The relationship between sitting balance and mobility outcome in stroke

The purpose of this study was to identify the relationship between static sitting balance in the acute post stroke patient and gait outcome; and to determine the relationship between initial and six-week post stroke mobility. Fifty-two patients with cerebral infarcts had sitting balance and gait assessed on hospital admission. Gait was reassessed six weeks later using the Functional Independence Measure- Locomotion (FIM Locomotion) score. Sitting balance was positively correlated with gait outcome. In particular, lack of static sitting balance initially is correlated with dependent gait at six weeks post stroke. Consideration of infarct location and side of hemiplegia may further enhance the strength of the correlation. The FIM Locomotion was a useful assessment tool with strong correlation between initial and final FIM Locomotion scores.


Key words: Cerebrovascular Disorders, stroke; Gait; Outcome and Process Assessment (health care)

For the stroke patient and physiotherapist in the 1990s, the economic reality is one of limited rehabilitation resources. Accordingly, there often is a need to establish an individual patient’s rehabilitation potential within the first week after stroke, in order to facilitate early transfer to subacute and rehabilitation facilities. A reliable, fast bedside test which correlates with a functional outcome in the rehabilitation stage would assist physiotherapists in making these difficult decisions.

Many studies over the last 20 years have attempted to identify predictive data for outcome following stroke, and to establish prognostic indicators. Lincoln et al (1989), examining 70 patients at a mean duration of 3.6 weeks post stroke, determined that the most important factor influencing outcome was degree of motor loss; Wade et al (1985) assessed 99 patients and determined that urinary incontinence present for seven to 10 days after stroke was the most important adverse prognostic factor for both survival and recovery of function. Jongbloed (1986) reviewed 33 such studies which predicted function after stroke and identified prior stroke, advanced age, urinary and bowel incontinence and visuospatial deficits as predictors of poor functional outcome. Most studies to date have been based on assessment of stroke patients in the subacute or rehabilitation stage. They therefore have limited usefulness in determining outcome from the vital acute stage, at which major decisions regarding potential for rehabilitation are made. There remains a paucity of objective physical predictive criteria, hence decisions regarding prognosis may be made on a somewhat subjective basis, particularly at the acute stage.

As a prerequisite for early functional activities, sitting balance is a valuable practical function for physiotherapists to investigate. Assessment and treatment of sitting balance is stressed particularly at the acute stage. Linke and Shepherd (1985) and the Bobath concept (Bobath 1990). Assisting a stroke patient to sit on the edge of the bed to enable visual observation of sitting alignment and components of balance reactions is a routine component of acute physiotherapy care. Sitting balance has previously been used as a measurement tool, eg in Wade et al’s 1984 study, which indicated that the side of stroke weakness may influence the pattern of initial deficits without affecting the ultimate physical outcome. Other studies have looked at the predictive value of sitting balance in the stroke patient, but were performed in the subacute or rehabilitation phase. Loewen and Anderson (1990), for example, assessed 57 stroke patients within seven days of onset, and three days after admission to an acute hospital. Using a modification of Carr and Shepherd’s Motor Assessment Scale (MAS), they
determined that balanced sitting one week post-stroke correlated with the Barthel Index at discharge ($r = 0.82$), and with the walking score at discharge (measured by modified MAS) ($r = 0.80$). Sandin and Smith (1990) demonstrated a strong correlation between Barthel Index score and each weekly sitting balance score in 24 stroke patients in a rehabilitation unit (admitted an average of 17 days post stroke). These studies suggest that sitting balance may be a valuable prognostic indicator and a viable test in the acute setting.

The use of outcome measures in physical rehabilitation is becoming increasingly important. Objective and valid measurement of changes can be used to determine appropriate resource allocation, as well as record the status of the patient and assist data collection in a uniform manner. The Functional Independence Measure (FIM) was introduced for use as a measurement tool into Australian hospitals in 1989. Granger et al (1990) claim that the FIM has satisfactory reliability, validity, precision and feasibility. They determined the intraclass correlation ICC (2,1) to be 0.86 on admission and 0.88 at discharge. In a study of persons with multiple sclerosis, the FIM and the Barthel Index correlated highly with the minutes of help that the person needed per day (Granger et al 1990).

Following recent further refinement of the FIM to a seven-level version (Table 1), Hamilton et al (1991) argue that an intrarater reliability for locomotion of $r = 0.93$ reflects its value as a precise measure of functional change. Given the increasing clinical use of the FIM and its wide acceptance in the rehabilitation setting, assessment using the FIM would appear justified in any study aimed at examining outcome following stroke.

Previous studies suggest six weeks post-stroke is an appropriate time frame for reassessment. For example, Wade et al (1985), using a wide range of dependent variables including locomotion, found 79 of 99 stroke patients who were independent in

### Table 1. Seven-level Functional Independence Measure for Locomotion. Adapted (omitting wheelchair scores) from Keith et al 1987.

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>7</td>
<td>Complete Independence, walks a minimum of 45.72 m without assistance, performs safely, and does not use a wheelchair.</td>
</tr>
<tr>
<td>6</td>
<td>Modified Independence, walks a minimum of 45.72 m with a brace (orthosis) or prosthesis on a lower limb, or assists walking with other devices such as special shoes or cane. Takes more than reasonable time or there are safety considerations.</td>
</tr>
<tr>
<td>5</td>
<td>Supervision, requires stand-by supervision, cueing or coaxing to go a minimum of 45.72 m, or walks independently over short distances (min 15.24 m).</td>
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<tr>
<td>4</td>
<td>Minimal Contact Assistance*, performs 75 per cent or more of locomotion effort to walk a minimum of 45.72 m.</td>
</tr>
<tr>
<td>3</td>
<td>Moderate Assistance*, performs 50-74 per cent of locomotion effort to go a minimum of 45.72 m.</td>
</tr>
<tr>
<td>2</td>
<td>Maximal Assistance*, performs 25-49 per cent of locomotion effort to go a minimum of 45.72 m.</td>
</tr>
<tr>
<td>1</td>
<td>Total Assistance, performs less than 25 per cent of effort, or requires assistance of two people, or does not walk a minimum of 15.24 m.</td>
</tr>
</tbody>
</table>

* There are several ways to estimate percentage of effort. For example, a disabled individual who can walk unassisted for 22.86 m, then requires assistance for the remaining 22.86 m would be at Level 4 if steadying was required, or Level 3 if full support of one person was required for the remainder of the distance.
walking three months post-stroke had achieved independent gait by six weeks. The present study was designed to examine: (1) the correlation between sitting balance in the acute post stroke period and independent walking six weeks post stroke; (2) the relationship between FIM Locomotion scores in the acute and six-week post stroke periods; and (3) the relationship between radiological location of cerebral infarct and gait ability six weeks post stroke.

Method

Subjects

Following Ethics Committee approval, all stroke patients admitted over a six month period to a major Melbourne teaching hospital were included in the study. For all subjects admitted to the study, admission was within 24 hours of the stroke and none of the following exclusion criteria were established:

1. A confirmed or suspected subarachnoid or intracerebral haemorrhage.
2. A pre-existing neurological disorder, such as Parkinson’s disease, causing a motor deficit in addition to that resulting from the stroke.
3. A coincident disorder, such as fractured neck of femur or unstable blood pressure, which interferes with assessment of balance or mobility.
4. Minimal or no motor deficit resulting in safe and independent ambulation (FIM Locomotion score above five) on initial assessment.
5. A FIM Locomotion score exceeding five within one week post-stroke. (This criterion was set to exclude the possibility of transient ischaemic attack or the post-ictal phenomenon.)

Eighty patients were included in the study, of which 52 were available for follow up for the subsequent six weeks. There were 29 males and 23 females. The mean age was 73 years (range 51 to 84 years, SD 8.8 years). Forty-eight of the 52 patients were right handed (left dominant). Location of infarct was determined by radiological (CT scan) report (Table 2).

Dependent variables

Static sitting balance was assessed and scored using the basic elements of the protocol described by Sandin and Smith (1990). In this method, the patient was seated for 15 seconds on the side of a hospital bed, feet supported, hands resting on the lap and with back unsupported. Normal (Grade 4) represents performance without physical assistance; good (Grade 3), assistance required to right from hemiplegic side; fair (Grade 2), maintains static position but requires assistance with all righting tasks; and poor (Grade 1), unable to maintain static position. In the present study, patients were scored as either Grade 1 (no static balance) or >Grade 1 (has static sitting balance.) This protocol was followed as it most realistically approximates the basic observational element of current clinical assessment procedures undertaken by physiotherapists working with stroke patients. This acute stage bedside test applied no external stress, such as displacing the subject, and required no complex apparatus.

A pilot study of the sitting balance assessment procedure was conducted by physiotherapists to determine a satisfactory level of interrater reliability prior to the commencement of testing. Cohen’s kappa, a reliability measure used to quantify the degree of interaction tested by Pearson’s chi square (Matyas and Bach 1985), was found to be 0.80. A value >0.75 indicates strong agreement.

Mobility at initial assessment and six weeks later was scored according to the seven point FIM Locomotion scale (Keith et al 1987). Since all patients were being trained for ambulation, and none for wheelchair mobility, all FIM scores were scores for gait ability. All physiotherapists involved in this study were experienced in the administration of the FIM.

Procedure

Once inclusion in the study was determined, an initial assessment was performed. This included evaluation of sitting balance and the administration of the FIM Locomotion scale. Forty-five patients were assessed within 48 hours of admission and the remaining seven, within 72 hours. The physiotherapists involved in the data collection were unaware of the purpose of the study but experienced in neurological management.

Six weeks after initial assessment, or upon discharge from physiotherapy if less than six weeks, the patient’s gait was reassessed and FIM Locomotion score documented. This assessment was performed by a second
physiotherapist blind to the result of the initial assessment, either at the original acute hospital or one of three rehabilitation facilities. Forty-one patients were reassessed six weeks later. Eleven patients were discharged from physiotherapy before six weeks; eight from the acute hospital and three from rehabilitation facilities. All 11 patients were independent in walking on discharge (FIM>5). Between initial and second assessments, patients in the study received physiotherapy treatment broadly based on the principles of motor relearning (Carr and Shepherd 1987) or facilitatory approach (Bobath 1990).

Data analysis
A chi square analysis was used to determine the existence of a relationship between (1) sitting balance and gait ability at six weeks; (2) initial and six-week gait ability; and (3) infarct location and six week gait ability. The phi coefficient was then used to estimate the strength of the relationship in each situation being 0 when no relationship exists and +1 when variables are perfectly related.

Results
Cross tabulation of the two variables sitting balance and six-week gait ability is presented in Table 3.

Chi square analysis revealed a significant association between the two variables, sitting balance and gait ability ($\chi^2 = 12.49; p = 0.0004$). Calculation of the phi coefficient demonstrated a moderate relationship between sitting balance and six-week gait performance ($\Phi = 0.49$). However, for the subgroup of patients without static sitting balance, a chi square one sample test was performed and demonstrated a significant correlation between inability to sit initially and inability to walk independently at six weeks post stroke ($p<0.001$).

The initial FIM Locomotion scores for the 52 patients completing the study were FIM1: $n = 38$; FIM 2-4: $n = 11$; and FIM 5: $n = 3$. Because of the skewed distribution, the full seven point scale was not used in data analysis and the subjects were divided into two categories for the purposes of evaluation. The two groups were (a) patients with initial scores of FIM = 1 ($n = 38$) and (b) patients with initial scores of FIM>1 ie 2, 3, 4 or 5 ($n = 14$). Data indicating initial FIM Locomotion score against six week FIM Locomotion score (full 7-point scale) is shown in Table 4.

The results of the cross tabulation of the two variables (initial and final gait ability) are presented in Table 5.

The $\chi^2$ analysis revealed a significant association between the initial and final FIM Locomotion score ($\chi^2 = 21.9; p = 0.0001$). Calculation of the phi coefficient demonstrated a moderate to strong relationship between initial and final FIM Locomotion score ($\Phi = 0.65$). The data from the 35 patients able to sit unsupported on initial assessment were further analysed to determine whether the location of the infarct might be another factor influencing walking ability at six weeks post stroke. Location of the infarct was categorised as either a (1) cortical lesion or (2) non-cortical lesion for the purposes of analysis. Cross tabulation of the two variables infarct location and six week gait ability, for the sub-group of patients with independent sitting balance on initial assessment, is presented in Table 6.
Table 5.
Cross tabulation of initial against six week gait ability.

<table>
<thead>
<tr>
<th></th>
<th>Initial FIM=1</th>
<th>Initial FIM&gt;1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent gait</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>FIM&lt;6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Independent gait at 6 weeks</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>FIM&gt;5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>38</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 6.
Cross tabulation of infarct location against six week gait ability (for the sub-group of patients who achieved sitting balance on initial assessment).

<table>
<thead>
<tr>
<th></th>
<th>Non-Cortical</th>
<th>Cortical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Gait</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>FIM&lt;6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Independent Gait at 6 weeks</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>FIM&gt;5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>18</td>
<td>17</td>
</tr>
</tbody>
</table>

Discussion

Initial acute sitting balance and gait ability at six weeks post stroke were found to be moderately correlated. Loewen and Anderson (1990) had previously suggested that initial (immediate post-stroke) sitting balance could be adversely affected by anxiety and transient disorientation and that one week post-stroke assessment correlated with outcome more strongly. However the useful relationship demonstrated in the present study may be a reflection of the non-threatening nature of the assessment procedure, ie assessment was carried out at the bedside and no attempt was made to disturb balance. Although this test is limited in that it does not include a measurement of symmetry or other qualitative features of the activity, its simplicity eliminated excessive disturbance of the patient which might be considered anxiety-provoking.

A significant correlation was established between initial and final FIM Locomotion scores, ie a patient’s initial ability to ambulate post-stroke gives the therapist useful information in determining future mobility status. Although it is acknowledged that the FIM Locomotion scale provides little detail regarding quality of gait, it remains a useful scale for assessment of the patient’s burden of care rather than purely the recovery of motor function (Granger et al 1990).

CT results alone have been used as a potential predictor of functional recovery (Miller and Miyamato 1979). Small superficial lesions shown by CT correlated with good function at discharge, whereas poor function at discharge tended to be associated with large and deep lesions on CT. More detailed analysis of CT results for the subjects in the present study may establish a stronger correlation between site of infarct, sitting balance and mobility outcome.

This study supports the findings of Sandin and Smith’s 1990 study, which determined that those patients with poor/no sitting balance also had poor Barthel Index scores, ie poor mobility, transfers and independence in activities of daily living.

Previous research has identified factors such as side of hemiplegia (Bohannon et al 1986) and the presence of other cortical symptoms such as hemi-inattention (Goldie and Kinsella 1991) as affecting sitting balance and recovery tempo following stroke. A stronger correlation between initial sitting balance and gait outcome may have been identified if there had been greater subject numbers.

Conclusion

In the present study, assessment of static sitting balance in the acute stroke patient was found to be positively correlated with gait outcome. In particular, findings suggest that lack of static sitting balance initially may be correlated with a lack of independent gait six weeks post-stroke. In those instances where the patient has achieved independent static sitting balance, the FIM Locomotion score can be used to enhance the therapist’s ability to determine mobility outcome. Finally, the FIM Locomotion assessment alone could be useful in predicting mobility outcome six weeks post stroke from an initial assessment in the acute stage.

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**References**


