how well the observed responses correspond to the responses that would have been predicted if the items were perfectly ordered (12). Conventionally, a coefficient of reproducibility of 0.9 confirms the existence of a valid cumulative and unidimensional Guttman scale (12). The coefficient of scalability indicates the proportion of responses that can be correctly predicted from the total score, allowing for the relative frequency that different items are passed. For a valid Guttman scale to be considered acceptable, the coefficient of scalability is generally expected to be >0.6 (13).

The convergent construct validity of the RMI was assessed by comparing the results of the RMI with those of the BBS and BI using the Spearman correlation coefficient.

The predictive validity of the RMI was assessed by comparing the results of the RMI at admission with those of the BI at discharge using the Spearman correlation coefficient.

Responsiveness can be defined as the ability to detect minimal clinically important differences (14, 15). In this study, we defined clinically significant improvement as an improvement of 3 or more points on the RMI (16). The patient's functional recovery during the same period was chosen as an external criterion. The relationship between the change in score of the RMI and BI score was examined using the Spearman correlation coefficient.

RESULTS

A total of 38 patients met the selection criteria and were invited to participate in the study. Most of the patients excluded were those who suffered recurrent stroke or could not follow commands (e.g. patients with global aphasia). Further information about the study sample is presented in Table I. The time needed to administer the RMI ranged from about 3 to 5 minutes.

The results show that the RMI fulfilled the Guttman scaling criteria (coefficient of reproducibility = 0.95 at admission and discharge, coefficient of scalability = 0.74 at admission and 0.79 at discharge). The RMI score was highly correlated with that of the BI, (Spearman $r = 0.67$ at admission and 0.73 at discharge, $p < 0.001$) and that of the BBS, (Spearman $r = 0.81$ at admission and 0.89 at discharge, $p < 0.001$). The RMI scores at admission were closely correlated with the BI scores at discharge (Spearman $r = 0.77$, $p < 0.001$). About 76% (29) of 38 subjects improved by more than 3 RMI points (median = 5) during this period. Figure 1 shows a fair correlation between the change in score of the RMI and BI (Spearman $r = 0.6$, $p < 0.001$).

DISCUSSION

Although loss of mobility is of crucial importance in daily activities, few measures concentrate on mobility disability. The psychometric characteristics of the RMI, which was developed to measure mobility, have not been thoroughly investigated. The present study examined the validity and responsiveness of the RMI in stroke patients. The results indicate that the RMI is a valid measure and is sensitive to change over time.

Our results show that the RMI fulfilled the Guttman scaling criteria (coefficient of reproducibility >0.9, coefficient of scalability >0.6) in stroke patients. This indicates that the RMI forms a unidimensional scale and supports the construct validity of the RMI. The Guttman scale has many advantages over summated indices, since the score provided by a summated index does not necessarily indicate the level of performance reached (17). Hierarchically ranked scales have the advantage that patients with the same scores accomplish the same items. The total score therefore has a clear meaning and changes in score represent comparable changes in ability. With a summated index, the same total score can be obtained from different combinations of items and this gives little idea of the patient's general pattern or degree of disability (18).

Our results also show that the RMI score was highly associated with the BI and the BBS scores. These results are similar to those of Collen et al.'s study (1) in patients with head injuries or stroke, and show that mobility is related to balance

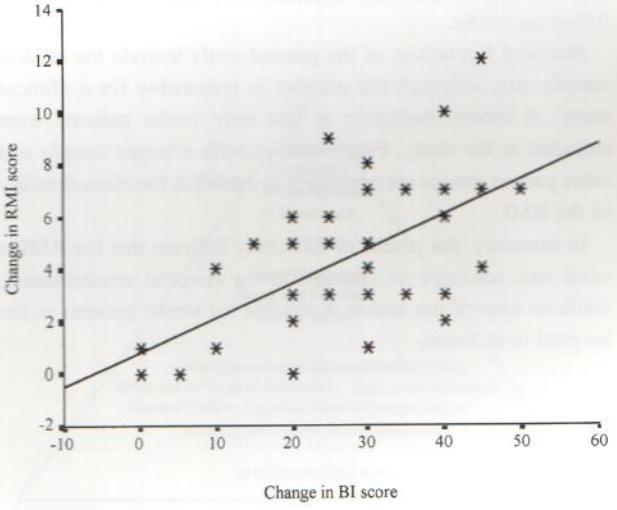

Fig. 1. The relationship between the change in score of the Rivermead Mobility Index (RMI) and the Barthel Index (BI).

and basic ADL performance. The findings of this study further confirm the convergent construct validity of the RMI.

Early prediction of the patient's functional status on discharge from rehabilitation is important, in order to allow selection of an appropriate rehabilitation strategy. In this study, the RMI scores at admission were highly correlated with the BI scores at discharge, indicating that mobility at rehabilitation admission is a potential predictor of functional status at discharge. The result supports the predictive validity of the RMI. Future research to investigate whether the RMI is a better predictor of functional status at rehabilitation compared with other measures is needed.

Responsiveness is one of the necessary requirements for instruments designed primarily to measure change over time, if they are to be useful in both clinical and research settings (15). Kolobe et al. (19) proposed that two aspects of responsiveness should be addressed. The first is to determine whether there is improvement over time and the magnitude of the change in scores. The second aspect of responsiveness concerns the meaningfulness of the changes. Our results show that the median change in score was 5 points during subacute hospital rehabilitation and that most (76%) of the subjects improved by more than 3 RMI points (the criterion of clinically significant improvement set by a previous study (16)). Furthermore, the relationship between the change in score of the RMI and BI was fair which suggests that an improvement of the RMI score may reflect an improvement in functional status. These results support the responsiveness of the RMI.

Gait speed, usually timed over a 10-m walk, is one of the commonly used instruments for assessing mobility in stroke patients. The 10-m timed walk is simple, reliable, valid, and sensitive (5). However, the gait-speed test does not cover as wide a range of disability as the RMI. The other commonly used mobility instruments are the mobility sections within the basic ADL, the instrumental ADL, and the disability scale (5). However, these instruments do not specify how activities are carried out and thus they do not measure mobility directly (5). Thus, the RMI may be the most suitable test to measure mobility following stroke.

Potential limitations of the present study include the modest sample size, although the number is reasonable for a clinical study. A second limitation is that only stroke patients were included in the study. Future studies with a larger sample and other patient groups are necessary to establish the clinical utility of the RMI.

In summary, the results of this study indicate that the RMI is valid and sensitive to change during hospital rehabilitation, while its ease-of-use makes it suitable for stroke patients in the hospital or at home.

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