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Research paper

Functional outcomes in inpatient rehabilitative care of stroke patients: predictive factors and the effect of therapy intensity

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ABSTRACT

Background The knowledge of factors predicting functional recovery and the optimum amount of therapy given to stroke patients is crucial for predicting and achieving best possible outcomes.
Objectives To evaluate factors predicting activities of daily living (ADL) dependency upon planned discharges and the effect of intensity of therapy during inpatient rehabilitation of stroke patients.
Methodology Observational study of 200 stroke patients in two community (rehabilitation) hospitals. Assessments were made on admission and discharge that included functional and neurological impairment, depression, cognitive impairment and medical chart data on total hours of therapy.
Results On admission and on discharge, 54% and 19% respectively of the patients were ADL dependent. In multivariate analyses, the independent significant predictors were cognitive impairment (hazard ratio (HR) = 4.11, 95% confidence interval (CI) 1.41, 11.95), ADL dependency upon admission (HR = 9.76, 95% CI 1.28, 74.12), severe neurological impairment on admission (HR = 2.70, 95% CI 1.31, 5.53) and recurrent stroke (HR = 2.89, 95% CI 1.31, 5.53). Adjusted for these variables, each hour of therapy significantly reduced the risk of ADL dependency at discharge.
Conclusion Functional recovery in stroke patients is predicted by clinical and neurological factors and by the intensity of therapy.

Keywords: functional recovery, predictors, stroke

Introduction

A majority of stroke survivors in rehabilitative care present with significant physical, cognitive and psychosocial impairments and disabilities.[1] Functional recovery of stroke patients during rehabilitation is affected by the coexistence of these psychosocial and cognitive impairments, as well as by a wide range of other neurological and sociodemographic factors.[2–11] Unfortunately because of heterogeneity in study design,

setting and methodology in previous research studies, the variables affecting the functional recovery of stroke patients are not well understood.

The identification of baseline modifiable and non-modifiable factors predicting functional outcomes of stroke rehabilitation from a wide range of variables in the same cohort of stroke patients is crucial to develop an understanding of appropriate interventional strategies that could be mounted for maximising their functional recovery.

Rehabilitative therapy is the mainstay of care for stroke patients. However, there is still a lack of consensus on the relationship between intensity of therapy and outcomes. While some studies reported that more intense therapy leads to improved outcomes,[12–16] other studies do not support enhanced benefits from more intense therapy.[17–20]

Knowledge of the baseline factors affecting the functional outcome in terms of functional dependence at the end of inpatient rehabilitative therapy and the optimum amount of therapy to be given to stroke patients is crucial for achieving functional recovery, which typically has the most impact within the first two months of stroke onset.[21–23]

The aim of this study was to identify predictors of functional recovery in stroke patients during their rehabilitation. We also hypothesised that more intense therapy leads to better functional recovery of stroke patients during their rehabilitation.

Methods

Patients

We conducted a prospective cohort study on 200 stroke patients who were admitted into two community hospitals in Singapore, which provide step-down care for stroke patients discharged from acute hospitals. The stroke cases satisfied the World Health Organization (WHO) criteria for definition of stroke: rapidly developed clinical signs of focal disturbance of cerebral function lasting more than 24 h or leading to death with no apparent cause other than vascular origin, including subarachnoid haemorrhage. Patients with severe aphasia were excluded because the measurement tools used in the study required participants to be able to communicate. The study was approved by the ethics committees of the hospitals, and all patients in the study gave informed consent for participation in the study. Of 252 patients who were consecutively admitted, 48 patients were excluded, four patients refused participation, and 200 patients fulfilled the inclusion criteria for enrolment into the study. Of these, 22 patients had unplanned discharges and referrals for acute complications for unresolved problems, hence the data of 178 patients who remained on rehabilitative care until planned discharges were analysed in this study.

On admission, data were collected from reviews of case notes, physical and functional assessments, and questionnaire interviews. Neurological and functional assessment was performed by a physician (SKS), and questionnaire interviews were performed by a trained research nurse, with translations for non-English-speaking patients.

Measurements

Information obtained on admission included demographic and socio-economic variables (gender, age, ethnicity, marital status, education, living arrangement, care giver).

Clinical variables extracted from clinical case records included the presence of cardiovascular risk factors, namely smoking, hypertension, hyperlipidaemia, diabetes, ischaemic heart disease and atrial fibrillation; visual impairment and hearing impairment. Neurological variables included stroke lesion type (ischaemic vs haemorrhagic), location of stroke (cortical vs non-cortical), side and distribution (unifocal or multifocal, based on computed tomography (CT) head reports), and whether the stroke was recurrent. Post-stroke complications included occurrence of post-stroke urinary incontinence (defined as involuntary loss of urine in a post-stroke patient), dysphagia (as diagnosed by a swallowing therapist), aspiration pneumonia (as diagnosed by a clinician) and post-stroke seizures (excluding those with pre-existing epilepsy), on-admission Ryle's tube, and urinary catheterisation.

The total hours of therapy during the total period of stay in rehabilitation hospitals for individual patients was computed from service documentation records.

The Geriatric Depression Scale (15-item short form version), GDS-15, was used to assess depressive symptoms. The GDS is a validated questionnaire, which has been found to be a suitable instrument to screen for depression in the general population and in the elderly Chinese population in Singapore.[24,25] It has scores ranging from 0 to 15, with a score of 5 or more indicating depression.

The Abbreviated Mental Test (AMT) was used to assess cognitive impairment. In elderly patients, AMT has been shown to give good predictive validity of cognitive impairment and dementia.[26] The 10-item scale gives scores ranging from 0 to10 with a score of 7 or less indicating cognitive impairment. The AMT has also been recommended by both the Royal College of Physicians and the British Geriatric Society to screen for the initial assessment of cognition in elderly patients admitted to hospitals.[26]

Functional impairment was assessed by the Barthel Index of independence in activities of daily living (ADL; grooming, walking, bladder/bowel control, dressing, climbing stairs, feeding and bathing), which has been validated and widely used in stroke patients.[1,27] The scores of the scale range from 0 to 100, with a score 100 denoting complete independence. Three categories of functional limitations were defined using the following cut-off values: (1) severe: 0–50 (2) moderate: 51–75 (3) mild to no impairment: 76–100. Continued ADL dependency on discharge was defined as a Barthel Index score $\leq$50. For analysis the cut-off points to label the two prognostic groups on admission with mild-to-moderate functional impairment vs ADL dependency or severe functional impairment was based on clinical judgement, as has also been used in previous research studies.[28]

Neurological impairment was assessed by using the National Institute of Health Stroke (NIHS) scale.[29,30] Items in the NIHS scale assess level of consciousness, gaze, visual fields, facial palsy, motor strength, ataxia, sensory system, language, dysarthria and extinction/inattention. The scale scores range from 0 to 42, with 42 denoting the most severe neurological impairment. The NIHS scale has been shown to have high intra- and inter-rater reliability, good predictive validity for long-term stroke outcome, and to predict post-acute care disposition among stroke patients as well.[29,30] Three categories of neurological impairment, namely mild, moderate and severe, were defined with the following cut-off values: (1) mild impairment: 1–6, (2) moderate impairment: 7–12, (3) severe impairment: 13–42. For analysis the cut-off points to label the prognostic groups on admission with mild to moderate neurological impairment versus severe neurological impairment was based on clinical judgement as has also been used in previous research studies.[30]

Statistical analysis

The data in the study pertained to time-to-event, as the patients were hospitalised in the rehabilitation hospitals for different time periods and the outcome of interest was ADL dependency upon planned discharge from the hospitals.

Hence the factors predicting ADL dependency (Barthel Index $\leq$50) upon planned discharges from community hospitals were modelled using Cox regression analyses (i.e. the event was ADL dependency upon planned discharge from the hospitals and the time was length of hospital stay in the rehabilitation hospitals).

Significant variables identified from univariate analyses were included in the final regression model using forward selection procedures for entry at $P = 0.05$ and removal at $P = 0.10$. The strengths of association of the predictors were expressed as the hazard ratio and their 95% confidence intervals (CIs). Data were analysed using Statistical package for Social Sciences (SPSS), version 12.0.

Results

Patient characteristics

The mean length of stay in community hospitals was 34.4 days (standard deviation (SD) = 18.4) for patients with planned discharges ($n = 178$) and 21.0 days (SD = 11.8) for patients with unplanned discharges ($n = 22$).

The patients in the study were aged between 40 and 96 years, mean 71.5 (SD = 10.5); 54% were males; 88% were Chinese, 7% Malays, and 5% Indians; 50% were married, 7% were unmarried and 43% were either widowed or divorced. Among the patients, 10% were living alone, 12.5% did not have an identifiable care giver.

Visual and hearing impairment were present in 10% and 5% of the patients. The prevalence of cardiovascular risk factors and comorbidities were: hypertension: 87%; diabetes: 47%; smokers: 45%; ischaemic heart disease: 22%; atrial fibrillation: 7%; hyperlipidaemia: 72%. The stroke lesions were haemorrhagic in 12.5% of the patients; cortical in 28%; multifocal in 49% and 42% had recurrent stroke. Among the patients, 25% had post-stroke dysphagia, 59% urinary incontinence, 5% aspiration pneumonia; 2% seizures; 6% required urinary catheter and 13.5% required Ryle's tube on admission. Neurological impairment was assessed according to the NIHS scale as mild in 47% of the patients, moderate in 36% and severe in 16% of the patients. On admission, 60% of the patients were depressed and 54% were cognitively impaired.

The mean Barthel Index on admission was 47.2 (SD = 27.7) and was 71.1 (SD = 20.0) on planned discharge (difference = 23.9; $P < 0.01$). On admission, 89 patients (54%) had a Barthel Index of $\leq$50 (severe functional limitation); upon discharge the proportion was 19% ($n = 34$; $P < 0.01$).

The effect of intensity of therapy on ADL dependency at discharge was evaluated on the 89 patients who were ADL dependent upon admission and subsequently had planned discharges from the hospitals. Among these patients, the cumulated duration of therapy was 52.4 h (SD 27.9) in those who did not remain ADL dependent on discharge ($n = 55$) and 41.9 h (SD 21.2) among those who remained ADL dependent on planned discharges ($n = 34$).

Univariate analyses of variables associated with ADL dependency on discharge

In univariate analyses, significant predictors of ADL dependency (Barthel Index $\leq$50) on planned discharge (see Table 1) were age $\geq$81 years (hazard ratio (HR) = 4.21, 95% CI 1.53, 11.61); cognitive impairment on admission (HR = 5.50, 95% CI 1.93, 15.68); depression on admission (HR = 2.35, 95% CI 1.02, 5.42); and ADL dependency on admission (Barthel Index $\leq$50) (HR = 18.20, 95% CI –2.48, 133.52). Significant neurological variables (see Table 2) were post-stroke dysphagia (HR = 3.88, 95% CI 1.94, 7.75); urinary incontinence (HR = 9.07, 95% CI 2.16, 37.93); Ryle's tube on admission (HR = 4.06, 95% CI 2.01, 8.17); recurrent stroke (HR = 2.89, 95% CI 1.32, 6.35) and severe neurological impairment on admission (HR = 5.03, 95% CI 2.50, 10.09) (see Tables 1 and 2).

Multivariable analysis of ADL dependency on discharge

Significant independent predictors of ADL dependency on discharge taking confounding into account in the final Cox regression model were cognitive impairment on admission (HR = 4.11, 95% CI 1.41, 11.95), ADL dependency on admission (HR = 9.76, 95% CI 1.28, 74.12), recurrent stroke (HR = 2.70, 95% CI –1.31, 5.53) and severe neurological impairment on admission (HR = 2.70, 95% CI 1.31, 5.53) (see Table 3).

Multivariable analysis of ADL dependency on discharge including total hours of therapy in the predictive model

To evaluate the effect of hours of therapy on ADL dependency upon planned discharge from hospitals, we analysed the data for all 89 patients who were ADL dependent (Barthel Index $\leq$50) upon admission and subsequently had planned discharges from the community hospitals. Of these cases, 34 patients remained ADL dependent on discharge, while 55 patients showed positive changes in Barthel scores (Barthel Index $\geq$51), indicating recovery on ADL dependency. Cox regression analysis (see Table 3) was performed including the four independent significant variables (to take confounding into account) of ADL dependency in our study, and total hours of therapy during hospitalisation to these 89 patients.

In the model, total hours of therapy was a significant correlate of ADL dependency upon planned discharge from the hospital (negatively correlated, $P < 0.01$); (HR = 0.90, 95% CI –0.87, 0.94), suggesting that each hour of therapy significantly decreased the risk of being ADL dependent upon discharge (see Table 3).

Discussion

In this study of the outcomes of rehabilitative care for stroke, a majority of patients made good functional recovery. However, about 20% of patients remained ADL dependent on discharge. The patients in this group are likely to pose considerable burden of care at home after discharge. A clearer definition of the predictors of poor functional outcomes should direct better interventional strategies that help to improve the outcomes of care for stroke. They represent an identifiable group of patients for which more active or special treatment and rehabilitation strategies aimed at maximising early neurological and functional recovery in the patients may be potentially beneficial.

In this population of stroke patients receiving in-hospital rehabilitative care for acute stroke, we observed that the prognosis for functional recovery was predicted by a number of baseline variables, namely severe neurological impairment, ADL dependency, cognitive impairment and recurrence of stroke.

Severe neurological impairment has been consistently reported in previous research to be a significant correlate of dependency or poor functional outcome.[6–9] Likewise, a consistent association has also been shown for post-stroke cognitive decline.[9,31–33] This may be because of inability of cognitively impaired patients to participate appropriately in the rehabilitation. Potential interventions that improve cognitive function are at present limited, and require further interventional studies, as improvement in cognition is associated with improvement in ADL.[34]

As expected, we found that ADL dependency on admission significantly predicted functional dependency outcome.[35–37] It is interesting to note that both ADL dependency and neurological impairment on admission independently predicted continued ADL dependency on discharge. Their independent predictions in multivariate modelling support the complementary use of both measures in prognosticating outcomes in rehabilitative stroke care.

Ryle's tube on admission, post-stroke dysphagia and urinary incontinence were significant predictors of ADL disability on univariate analysis, but given the use of the Barthel Index as a tool of assessment to measure ADL dependency these were not significant independent predictors as they are measured as separate domains on the Barthel Index scale.

Recurrent stroke as compared to first time stroke was significantly associated with ADL dependency in our study, as has been reported in previous

Table 1 Univariate analysis: predictors of ADL dependency (Barthel index ≤50) on planned discharges from hospitals

Baseline sociodemographic and clinical variables	ADL dependent $n = 34$ (%)	ADL independent $n = 144$ (%)	*P*	Hazard ratio	95% CI
Age (years)					
≤65	6 (17.6)	51 (35.4)			
66–80	17 (50.0)	72 (50.0)	NS	1.77	0.69, 4.51
≥81	11 (32.4)	21 (14.6)	<0.01	4.21	1.53, 11.61
Sex					
male	17 (50.0)	80 (55.6)		1.00	
female	17 (50.0)	64 (44.4)	NS	1.19	0.60, 2.36
Ethnicity					
Chinese	28 (82.4)	129 (89.6)		1.00	
Malay	4 (11.8)	9 (6.3)	NS	0.99	0.34, 2.87
Indian	2 (5.9)	6 (4.2)	NS	3.29	0.73, 14.67
Marital status					
married	17 (50.0)	76 (52.8)	NS	1.00	
unmarried	3 (8.8)	9 (6.3)	NS	1.90	0.55, 6.55
widow/divorced	14 (41.2)	59 (41.0)		0.68	0.33, 1.42
Education level					
>secondary	4 (11.8)	25 (17.4)		1.00	
≤secondary	30 (88.2)	119 (82.6)	NS	1.10	0.38, 3.14
Living arrangement					
living with someone	34 (100.0)	127 (88.2)		1.00	
living alone		17 (11.8)	NS	0.04	0.01, 5.94
Care-giver					
present	33 (97.1)	123 (85.4)		1.00	
absent	1 (2.9)	21 (14.6)	NS	0.21	0.02, 1.57
Visual impairment					
present	6 (17.6)	13 (9.0)		1.59	0.64, 3.94
absent	28 (82.4)	131 (91.0)	NS	1.00	
Hearing impairment					
present		9 (6.3)		0.05	0.0, 63.43
absent	34 (100.0)	135 (93.7)	NS	1.00	
Hypertension					
present	31 (91.2)	126 (87.5)		1.12	0.36, 3.98
absent	3 (8.8)	18 (12.5)	NS	1.00	
Diabetes mellitus					
present	17 (50.0)	62 (43.1)		1.22	0.61, 2.42
absent	17 (50.0)	82 (56.9)	NS	1.00	
Smoking					
present	16 (47.1)	66 (45.8)		0.89	0.44, 1.76
absent	18 (52.9)	78 (54.2)	NS	1.00	
Ischaemic heart disease					
present	10 (29.4)	10 (6.9)		1.24	0.59, 2.61
absent	24 (70.6)	134 (93.1)	NS	1.00	

Table 1 Continued

Atrial fibrillation					
present	2 (5.9)	3 (4.9)		0.72	0.17, 3.02
absent	32 (94.1)	58 (95.1)	NS	1.00	
Hyperlipidaemia					
present	21 (61.8)	106 (73.6)		0.71	0.35, 1.42
absent	13 (38.2)	38 (26.4)	NS	1.00	
Cognitive impairment					
present	30 (88.2)	65 (45.1)		5.50	1.93, 15.68
absent	4 (11.8)	79 (54.9)	<0.01	1.00	
Depression					
present	27 (79.4)	76 (52.8)		2.35	1.02, 5.42
absent	7 (20.6)	68 (47.2)	<0.05	1.00	
Functional impairment (on admission)					
mild to moderate	0 (0.0)	83 (60.1)		1.00	
severe	34 (100)	55 (39.9)	<0.01	18.20	2.48, 133.52

NS: not significant

studies.[38,39] This finding suggests the importance of having clinical preventive measures in primary care aimed at reducing the first incidence, and recurrence of stroke, and its severity. This would eventually have a strong impact on outcomes of rehabilitative stroke care.

Post-stroke depression has been reported to be a significant independent correlate of ADL dependency in previous studies, and remission of depression has been found to be associated with improvement in ADL and improvement in cognitive status of stroke patients.[32,40–42] In this study, depression was found to significantly predict ADL dependency on univariate analysis, but, given the presence of cognitive impairment in multivariate analysis, did not significantly predict ADL dependency. This could possibly be explained by the fact that in this study, we have only examined the relationship between in-hospital depressive symptoms and short-term functional recovery in the first few months after stroke onset. The nature and duration of post-stroke depressive symptoms not amounting to DSM-IV criteria for defining major depressive disorder may differ in their impact on short- and longer-term functional outcomes.

In our study we found that increasing age was a significant predictor of ADL dependency in univariate but not multivariate analysis. This has also been shown in a previous study,[8] although other studies have reported that increasing age has an adverse prognosis for functional recovery in stroke patients.[6,43]

Our observation of a lack of a significant relationship between lesion type and location and functional dependency agrees with that of an earlier study.[44] Comorbid conditions were also not a significant predictor of dependent living in our study. This has also been reported by other investigators,[43] although Paciaroni *et al* have reported that ischaemic heart disease and cardiac arrhythmias are predictors of serious disability on discharge.[8]

In our study we observed that residual ADL dependence upon planned discharge from hospitals was reduced in patients who received more hours of therapy. This observation supports the hypothesis that more intense therapy is associated with better functional recovery, as has been found in other research studies.[14,15] The optimum level of therapy that patients suffering from different severities of stroke should receive should be further investigated.

In conclusion, poor functional recovery observed in a minority of stroke patients in rehabilitative care in the first few months after stroke is significantly predicted by severe neurological and functional impairment on admission and by cognitive impairment and stroke recurrence. They represent an identifiable group of patients for whom more active or special treatment and rehabilitation strategies aimed at maximising early neurological and functional recovery may potentially be beneficial.

Table 2 Univariate analysis: predictors of ADL dependency (Barthel index ≤50) on planned discharges from hospitals

Baseline neurological variables	ADL dependent $n = 34$	ADL independent ($n = 144$)	*P*	Hazard ratio	95% CI
Lesion type					
haemorrhage	2 (5.9)	21(14.6)		1.00	
infarction	32 (94.1)	123 (85.4)	NS	1.93	0.46, 8.11
Lesion location					
cortical	11 (35.5)	37 (38.0)		1.00	
non-cortical	20 (64.5)	95 (72.0)	NS	0.75	0.35, 1.58
Lesion distribution					
focal	14 (45.2)	63 (47.7)		1.00	
multifocal	17 (54.8)	69 (52.3)	NS	1.43	0.68, 2.99
Recurrence					
present	9 (18.4)	24 (17.1)	<0.01	2.89	1.32, 6.35
absent	25 (81.6)	116 (82.9)		1.00	
Neurological impairment (on admission)					
mild to moderate	17 (50.0)	136 (94.4)		1.00	
severe	17 (50.0)	8 (5.6)	<0.01	5.03	2.50, 10.09
Ryle's tube on admission					
present	13 (38.2)	6 (4.2)	<0.01	4.06	2.01, 8.17
absent	21 (61.8)	138 (95.8)		1.00	
Urinary catheter on admission					
present	2 (5.9)	6 (8.4))	NS	1.87	0.44, 7.89
absent	32 (94.1)	138 (91.6)		1.00	
Post-stroke dysphagia					
present	19 (55.9)	20 (13.9)	<0.01	3.88	1.94, 7.75
absent	15 (44.1)	124 (86.1)		1.00	
Post-stroke urinary incontinence					
present	32 (94.1)	5 (3.5)	<0.01	9.07	2.16, 37.93
absent	2 (5.9)	139 (96.5)		1.00	
Post-stroke aspiration pneumonia					
present	4 (11.8)	1 (1.6)	NS	2.42	0.84, 6.95
absent	30 (88.2)	60 (98.4)		1.00	
Post-stroke seizures					
present	2 (5.9)	1 (0.7)	NS	2.48	0.58, 10.29
absent	32 (94.1)	143 (99.3)		1.00	

NS: not significant

Table 3 Multivariable Cox regression model of predictors of ADL dependency on discharge[a]

Significant variables	*P*	Hazard ratio	95% CI
All patients with planned discharges from hospitals ($n = 78$)			
recurrence of stroke	<0.01	2.70	1.31, 5.53
severe functional dependency (Barthel Index $\leq$50) on admission	<0.05	9.76	1.28, 74.12
cognitive impairment on admission	<0.01	4.11	1.41, 11.95
severe neurological impairment (NIHS score: 13–42) on admission	<0.01	2.70	1.31, 5.53
Subjects with Barthel Index score $\leq$50 on admission receiving therapy ($n = 89$)			
hours of therapy during hospitalisation (controlling for recurrence, Barthel Index on admission, cognitive impairment and NIHS score on admission)	<0.01	0.90	0.87, 0.94

[a]Forward selection with probability of entry at 0.05 and removal at 0.10

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REFERENCES

1 Gresham GE, Alexander D, Bishop DS *et al.* American Heart Association Prevention Conference. IV. Prevention and Rehabilitation of Stroke. Rehabilitation. *Stroke* 1997;28:1522–6.
2 Herrmann N, Black SE, Lawrence J, Szekely C and Szalai JP. The Sunnybrook Stroke Study: a prospective study of depressive symptoms and functional outcome. *Stroke* 1998;29:618–24.
3 Fuh JL, Liu HC, Wang SJ, Liu CY and Wang PN. Poststroke depression among the Chinese elderly in a rural community. *Stroke* 1997;28:1126–9.
4 Zhu L, Fratiglioni L, Guo Z *et al.* Association of stroke with dementia, cognitive impairment, and functional disability in the very old: a population-based study. *Stroke* 1998;29:2094–9.
5 Kase CS, Wolf PA, Kelly-Hayes M *et al.* Intellectual decline after stroke: the Framingham Study. *Stroke* 1998;29:805–12.
6 Johnston KC, Connors AF Jr, Wagner DP *et al.* A predictive risk model for outcomes of ischemic stroke. *Stroke* 2000;31:448–55.
7 Appelros P, Nydevik I and Viitanen M. Poor outcome after first-ever stroke. *Stroke* 2003;34:122–6.
8 Paciaroni M, Arnold P, Van Melle G and Bogousslavsky J. Severe disability at hospital discharge in ischaemic stroke survivors. *European Neurology* 2000;43:30–4.
9 Paolucci S, Antonucci G, Gialloreti LE *et al.* Predicting stroke inpatient rehabilitation outcome. The prominent role of neuro-psychological disorders. *European Neurology* 1996;36:385–90.
10 Alexander MP. Stroke rehabilitation outcome. A potential use of predictive variables to establish levels of care. *Stroke* 1994;25:128–34.
11 Teasell RW, Mcrae MP and Finestone HM. Social issues in the rehabilitation of younger stroke patients. *Archives of Physical Medicine and Rehabilitation* 2000;81:205–9.
12 Teasell RW and Kalra L. What's new in stroke rehabilitation? *Stroke* 2004;35:383–5.
13 Sunderland A, Tinson DJ, Fletcher D, Hewer RL and Wade DT. Enhanced physical therapy improves recovery of arm function after stroke. A randomized controlled trial. *Journal of Neurology, Neurosurgery and Psychiatry* 1992;55:530–5.
14 Bhogal SK, Teasell R and Speechley M. Intensity of aphasia therapy, impact on recovery. *Stroke* 2003;34:987–93.
15 Sivenius J, Pyorala K, Heinonen OP, Salonen JT and Riekkinen P. The significance of intensity of rehabilitation of stroke – a controlled trial. *Stroke* 1985;16:928–31.
16 Kwakkel, Wagenaar RC, Koelman TW, Lankhorst GJ and Koetsier JC. Effects of intensity of rehabilitation after stroke. *Stroke* 1997;28:1550–6.
17 Rodgers H, Mackintosh J and Price C. Does an early increased-intensity interdisciplinary upper limb therapy program following acute stroke improve outcome? *Clinical Rehabilitation* 2003;17:579–89.
18 Lincoln NB, Parry RH and Vass CD. Randomised, controlled trial to evaluate increased intensity of physiotherapy treatment of arm function after stroke. *Stroke* 1999;30:573–9.

19 Lee JH, Snels IA, Beckerman H and Lankhorst GJ. Exercise therapy for arm function in stroke: a randomized controlled trial. *Clinical Rehabilitation* 2001;15:20–31.
20 Martinsson L, Eksborg S and Wahlgren NG. Intensive early physiotherapy combined with dexamphetamine treatment in severe stroke: a randomized, controlled pilot study. *Cerebrovascular Diseases* 2003;16:338–45.
21 Kwakkel G, Wagenaar RC, Kollen BJ and Lankhorst GJ. Predicting disability in stroke – a critical review of literature. *Age and Aging* 1996;2:479–89.
22 Dignan MB, Howard G, Toole JF, Becker C and McLeroy KR. Evaluation of the North Carolina Stroke Care Program. *Stroke* 1986;17:382–6.
23 Dombovy ML, Basford JR, Whisnant JP and Berstrahl E. Rehabilitation for stroke: a review. *Stroke* 1986;17:363–9.
24 De Craen AJ, Heeren TJ and Gussekloo J. Accuracy of the 15 item Geriatric Depression Scale in a community sample of oldest old. *International Journal of Geriatric Psychiatry* 2003;18:63–6.
25 Lim PP, Ng LL, Chiam PC *et al.* Validation and comparison of three brief depression scales in an elderly Chinese population. *International Journal of Geriatric Psychiatry* 2000;15:824–30.
26 Swain DG, O'Brien AG and Nightingale PG. Cognitive assessment in elderly patients admitted to hospital: the relationship between the abbreviated mental test and the mini mental state examination. *Clinical Rehabilitation* 1999;13:503–8.
27 Wade DT and Collin C. The Barthel ADL Index: a standard measure of physical disability? *International Disability Studies* 1988;10:64–7.
28 Ronning OM and Guldvog B. Outcome of subacute stroke rehabilitation. *Stroke* 1998;29:779–84.
29 Muir KW, Weir CJ, Murray GD, Povey C and Lees KR. Comparison of neurological scales and scoring systems for acute stroke prognosis. *Stroke* 1996;27:1817–20.
30 Schlegel D, Kolb SJ, Luciano JM *et al.* Utility of the NIH Stroke Scale as a predictor of hospital disposition. *Stroke* 2003;34:134–7.
31 Pohjasvaara T, Erkinjuntti T, Vataja R and Kaste M. Correlates of dependent living 3 months after ischemic stroke. *Cerebrovascular Diseases* 1998;8:259–66.
32 Pohjasvaara T, Vataja R, Leppavuori A *et al.* Cognitive functions and depression as predictors of poor outcome 15 months after stroke. *Cerebrovascular Diseases* 2002;14:228–33.
33 Tatemichi TK, Desmond DW, Stern Y *et al.* Cognitive impairment after stroke: frequency, pattern and relationship to functional abilities. *Journal of Neurology, Neurosurgery and Psychiatry* 1994;57:202–7.
34 Carter LT, Oliveira DO, Duponte J and Lynch SV. The relationship of cognitive skills performance to activities of daily living in stroke patients. *American Journal of Occupational Therapy* 1988;42:449–55.
35 Shelton FD, Volpe BT and Reding M. Motor impairment as a predictor of functional recovery and guide to rehabilitation treatment after stroke. *Neurorehabilitation and Neural Repair* 2001;15:229–37.
36 Chae J, Johnston M, Kim H and Zorowitz R. Admission motor impairment as a predictor of physical disability after stroke rehabilitation. *American Journal of Physical Medicine and Rehabilitation* 1995;74:218–23.
37 Inouye M, Kishi K, Ikeda Y *et al.* Prediction of functional outcome after stroke rehabilitation. *American Journal of Physical Medicine and Rehabilitation* 2000;79:513–18.
38 Clavier I, Hommel M, Besson G, Noelle B and Perret JE. Long-term prognosis of symptomatic lacunar infarcts. A hospital-based study. *Stroke* 1994;25:2005–9.
39 Modrego PJ, Pina MA, Fraj MM and Llorens N. Type, causes, and prognosis of stroke recurrence in the province of Teruel, Spain. A 5-year analysis. *Neurological Sciences* 2000;21:355–60.
40 Chemerinski E, Robinson RG and Kosier JT. Improved recovery in activities of daily living associated with remission of poststroke depression. *Stroke* 2001;32:113–17.
41 Chemerinski E, Robinson RG, Arndt S and Kosier JT. The effect of remission of poststroke depression on activities of daily living in a double-blind randomized treatment study. *Journal of Nervous and Mental Disease* 2001;189:421–5.
42 Kimura M, Robinson RG and Kosier JT. Treatment of cognitive impairment after poststroke depression: a double-blind treatment trial. *Stroke* 2000;31:1482–6.
43 Jorgensen HS, Reith J, Nakayama H *et al.* What determines good recovery in patients with the most severe strokes? The Copenhagen Stroke Study. *Stroke* 1999;30:2008–12.
44 Jorgensen HS, Nakayama H, Raaschou HO and Olsen TS. Intracerebral hemorrhage versus infarction: stroke severity, risk factors, and prognosis. *Annals of Neurology* 1995;38:45–50.

CONFLICTS OF INTEREST

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