Selection of acute stroke patients for treatment of visual neglect

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Abstract

Although visual neglect is a predictor of poor outcome after stroke, some patients regain independence, whilst others take up considerable rehabilitation resources. Intensive treatment of visual neglect is available and a knowledge of the predictive features in the recovery of these patients would be helpful in the early selection of patients for treatment. A study was therefore carried out to determine the prognosis of patients presenting with visual neglect at two to three days after stroke. Linear logistic regression showed that the initial degree of paralysis (measured by the Motricity Index), the severity of neglect (measured by the Visual Neglect Recovery Index) and the patient's age were the significant predictors of independence (Barthel score 20), mild dependence (Barthel 15-19), and moderate/severe dependence (Barthel 0-14) in surviving patients at three months and at six months. Regression equations correctly predicted 78% of outcomes, and had a sensitivity and specificity for "independence" of 84% and 90% respectively, and a sensitivity and specificity for "moderate/severe dependence" of 89% and 80%. It is suggested that these equations may be useful in selecting comparable groups of patients for randomised controlled trials of treatment of visual neglect.

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Patients with visual neglect due to a stroke ignore relevant visual stimuli on the side opposite their cerebral lesion, when carrying out a task or activity.^{1,2} This may adversely affect many self-care activities and the presence of visual neglect is known to be a predictor of poor outcome in both acute³ and convalescent⁴ stroke patients. Such patients take up considerable rehabilitation resources, although some make a good recovery.

Intensive treatment of visual neglect is available. Trials of treatment are divided on its value^{5,6} but did not match patients in treatment groups according to time after stroke, severity of neglect or prognosis for independence. A knowledge of the predictors of recovery of patients with visual neglect would be helpful in selecting comparable groups of patients for randomised trials of treatment.

Fullerton *et al*⁷ carried out a study which

showed that the initial severity of visual neglect was predictive of outcome. Equations were produced estimating the probability of independence. These could be used to allocate patients to trials of treatment. Their study, however, may have omitted a significant proportion of patients with visual neglect by only using one test of neglect.^{7,8} It may have exaggerated the association of visual neglect with a poor outcome by giving the mean neglect score to patients too ill to be assessed for visual neglect, who constituted a third of their population and of whom over 80% died. Moreover, the categorisation of outcome as recovered, independent, dependent and dead may have diminished the usefulness of the study as the cost of stroke relates mainly to the loss of independence in self-care, rather than to mortality (which occurs early and predictors of which are well known).⁹ Grouping all dependent patients together ignores the implications that the degree of dependency has for service provision. The assessment of self-care used in the study was unstandardised and appeared to exclude washing and dressing. A prognostic study that enabled early identification of the more dependent survivors might be more useful, and thus encourage the development of new therapies to improve outcome.

We therefore carried out such a study. Only the outcome in survivors was considered and "dependent" patients were divided into three groups "mild", "moderate" and "severe", according to their self-care ability as assessed by a standardised measure, the Barthel Index,¹⁰ that notes the presence of disability and estimates its severity, using a checklist of ten items (transfers, walking, continence of faeces and of urine, feeding, washing, dressing, toileting, bathing and climbing stairs). A standard battery of 7 tests, a modified form of the Behavioural Inattention Test^{8,11} was used to increase the detection of patients with visual neglect and the mean neglect score was not given to the patients who were too ill to be assessed for visual neglect.

Method

Patients

A total of 171 consecutive patients mean (SD) age 72.37 (12.11) years, with an acute hemispheric first stroke (69 right hemisphere, 102 left), defined by modified WHO criteria⁸ and admitted to St Bartholomews and Homerton hospitals, were assessed by a clini-

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cian (SPS) two to three days after stroke (table 1). All patients were admitted as emergencies. Patients with subarachnoid haemorrhage were excluded from the study. Patten's criteria were used to define a hemispheric stroke.¹² A total of 156 patients had infarcts and 15 had haemorrhages as assessed by CT brain scan at three to five days (127 patients) or the Guys's diagnostic index¹³ (44 patients). Thirteen patients (8%) had lacunar strokes; 11 of the pure motor hemiparesis variety and two of the sensorimotor type.¹⁴ Of those who were scanned 48 (38%) had no visible lesion, 37 (29%) had cortical lesions, 20 (16%) had deep lesions and 22 (17%) had both. The 30 day case fatality rate was 27%.

Ninety eight patients (50 right hemisphere, 48 left) had visual neglect detected by a standard battery,⁸ 37 had no visual neglect and 36 were too drowsy or aphasic to be assessed for neglect. All patients were followed up at three and at six months to determine outcome, with the following exceptions (table 2): of the patients with visual neglect, five had pre-existing disability that affected their independence in self-care, 11 died of non-stroke related disease, five had second strokes and two refused follow up. Of the patients without neglect, two had pre-existing disability, two died of other disease, one had a second stroke and eight were lost to or refused follow up. There were thus 75 patients with neglect, 24 without neglect whose three month outcome was known.

At three months, 10 of the neglect patients died of their stroke or of the consequences of stroke related immobility. None of those without neglect died. There were thus 65 neglect patients and 24 non-neglect patients alive at three months whose outcome was known.

A further two patients were lost to six month follow up, one died of other disease, one extended their stroke and one died of the consequences of stroke-related immobility.

Of the 36 unassessable patients, 27 were dead at three months, and the rest were severely dependent.

Outcomes

Outcome at three months and at six months was assessed by Wade *et al*'s modification¹⁵ of the Barthel Index which measures independence in self-care, using the checklist of ten

activities of daily living described above. To each of these is allotted a score. The individual scores are summated to give the Barthel score, out of a maximum of 20. Outcome was then categorised in the standard manner¹⁰ as "Independent" (Barthel score 20), "Mild Dependence" (Barthel 15–19), "Moderate Dependence" (Barthel 10–14), "Severe Dependence" (Barthel 0–9).

Clinical assessments

Visual neglect was assessed by a modified version of the Behavioural Inattention Test,¹¹ which had been standardised for patients with acute stroke.⁸ Its severity was measured by the Visual Neglect Recovery Index (VNRI).¹⁶ This expresses performance on six tests from the battery (Pointing to Objects, Meal, Reading a menu, Line cancellation, Star Cancellation and Coin selection) as a percentage of complete recovery from the maximum measurable visual neglect. A score of 0% indicates maximal visual neglect and a score of 100% indicates no visual neglect. Strategies for assessing patients with aphasia have been described elsewhere.⁸

The following features of the neglect syndrome and related disorders were also assessed using standardised definitions and methods¹⁷: hemi-inattention, visual and sensory extinction, allesthesia, and anosognosia. These were recorded in categorical form as Present (1) or Absent (0).

Other neurological features identified by other studies as having prognostic significance for survival or recovery of independence were assessed. These were: level of consciousness, gaze paresis, visual field defect, power loss and proprioception. The level of consciousness was assessed using Oxbury *et al*'s 0–5 grading system.⁹ Gaze paresis, field defect, and proprioception were assessed as described and standardised elsewhere.¹⁷ The assessments were further simplified and recorded in categorical form as impaired (1) or normal (0) for level of consciousness¹⁸ and proprioception¹⁸ and as present (1) or absent (0) for gaze paresis and field defect.¹⁸ Where patients were too drowsy (level of consciousness grade 3–5) or too aphasic to be assessed, this was noted.

Power loss was expressed by the Motricity Index,¹⁹ which converts the MRC grades of power into a figure that represents the percentage of "total motor recovery". This was entered as continuous data.

Statistical analyses

The relationship between the outcome groups (dependent variables) at three and six months and the clinical assessments at two to three days (independent variables) was examined by means of ANOVA for continuous data and by Chi Square tests for categorical data, using a significance level of $p < 0.01$, in view of the number of analyses undertaken. Linear logistic regression was then carried out using the Logist procedure of SAS.²⁰ A "p value for inclusion" of 0.05 was set and the best stepwise solution sought.

Table 1 Patient characteristics

Hemisphere		Infarct	Haemorrhage	Visual neglect	No visual neglect	Unable to be assessed
Right	Left					
69	102	156	15	98	37	36

Table 2 Factors excluding patients from three month follow up.

	Previous disability	Death unrelated to stroke	Subsequent stroke	Refused follow up
Visual neglect	5	11	5	2
No neglect	2	2	1	8

Results

Of the three month survivors 50 were independent, 19 mildly dependent, 10 moderately dependent and 10 severely dependent (table 3). At six months 54 were independent, 16 mildly, seven moderately and seven severely dependent. The severe and moderate groups were amalgamated as their numbers were too low for successful linear logistic regression.

ANOVA and Chi-squared tests showed that at both time points Level of consciousness, Gaze paresis, Visual Field Defect, Hemi-inattention, Visual Neglect Recovery Index and the Motricity Index were the significant predictor variables in survivors. Linear logistic regression found that at both time points, 3 variables made an independent contribution to outcome in survivors: Visual Neglect Recovery Index, Motricity Index and age (table 4).

When each patient was assigned to the outcome group with the highest probability, the predictive accuracy of the statistical model at 3 months was 78%. Ninety per cent of independent and 80% of moderate/severe outcomes were correctly predicted. At six months the model had an overall predictive accuracy of 75%, with 91% of independent and 71% of moderate/severe outcomes being correctly predicted (table 5). Prediction of mild dependence was considerably less accurate, many being predicted to be independent.

Table 3 Numbers of survivors in each outcome category

	Independent	Mildly dependent	Moderately dependent	Severely dependent
Number at 3 months	50	19	10	10
Number at 6 months	54	16	7	7

Table 4 Regression coefficients for significant predictor variables

Variable	3 months			6 months	
	regression coefficient	(b)	significance level	regression coefficient	significance level
Power (MI)	0.0416		<0.0001	0.0375	<0.0001
Neglect (VNRI)	0.0441		<0.0001	0.0381	<0.0001
Age	-0.0967		0.0027	-0.0741	0.0194
Intercept a_1		1.5067			1.0917
Intercept a_2		3.9586			3.3572

The probability, $p(1)$, of a patient being independent at 3 or 6 months is given by the equation $-(a_1 + \{b_1 \times MI\} + \{b_2 \times VNRI\} + \{b_3 \times age\}) p(1) = 1/1 + e$

The probability, $p(2)$, of a patient being mildly dependent is given by the same equation with a different intercept, a_2 .

The probability of moderate/severe dependence is given by $1-p(1)-p(2)$

Table 5 Comparison of predicted and actual outcome at 3 and at 6 months in patients presenting with neglect.

	Predicted outcome					
	at 3 months			at 6 months		
	Barthel 20	Barthel 15-19	Barthel 0-14	Barthel 20	Barthel 15-19	Barthel 0-14
Actual outcome						
Barthel 20	45 (90%)	5 (10%)	0 (0%)	49 (91%)	5 (9%)	0 (0%)
Barthel 15-19	9 (47%)	8 (42%)	2 (11%)	9 (56%)	4 (25%)	3 (19%)
Barthel 0-14	0 (0%)	4 (20%)	16 (80%)	0 (0%)	4 (29%)	10 (71%)

Discussion

Any statistical model which predicts the outcome of stroke should be based on a representative sample of patients, yield a result that makes clinical sense, and be accurate. Preferably, the resultant equation should be simple and the methods used related to standard clinical practice.

The model resulting from our study shows that in a series of patients surviving at least 3 months, the degree of independence is predicted by 3 factors: the severity of weakness at two to three days, the severity of neglect and the patient's age.

This model is based on a representative sample of stroke patients presenting to a district general hospital. The significant predictive factors make clinical sense. Power loss^{3 10 18 21 22} has previously been identified as a prognostic factor as have both the presence⁴ and the severity³ of visual neglect. Motor skills are important in self care, and the difficulties of using a hemiparetic limb in that side of space, or of compensating by using the non-weakened limb in that side of space, would be exacerbated by visual neglect.

Although ANOVA did not show that age was significant on its own, it was significant when taken into account with the other variables in logistic regression. The adverse effect of age has been noted in other studies.^{10 18 21-3} This may reflect loss of neurological reserve after injury to the brain but may also reflect the lower expectations from physicians and therapists for older patients and thus less sustained attempts at active rehabilitation. The level of consciousness was not found to be an independent predictor of outcome. This contrasts with Allen's¹⁸ and Oxbury *et al*'s⁹ studies, for example, which found that any impairment of consciousness, however mild, had a significant effect on outcome. The reason our study did not show this may well be that most patients with impaired consciousness died and were therefore excluded from the study, whereas Allen¹⁸ and Oxbury *et al*⁹ included death as an outcome.

The predictive accuracy of the model was high for independence (sensitivity 84%, specificity 90% at three months) and for moderate/severe dependence (sensitivity 89%, specificity 80%). Prediction of mild dependence was less accurate. The accuracy of prediction in this and other^{3 18 22-4} prognostic studies of stroke may be limited by several factors. Firstly, neither remedial therapy nor medical treatment is likely to have been standardised in the sample of patients examined; although nearly all patients received occupational as well as physiotherapy, none received specialised therapy^{3 6} for visual neglect and many of those who reached a Barthel score of 20 received less therapy than those with worse outcomes. Secondly, the pre-stroke level of independence may not have been clearly established. This may explain why, for example, a significant proportion of patients predicted to be independent had a Barthel score of 18-19, due to pre-existing inability to bath or to climb stairs. Thirdly, factors

such as motivation, known to affect outcome²³ may not be measured.

The predictive equations derived from the model are relatively simple, requiring assessment of only two clinical variables, visual neglect and power. The assessment of power is closely related to the standard clinical method, and the VNRI is based on the Behavioural Inattention Test,¹¹ which is being increasingly used by occupational therapists. The necessary mathematics can be performed by a basic pocket calculator. The equation is a little simpler than those produced by Fullerton *et al*,³ which contain six variables, some of which have to be weighted (Hodkinson's Mental Test Score) and some of which (for example, leg power, arm function) are not standardised measures.

Our study confirmed the findings of Fullerton *et al*³ that the initial severity of visual neglect was a predictor of outcome, and that being "unassessable" for neglect was a good predictor of death. However, our study avoided the possibility of exaggerating the association of neglect with a poor outcome, by not allocating the mean VNRI score to the "unassessables" and by not including death as an outcome. The separation of "dependent" patients into two groups that reflected the practical difficulties of arranging a discharge, enabled us to identify a group in particular need of attention.

Lincoln *et al*²⁵ have recently pointed out the limitations of prognostic studies in predicting exact outcome for individual patients, but stressed their usefulness in targeting a group of patients in need of special intervention. We suggest that our regression equations could be used in such a manner to select patients for randomised controlled trials of treatment of visual neglect.

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