Association of Ability to Rise from Bed with Improvement of Functional Limitation and Activities of Daily Living in Hemiplegic Inpatients with Stroke: a Prospective Cohort Study

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Abstract. [Purpose] The purpose of this study was to investigate the association of ability to rise from bed with improvement in functional limitations and activities of daily living (ADL) in hemiplegic inpatients with stroke. [Subjects] Participants were 38 hemiplegic inpatients with stroke in a convalescence rehabilitation unit. [Methods] On admission, a newly developed assessment, rising from bed independence score (RIS) and rise from bed time (RBT) were measured. On discharge, the Berg Balance Scale, Functional Movement Scale, and Functional Independence Measure were measured. We calculated correlation coefficients between ability to rise from bed on admission and these traditional measures on discharge. The proportion of subjects who regained independent gait was calculated among subjects whose RIS was 7 on admission. [Results] RIS and RBT were significantly correlated with most of the traditional measures on discharge. Only RIS was significantly correlated with relative gain. Of those with RIS=7 on admission, 76.9% regained independent gait. [Conclusion] We found that ability to rise from bed of inpatients with stroke was associated with improvement of functional limitation and ADL in a convalescence rehabilitation unit. Ability to rise from bed on admission was a useful predictor of independent gait on discharge. Key words: Stroke, Rising from bed, Gait

INTRODUCTION

Improvement of function is important for patients after stroke. Previous studies have shown that impairment on admission could predict both Functional Independence Measure (FIM) raw scores1 and activities of daily living (ADL) scores on discharge2-5. Moreover, comorbidities and complications were predictive factors of ADL scores on discharge6. There have been many studies on recovery of gait after stroke. Sitting equilibrium 2 weeks after stroke was correlated with walking ability after 6 months, suggesting that assessment of sitting balance, even before the patient can stand, is important in early management of stroke patients7. Similarly, sitting ability on admission could predict independent gait8-10. Improvement in standing balance is another factor that is important for achieving improvement of gait11. Hence, lower-limb motor evoked potentials amplitudes could be a useful prognosis tool regarding lower-limb motor outcome12.
In several studies of post-stroke patients, the ability to rise from bed on admission predicted independent gait\(^{10}\). However, there is little information about the relationship between specific impairments and limitations in functions such as balance in patients after stroke. Rising from bed is one of the most basic movements of ADL. In healthy older subjects, rise from bed time (RBT) was longer than in the young\(^{13,14}\). RBT was correlated with sitting balance, flexibility of the trunk and rectus abdominis strength\(^{15}\), and was also correlated with ADL and balance\(^{16}\). Furthermore, RBT should be useful in older adults with mild-to-moderate transferring impairment and in older adults with subtle yet clinically significant declines in or improvements in transferring function\(^{17}\). To improve frail older adults’ performance in bed mobility tasks, specifically in rising from supine to sitting, it seems that training should move beyond improving trunk strength\(^{18}\).

In our clinical experience, post-stroke patients occasionally struggle to rise from bed because of impairments such as motor paralysis or weakness and sensory dysfunction. However, there has been little research into the ability of post-stroke patients to rise from bed. In one study, the ability to rise from bed was correlated with rectus abdominis strength\(^{19}\) as in the elderly. RBT is also thought to be correlated with space perception and somatosensory deficits after stroke\(^{20}\). Moreover, there is evidence for a relationship between instability in the single elbow support position and ability to rise from bed\(^{21–23}\). These findings suggest that rising from bed might be correlated with various physical abilities, including balance and ADL. Therefore, we hypothesized that improvement of function in patients with stroke is predictable from the ability to rise from bed. The purpose of this study was to investigate the association of independence in rising from bed and RBT with improvement of functional limitations and ADL in inpatients with stroke.

**SUBJECTS AND METHODS**

**Subjects**

Thirty-eight inpatients with hemiplegia resulting from stroke participated in this study (see Table 1 for subject characteristics). Subjects met the inclusion criteria if they were admitted to the convalescence rehabilitation unit and were discharged from it in a manner other than emergency discharge. All subjects received about 40 to 60 minutes of individual physical therapy and about 40 to 60 minutes of occupational therapy every day, as well as speech therapy when needed. Those with severe renal, cardiac, pulmonary, or hematologic disease were excluded. Subjects were given verbal and written information about the study and their written consent was obtained prior to their inclusion.

**Methods**

Ability to rise from bed was evaluated according to the rising from bed independence score (RIS). RIS was devised by the authors with reference to the FIM and motor assessment scales\(^{24}\) with the aim of evaluating subjects’ independence in rising. Subjects rose from bed at a comfortable speed and an examiner scored their movement. RIS was scored as follows: 7, independent; 6, independent but unable to sit up without using bed frame or taking over 10 seconds; 5, supervision; 4, little assistance; 3, moderate assistance; 2, maximum assistance; 1, full assistance or unable to sit up. Intra-rater reliability showed 80.0% agreement (Kappa = 0.73), and inter-rater reliability showed 66.7% agreement (Kappa = 0.70).

RBT was also measured in all but 12 subjects (who were unable to rise by themselves or in whom it could not be measured). RBT was assessed by measuring the time taken to rise from supine to erect sitting on a platform at maximum speed. After subjects practiced a few times, an examiner measured RBT 3 times, and these 3 measurements were averaged. The intraclass correlation coefficient (ICC(1, 1)) of this method was 0.86 (95% confidence interval (CI) 0.75 to 0.93) and ICC (2, 1) was 0.99 (95%CI 0.98 to 0.99)\(^{20}\). Hence, RIS and RBT both appeared to have high reliability.

Balance was evaluated using the Berg Balance Scale (BBS)\(^{25}\). Movement ability was evaluated using the Functional Movement Scale (FMS)\(^{26}\) and ADL status was evaluated using the Functional Independence Measure (FIM)\(^{27}\). All measurements were performed on admission and discharge.

To investigate the association of ability to rise from bed with functional limitations and ADL, Spearman’s rank correlation coefficients between RIS and RBT on admission and BBS, FMS, and FIM (motor, cognitive, and total) on discharge were used. To investigate correlations between the
ability to rise from bed and independent gait on discharge, Spearman’s rank correlation coefficients between RIS, RBT on admission, and gait independence score on FIM were also used. The relative gain was used as one variable. This reflects the patient’s specific potential for improvement and was calculated as gain/ (maximum score – admission score)28). For example, the relative gain in BBS was calculated as gain/ (56 – admission score). Using the relative gain helps to overcome the ceiling effect, the fact that the gain achievable by subjects with high admission scores is limited compared with that achievable by those with low admission scores.

To assess the ability of RIS to predict the patient’s likelihood of regaining independent gait, the proportion of subjects who regained independent gait among those who were unable to walk by themselves on admission (gait score on FIM<6) was calculated according to RIS<6 vs. RIS=7 on admission. Independent gait was defined as a gait score on FIM of 6 or 7 on discharge. Sensitivity and specificity were calculated for RIS with a cut-off of 7 on admission as a predictor of regaining independent gait.

In all statistical analyses, a p value less than 0.05 was taken to indicate statistical significance. All statistical analyses were performed using SPSS 11.0J for Windows.

RESULTS

Table 2 shows RIS and RBT on admission. On admission, 25 subjects had RIS=7, and 4 had RIS=6. Both median and mode of RIS were 7. Therefore, almost all subjects could rise from bed independently. RBT could be measured for 26 subjects. The mean time was 3.9 seconds, the minimum time was 1.3 seconds, and the maximum time was 11.5 seconds.

The means, gains and relative gains of BBS, FMS, and FIM are shown in Table 3.

Table 4 shows correlation coefficients between measures on discharge and RIS and RBT on admission. Both RIS and RBT had significant correlations with BBS, FMS, FIM on discharge (although there was no correlation between RBT and FIM-cognitive). Only RIS had significant correlations with relative gains of BBS, FMS, and FIM (although there was no correlation with FIM-cognitive). The correlation between RIS and the relative gain of FIM was particularly strong.

Twenty-six subjects could not walk independently on admission. When RIS was 7 on admission, 76.9% of these patients regained independent gait. However, when RIS was 1 to 6 on admission, no subject regained independent gait (Table 5). Sensitivity was 100.0% and specificity was 81.3%.

DISCUSSION

Almost all subjects in this study could rise from bed by themselves. RIS was similar among subjects, while the variation in RBT was relatively high (SD = 2.5). RBT could be used to discriminate ability to rise from bed for subjects who were able to rise from bed by themselves.

RIS and RBT correlated well with almost all measures on discharge. RIS on admission also correlated with the relative gain of most measures. The present results suggest that ability to rise from bed is associated with functional ability and ADL performance. Several studies have drawn similar conclusions8–10). Subjects who were able to rise from bed on admission exhibited better performance on discharge and better improvement during hospitalization. The higher the score for
independent rising, the better the function (e.g., strength of rectus abdominis^{19}, space perception and somatosensory deficits^{20}) they demonstrated. It was suggested that stroke inpatients who can rise from bed by themselves on admission retain physical function and tend to spend considerable time active and out of bed. RIS therefore appears useful for predicting the performance of inpatients on discharge. Clinical evaluations to predict function after stroke must be simple\textsuperscript{29}, and RIS used in this study is straightforward. RIS on admission showed a stronger correlation with change of balance, movement ability, and ADL on discharge than RBT on admission. RIS was evaluated according to a 7-point scale while RBT was measured in seconds; hence, these two assessments differ in terms of what they measure. Moreover, RBT was measured only for subjects who could rise from bed by themselves, so subjects who underwent RBT measurement would have had better function than all the subjects who underwent RIS assessment. RBT subjects were a subset of

### Table 3. Mean (SD) of BBS, FMS, and FIM on admission and discharge (n=36)

<table>
<thead>
<tr>
<th></th>
<th>On admission</th>
<th>On discharge</th>
<th>Gain</th>
<th>Relative gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBS</td>
<td>30.3 (19.5)</td>
<td>40.2 (17.9)</td>
<td>9.9 (8.5)</td>
<td>0.46 (0.37)</td>
</tr>
<tr>
<td>FMS</td>
<td>28.7 (14.5)</td>
<td>35.0 (12.1)</td>
<td>6.3 (5.8)</td>
<td>0.48 (0.33)</td>
</tr>
<tr>
<td>Motor</td>
<td>59.2 (25.7)</td>
<td>72.7 (24.1)</td>
<td>13.5 (10.7)</td>
<td>0.59 (0.31)</td>
</tr>
<tr>
<td>Cognitive</td>
<td>26.5 (10.3)</td>
<td>29.1 (9.0)</td>
<td>2.5 (3.2)</td>
<td>0.24 (0.07)</td>
</tr>
<tr>
<td>Total</td>
<td>85.7 (35.1)</td>
<td>101.7 (32.6)</td>
<td>16.0 (12.6)</td>
<td>0.58 (0.30)</td>
</tr>
</tbody>
</table>

Gain: discharge score – admission score. Relative gain = gain / (maximum score – admission score).
BBS, Berg Balance Scale; FMS, Functional Movement Scale; FIM, Functional Independence Measure.

### Table 4. Correlation coefficients between ability of rising from bed (RIS, RBT) and functional ability and ADL

<table>
<thead>
<tr>
<th></th>
<th>On admission</th>
<th>RBT</th>
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<tbody>
<tr>
<td></td>
<td>RIS</td>
<td>RBT</td>
</tr>
<tr>
<td>On discharge</td>
<td>BBS 0.81** –0.79**</td>
<td>–0.79**</td>
</tr>
<tr>
<td></td>
<td>FMS 0.84** –0.60**</td>
<td>–0.60**</td>
</tr>
<tr>
<td></td>
<td>Gait independence score on FIM 0.84** –0.55**</td>
<td>–0.55**</td>
</tr>
<tr>
<td></td>
<td>Motor 0.83** –0.61**</td>
<td>–0.61**</td>
</tr>
<tr>
<td></td>
<td>FIM 0.68** –0.23</td>
<td>–0.23</td>
</tr>
<tr>
<td></td>
<td>Cognitive 0.81** –0.62**</td>
<td>–0.62**</td>
</tr>
<tr>
<td></td>
<td>Total 0.71** –0.31</td>
<td>–0.31</td>
</tr>
</tbody>
</table>

RIS, independence score of rising from bed. RBT, rise from bed time. BBS, Berg Balance Scale; FMS, Functional Movement Scale; FIM, Functional Independence Measure.

### Table 5. Regaining independent gait

<table>
<thead>
<tr>
<th></th>
<th>Gait independence score on FIM on discharge</th>
</tr>
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<tbody>
<tr>
<td>on admission</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>1 to 6 (n=13)</td>
<td>6 3 0 1 3 0 0</td>
</tr>
<tr>
<td>7 (n=13)</td>
<td>0 0 0 3 5 5</td>
</tr>
</tbody>
</table>
RIS. Overall, we consider that RBT is not suitable for discriminating ability to rise from a bed.

In predicting independent gait, all subjects who regained independent gait could rise from bed without using the bed frame and within 10 seconds (RIS=7) on admission. In subjects who could rise from bed at 10 days after stroke, 42% regained gait by the 20th days, and 50% did so by the 30th day. Although subjects in the present study were inpatients admitted to a convalescence rehabilitation unit after stroke, the ability to rise from bed appeared to be a good predictor of regaining independent gait. We hypothesize that developing the ability to rise from bed in a convalescence rehabilitation unit could lead to improved balance, movement ability, and ADL.

There were several limitations of this study. First, few subjects were eligible for the assessment of changes in balance, ability of functional movement, and ADL. This was also true for predicting independent gait. Second, on admission the mean time since stroke was 45.2 days, and mean length of stay was 73.4 days. This study was therefore limited in duration, and a longer prospective study is necessary to more accurately predict prognosis. Third, it is necessary to compare rising ability with ability to perform other movements (e.g., rolling, standing up) and postural balance (e.g., sitting balance, standing balance) in order to characterize the movements involved in rising from bed. Finally, for more accurate prediction, mental function, CT imaging, and cerebral blood flow must be observed.

REFERENCES

20) Shinozaka T, Uchida E, Usuda S: Relation of sitting up


