Measures of activity limitation on admission to rehabilitation after stroke predict walking speed at discharge: an observational study

Suzanne S Kuys[1,2], Paul G Bew[3], Mary R Lynch[1], Greg Morrison[2] and Sandra G Brauer[1]

[1]The University of Queensland, [2]Princess Alexandra Hospital, [3]The Prince Charles Hospital Australia

Question: Which measures of activity limitation on admission to rehabilitation after stroke best predict walking speed at discharge? **Design**: Prospective observational study. **Participants**: 120 people with stroke undergoing inpatient rehabilitation. **Outcome measures**: Predictors were admission walking speed, Timed Up and Go, Motor Assessment Scale, Modified Elderly Mobility Scale, and Functional Independence Measure scores measured on admission to rehabilitation. The outcome of interest was walking speed at discharge from inpatient rehabilitation. **Results**: Admission walking speed (B 0.47, 95% CI 0.27 to 0.67) and Item 2 of the Motor Assessment Scale, ie, moving from supine lying to sitting over the side of a bed (B 0.05, 95% CI 0.01 to 0.09) predicted walking speed on discharge from rehabilitation. These two predictors explained 36% of the variance in discharge walking speed. **Conclusion**: Walking speed at discharge from inpatient rehabilitation was best predicted by admission walking speed and Motor Assessment Scale Item 2. **[Kuys SS, Bew PG, Lynch MR, Morrison G, Brauer SG (2009) Measures of activity limitation on admission to rehabilitation after stroke predict walking speed at discharge: an observational study. *Australian Journal of Physiotherapy* 55: 265–268]**

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Introduction

A key factor in minimising the participation restrictions associated with stroke is the achievement of community ambulation. It is possible that walking speed can discriminate between different levels of community ambulation (Lord et al 2004). A walking speed of 0.8 m/s has been suggested as the minimum speed required for safe and independent community ambulation by stroke survivors (Hill et al 1997, Perry et al 1995). While community ambulation is more than the achievement of a particular walking speed, walking speed has been identified as an appropriate measure to use in clinical trials investigating community mobility (Lord et al 2004).

The majority of studies predicting walking after stroke have focused on recovery of walking or the achievement of independent walking, measured through global measures such as the Barthel Index (Loewen and Anderson 1990, Wandel et al 2000), the Functional Independence Measure (Bohannon and Eriksrud 2001, Jorgensen et al 1995), or the ability to walk 10 metres (Petrilli et al 2002). Few studies have investigated the prediction of walking speed achieved by discharge from rehabilitation. On admission to rehabilitation after stroke, validated measures of activity limitation that focus on or include mobility, such as the Motor Assessment Scale (Carr et al 1985), Functional Independence Measure (Kidd et al 1995), walking speed (Wade et al 1987), and Timed Up and Go Test (Podsiadlo and Richardson 1991) are commonly recorded. It would enhance the ability to provide accurate information to the patient, the family, and the rehabilitation team if it were possible to use these typical measures to predict the walking speed achieved by the end of the inpatient rehabilitation period. Therefore, the research question for this study was:

> Which measures of activity limitation on admission to rehabilitation after stroke best predict walking speed at discharge?

Method

Design

A prospective cohort observational study was undertaken. Participants were recruited from the Princess Alexandra Hospital Geriatric and Rehabilitation Unit in Brisbane, Australia. They received a rehabilitation program specific to individual needs as prescribed by the multidisciplinary team. Commonly-used validated measures were collected within 72 hours of admission and discharge by the treating physiotherapist. Physiotherapists were provided with training, written instructions, and standard equipment to ensure consistency in use and scoring of each measure.

Participants

All patients with a primary diagnosis of stroke admitted to the rehabilitation unit over a two-year period were eligible to be included in this study. Demographic and clinical information collected included age, gender, time from stroke to admission to rehabilitation, rehabilitation length of stay, and living arrangements prior to stroke.

Outcome measures

Predictors were the Functional Independence Measure (Kidd et al 1995), Motor Assessment Scale (Carr et al 1985), Modified Elderly Mobility Scale (Kuys and Brauer 2006), admission walking speed measured using the 10-m Walk Test (Wade et al 1987), and Timed Up and Go (Podsiadlo and

Richardson 1991) measured on admission to rehabilitation. The Functional Independence Measure is commonly used in rehabilitation settings to assess the level of assistance required during the performance of motor tasks, self-care activities, communication, and cognitive tasks. It comprises 18 items each scored from 1 to 7 (18 to 126) which can be divided into a motor component of 13 items (13 to 91) and a cognitive component of 5 items (5 to 35) with higher scores indicating greater level of independent activity. It has inter-rater reliability (ICC > 0.91) (Hamilton et al 1994). The Motor Assessment Scale, specifically developed for people with stroke, assesses performance on 8 activities (Carr et al 1985) and has inter- and intra-tester reliability (Carr et al 1985, Kjendahl et al 2005, Loewen and Anderson 1988, Poole and Whitney 1988). The Modified Elderly Mobility Scale is an eight-item battery of activities comprising lying to sitting, sitting to lying, sitting to standing, standing balance, walking, timed 10-m walk, functional reach and climbing stairs with a maximum possible total score of 23 (Kuys and Brauer 2006). It has inter-rater and test-retest reliability and is significantly correlated with both the motor component (r = 0.73) and Functional Independence Measure (r = 0.72) score (Kuys and Brauer 2006). Walking speed (m/s) was scored as 0 m/s if participants were unable to walk 10 m. Timed Up and Go data were categorised as ordinal based on time taken to complete the test at a comfortable walking pace (Podsiadlo and Richardson 1991, Shumway-Cook et al 2000, Steffen et al 2002, Salbach et al 2001) in order to include those who were unable to complete the test in the analysis. The categories were < 12 seconds (coded as 1), 12–20 seconds (coded as 2), > 20 seconds (coded as 3), and unable (coded as 4).

The outcome of interest was walking speed (m/s) at discharge from rehabilitation (inpatient) measured using the 10-m Walk Test (Wade et al 1987).

Table 1. Characteristics of participant on admission to rehabilitation.

Characteristic	(n = 120)
Age *(yr)*, mean (SD)	70 (13)
Gender, n male (%)	64 (53)
Side of stroke, n left (%)	46 (38)
Time from stroke to rehabilitation admission *(days)*, mean (SD)	13 (10)
Walking speed *(m/s)*, mean (SD)	0.35 (0.4)
Timed Up and Go, n (%)	
< 12 s	14 (12)
12 to 20 s	15 (13)
> 20 s	19 (16)
unable	65 (54)
MEMS *(0 to 23)*, mean (SD)	11 (8)
FIM *(0 to 126)* mean (SD)	84 (23)
Motor FIM *(18 to 91)* mean (SD)	57 (21)
Cognitive FIM *(5 to 35)* mean (SD)	27 (7)
Motor Assessment Scale *(0 to 6), mean (SD)*	
Item 1 Supine to side lying	3.8 (2.3)
Item 2 Supine to sitting over side of bed	4.2 (2.1)
Item 3 Balanced sitting	3.9 (1.7)
Item 4 Sitting to standing	2.9 (2.1)
Item 5 Walking	2.1 (2.2)
Item 6 Upper arm function	3.4 (2.5)
Item 7 Hand movements	2.8 (2.6)
Item 8 Advanced hand activities	1.7 (2.0)

MEMS = Modified Elderly Mobility Scale; FIM = Functional Independence Measure

Data analysis

Correlation between predictors and discharge walking speed (m/s) was conducted to identify predictors. Regression coefficients (95% CI) were determined for each predictor using univariate analysis. Significant predictors were entered into the multiple regression ($p < 0.05$). An equation to predict discharge walking speed was developed from the coefficients (B) of the significant predictors from the multiple regression analysis ($p < 0.05$).

Results

Flow of participants through the study

One hundred and twenty patients with first stroke were admitted to the Princess Alexandra Hospital from January 2004 to December 2005 with 105 records containing complete data on admission and discharge. Those with missing data on some measures (n = 15) were no different from included patients in terms of age ($p = 0.33$), rehabilitation length of stay ($p = 0.22$) and admission scores ($p > 0.12$). Admission scores and demographics of participants are presented in Table 1. The mean age of participants was 70 years (SD 13), 64 (57%) were male, while 46 (47%) suffered a left sided lesion. The mean time between stroke onset and admission to rehabilitation was 13 days (SD 10) with 58 (%) participants unable to walk on admission.

The mean rehabilitation length of stay was 60 days (SD 49). At discharge from rehabilitation, 16 (13%) participants were unable to walk, 43 (36%) could walk slowly (< 0.8 m/s), and 59 (49%) were able to walk faster than 0.8 m/s. Overall the mean discharge walking speed was 0.7 m/s (SD 0.4).

Prediction of discharge walking speed

Univariate analysis revealed that admission walking speed, Modified Elderly Mobility Scale score, Motor Assessment Scale Items 1 to 5, the motor component of the Functional Independence Measure, Functional Independence Measure, and Timed Up and Go predicted discharge walking speed. Regression coefficients (95% CI) of the relationship between predictors and discharge walking speed and their level of significance are presented in Table 2.

When the significant predictors were entered into multiple linear regression, discharge walking speed was best predicted by admission walking speed and Motor Assessment Scale Item 2 (supine lying to sitting over side of bed) ($R^2 = 0.36$). Box 1 presents the regression coefficients of the predictors in the model, the prediction equation, and the accuracy of prediction of the model best able to predict discharge walking speed. Clinicians could, therefore, predict discharge walking speed by the following equation:

Discharge walking speed *(m/s)* = 0.33 + 0.47 admission walking speed + 0.05 Item 2 MAS score *(0 to 6)*

For example, if the walking speed of a stroke patient was 0.40 m/s and their Item 2 MAS score was 2 on admission to rehabilitation, their discharge walking speed would be predicted to be 0.62 m/s.

Table 2. Strength and significance of relationship between predictors and discharge walking speed from univariate analysis reported as r (*p*).

Predictor	Relationship with discharge walking speed
Admission walking speed (n = 120)	0.32 (< 0.001)
Timed Up and Go (n = 120)	0.20 (< 0.001)
MEMS (n = 107)	0.29 (< 0.001)
FIM (n = 120)	0.25 (< 0.001)
Motor FIM (n = 120)	0.29 (< 0.001)
Cognitive FIM (n = 120)	0.01 (0.31)
Motor Assessment Scale	
Item 1 Supine to side lying (n = 107)	0.21 (< 0.001)
Item 2 Supine to sitting over side of bed (n = 106)	0.23 (< 0.001)
Item 3 Balanced sitting (n = 105)	0.19 (< 0.001)
Item 4 Sitting to standing (n = 105)	0.26 (< 0.001)
Item 5 Walking (n = 105)	0.22 (< 0.001)
Item 6 Upper arm function (n = 105)	0.09 (0.14)
Item 7 Hand movements (n = 105)	0.06 (0.23)
Item 8 Advanced hand activities (n = 105)	0.07 (0.36)

MEMS = Modified Elderly Mobility Scale; FIM = Functional Independence Measure

Box 1. Mean (95% CI) regression coefficients (B) of predictors, prediction equation from the multivariate analysis, and accuracy of prediction of discharge walking speed (n = 105).

Regression coefficients of predictors

Constant = 0.33 (0.16 to 0.49)

Admission walking speed = 0.47 (0.27 to 0.67)

Modified Elderly Mobility Scale score = 0.01 (–0.01 to 0.03)

Item 1 MAS score = 0.04 (–0.01 to 0.09)

Item 2 MAS score = 0.05 (0.01 to 0.09)

Item 3 MAS score = 0.04 (–0.02 to 0.10)

Item 4 MAS score = 0.01 (–0.06 to 0.08)

Item 5 MAS score = –0.08 (–0.16 to 0.01)

FIM = –0.01 (–0.03 to 0.01)

Motor FIM = 0.02 (–0.13 to 0.04)

Timed Up and Go = 0.09 (–0.05 to 0.23)

Prediction equation

Discharge walking speed *(m/s)* = 0.33

+ 0.47 admission walking speed *(m/s)*

+ 0.05 Item 2 MAS score *(0 to 6)*

Accuracy of prediction

R^2 = 0.36

MAS = Motor Assessment Scale, FIM = Functional Independence Measure

Discussion

Predicting the walking speed of people with stroke at discharge from inpatient rehabilitation from activity and mobility measures commonly used on admission to rehabilitation is possible. Admission walking speed and the ability to move from supine lying to sitting over the side of the bed explained 36% of the variance in discharge walking speed.

The current study supports findings of an earlier study (Goldie et al 1999) which reported that admission walking speed of stroke patients able to walk moderately predicted discharge walking speed. The current study identified that the best prediction occurred when the ability to move from supine lying to sitting over the side of the bed was combined with admission walking speed. However, the level of association identified in both these studies suggests that other factors are involved in achieving a discharge walking speed. Factors such as stroke severity (Petrilli et al 2002), age, bowel control (Friedman 1990, Loewen and Anderson 1990), and independence in performing activities of daily living (Wandel et al 2000) may also influence walking speed. In addition, paretic leg strength (Bohannon 1986, Friedman 1990, Bohannon 1991, Bohannon and Eriksrud 2001) should also be considered as walking speed and independence are closely related (Bohannon 1986 and 1991).

Achieving a walking speed of 0.8 m/s by discharge from rehabilitation is important for people with stroke as benefits in minimising activity limitations and maximising quality of life have been demonstrated (Schmid et al 2007). The large number (48%) of participants unable to walk on admission to rehabilitation possibly contributed to the degree of explained variance found. For those patients admitted for rehabilitation after stroke who are walking slowly, this study suggests that targeting walking training with greater intensity of walking practice may increase the likelihood of achieving this target. For example, using the prediction equation developed by this study, a stroke patient whose admission walking speed was 0.40 m/s and admission Motor Assessment Scale Item 2 score was 2 would increase their walking speed by 0.22 m/s so that their discharge walking speed was 0.62 m/s. More practice than normal would therefore be needed to increase the discharge walking speed to 0.80 m/s.

The Motor Assessment Scale for Stroke, in particular, performance on Item 2 (supine lying to sitting over the side of the bed) at admission, along with admission living arrangements and age have been shown to predict discharge to home or residential aged care with an accuracy of 86% after rehabilitation (Brauer et al 2008). This and the current study are the first to examine the predictive ability of the Motor Assessment Scale and both have reported that the ability to move from supine lying to sitting over side of bed is predictive of activity limitations at discharge.

In conclusion, admission walking speed and ability to move from supine lying to sitting over side of bed were able to predict walking speed achieved by discharge from rehabilitation of people with stroke. ■

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Ethics: This study was approved by the Princess Alexandra Hospital Human Research Ethics Committee.

Correspondence: Suzanne Kuys, Physiotherapy Department, Princess Alexandra Hospital, Ipswich Road, Woolloongabba, Queensland, 4102, Australia. Email: s.kuys@uq.edu.au

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