The Influence of Visual Neglect on Stroke Rehabilitation

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Background and Purpose The poor outcome observed in stroke patients with visual neglect may be due to greater stroke severity or nonspecialist management.

Methods The effects of visual neglect were studied prospectively in 150 consecutive stroke patients with comparable stroke pathology and motor severity managed on a stroke unit. A randomized study was subsequently undertaken in 50 stroke patients with visual neglect to evaluate the effectiveness of spatial cueing during motor activity on functional outcome and resource use in these patients.

Results Visual neglect was present in 47 (32%) of a selected group of 146 patients (mean age, 77.0±8.2 years; 42% men) with moderate stroke severity. There were no differences in demography, prestroke function, or motor power in the arm (2.6±1.7 versus 2.3±2.1) or the leg (3.2±1.4 versus 3.0±1.6) on the affected side compared with 99 patients with no visual neglect. Although patients with visual neglect had lower median initial (4 versus 5, $P<.01$) and discharge (14 versus 16, $P<.01$) Barthel Index scores, equal proportions of patients were discharged home (60% versus 65%) or to institutions (34% versus 33%) in both groups. The durations of hospitalization (64 versus 36 days, $P<.001$) and therapy input (47.7 versus 27.8 hours, $P<.01$), however, were significantly greater in patients with visual neglect. The randomized controlled study showed a trend toward higher Barthel scores at 12 weeks (14 versus 12.5, P=NS) and significant reduction in median length of hospital stay (42 versus 66 days) in patients receiving spatiomotor cueing and early emphasis on functional rehabilitation.

Conclusions Patients with visual neglect managed on a stroke unit have similar destination of discharge despite lower Barthel Index scores compared with patients of equal stroke severity who do not have this deficit. Spatiomotor cueing and early emphasis on function can improve outcome and reduce resource use in these patients. (***Stroke*****. 1997;28:1386-1391.)**

Key Words • activities of daily living • neglect • outcome • rehabilitation

A number of studies have suggested that visual neglect is a major cause of disability and handicap in stroke patients that impedes functional recovery and is associated with a poor outcome.[1-8] This is of particular importance in stroke rehabilitation because as many as 20% to 80% of stroke patients may have visual neglect in the postacute phase, regardless of the side of stroke.[9,10] Despite the frequency and negative implications of this deficit, there have been very few studies on interventions aimed at improving visual neglect because of methodological problems.[11,12] The few case studies and small trials undertaken suggest that specific remedial interventions are of equivocal benefit, and although some show an improvement in patients' performance on test batteries or specific measures, there was little improvement in function on activities of daily living (ADL) tasks.[13-23]

Most of the studies on prevalence of visuospatial disorders have used sensitive instruments that detect even mild dysfunction, and it is probable that clinically significant impairment may be less frequent and hence pose fewer problems than suggested by these data.[4-6,9,10] Conversely, patients identified to have visual neglect in routine clinical practice may have a worse prognosis than that suggested by the literature because they are more likely to have severe deficits. Although visuospatial impairments have been shown to be a significant independent variable in logistic regression analyses in various studies, most studies do not specify the extent of neurological damage in patients included or the interaction with other impairments that may have contributed to the poor outcome observed. It is possible that visual neglect, when associated with other impairments, may be indicative of larger areas of neurological damage, resulting in poorer outcome. There are no studies that directly compare outcome between patients with or without visual neglect who have comparable stroke pathology and motor, visual, or cognitive impairments. The settings in which patients with visuospatial deficits included in these studies were managed may also be important. Testing for visual neglect is one of the most difficult aspects of stroke assessment and is frequently omitted in nonspecialist settings.[24] It is possible that poor awareness of perceptual problems may contribute to suboptimum management of these patients in nonspecialist settings and result in poorer outcome. The questions that need to be answered are whether patients with visuospatial neglect have different outcomes than those with comparable stroke severity when managed in specialist settings, and if not, can specific interventions in these patients improve these outcomes.

A prospective study was undertaken to evaluate the effect of visual neglect on outcome in 150 consecutive admissions to a stroke unit in the "middle group" of

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TABLE 1. Measures Used in the Study

Variable	Scoring
MRC grading for power	5=Normal power
	4=Diminished power
	3=Movement against gravity
	2=Movement with gravity eliminated
	1=Flicker when attempting movement
	0=No movement
Proprioception	3=Unable to find thumb, no attempt
	2=Finds arm, leads to the thumb
	1=Misses by <3 in, locates within 5 s
	0=Locates thumb accurately
Balance	3=Unable to sit or maintain sitting balance (side of bed, feet off the ground)
	2=Maintains sitting balance
	1=Maintains standing position, unable to walk
	0=Walks 10 ft (aids, no human support)

MRC indicates Medical Research Council.

stroke patients with comparable motor impairment and stroke severity. This observational study provided the background for a further randomized controlled study in this defined group of patients to evaluate the effectiveness of a rehabilitation intervention targeted at minimizing the functional consequences of visual neglect in improving outcome and reducing resource use in these patients.

Subjects and Methods

Patient Selection

Stroke patients with partial anterior circulation infarction determined according to clinical and radiological criteria were included in the study.[25] The "middle group" of patients was objectively defined on the basis of impairments in power, balance, proprioception, and cognition using a validated scale, which ranged from 1.6 (no deficits) to 6.4 (maximum deficit).[26,27] Patients scoring between 3 and 5 at 1 to 2 weeks after stroke were included in the study because they were known to be sensitive to rehabilitation interventions.[28] This period allowed the patients' medical condition to stabilize before comprehensive assessment was undertaken and the exclusion of patients with transient ischemic attacks or reversible neurological deficit. Patients with hemianopsia or severe dysphasia (restricting communication) were excluded from the study. There is a possibility that some patients with severe visual neglect (which mimics loss of visual fields on the affected side) may have been misdiagnosed as having hemianopsia and excluded from the study because more specific tests to exclude the possibility of pseudohemianopsia were not undertaken.

The Observational Study

All patients were assessed comprehensively for impairments and disabilities at the time of initial assessment. These included measures of motor power, balance, proprioception, cognition, and functional ability in addition to patient demography and stroke characteristics. Motor power was measured using the Medical Research Council scale (Table 1) on the affected side for shoulder extension; extension and flexion at the elbow; dorsiflexion and palmar flexion at the wrist in the arm; and hip, knee, and ankle flexion and extension in the leg. The average score for each affected limb was calculated to give an overall score for the limb, which was used in subsequent analysis. Proprioception was measured by the Thumb Finding Test[26,29] using a validated scoring system based on difficulty in achieving the task (Table 1). Static and dynamic balance was assessed for sitting and standing (Table 1) using validated scales.[26,29]

Patients with visual neglect were identified by comprehensive multidisciplinary assessments. These included clinical tests such as visual and sensory confrontation tests, the line bisection test, and observation of patients during activities using a structured observational test for function. More formal testing in patients suspected to have perceptual problems was undertaken by a trained therapist using the Rivermead Perceptual Assessment Battery (RPAB).[30] The RPAB was developed specifically to assess both right and left hemiplegic stroke patients, with and without speech deficits, and has been used in several previous studies.[4,5,9,14,17] The RPAB is a standardized validated battery of 16 visual perception tests, ranging from simple tasks such as picture, object, and color matching to more complex tasks such as cancellation, figure ground, sequencing, body image, and copying shapes, words, and three-dimensional figures.[30] The standard administration and scoring procedures were used. The criterion for visuoperceptual dysfunction was a score of <2 SD below the normative mean corrected for the patient's intelligence on three or more tests of the battery.[14] In addition to visual neglect, some patients showed evidence of other types of visuospatial dysfunction, which included impairments in matching and sequencing tests, body image, figure ground, and left/right orientation tasks. In keeping with other studies,[4,5,9,14,17,23,29] these patients were not excluded from the study because other visuospatial impairments frequently coexist with neglect in stroke patients due to the nature of the lesion.

The Controlled Trial

The observational study showed that patients with visuospatial neglect had greater functional disability at discharge and greater hospital resource use compared with patients who had no such deficits, despite comparable stroke characteristics and severity of motor deficit. It was hypothesized that outcome and resource use could be improved in these patients if rehabilitation was directed toward reducing the functional consequences of this deficit. Because remedial interventions in previous studies had shown only limited success in restoring function,[13,23] any new intervention needed to be exploratory and based on theoretical principles and local experience. The sample size of any preliminary investigation also was likely to be arbitrary, since the magnitude of the effect of the intervention was not known. It was considered appropriate to undertake a preliminary randomized study in a small number of stroke patients with visual neglect (n=50) defined by the above criteria to evaluate the potential of a different therapy approach in improving outcome in this patient group.

All eligible patients were managed on a stroke rehabilitation unit and were assessed for neurological impairments and functional disabilities. Patients were allocated to conventional therapy input concentrating on restoration of normal tone, movement patterns, and motor activity before addressing skilled functional activity[31] or to a modified approach involving

TABLE 2. Comparison of Patient and Stroke Characteristics of Patients in Middle Prognostic Group With or Without Visual Neglect

	No Perceptual Deficits	Perceptual Deficits	*P*
Patients, n	99	47	
Mean±SD age, y	79.2±7.5	77.0±9.2	NS
Men, n (%)	37 (37)	20 (42)	NS
Right hemisphere, n (%)	43 (43)	32 (68)	.01
Mean±SD MRC power			NS
Arm	2.3±2.1	2.6±1.7	
Leg	3.0±1.6	3.2±1.4	
Median balance score	2	2.5	.01
Median proprioception score	0.5	2	.001
Median MTS (range)	9 (7-10)	8 (7-10)	NS
Median BADL	5	4	.01

MRC indicates Medical Research Council score; MTS, Abbreviated Mental Test score; and BADL, Barthel Index of activities of daily living.

spatiomotor cueing based on the "attentional-motor integration" model[32] and early emphasis on restoration of function. The principle behind this approach was that movements of the affected limb in the deficit hemispace led to a summation of activation of the affected receptive fields of two distinct, but linked, spatial systems for personal and extrapersonal space, resulting in improvements in attentional skills and appreciation of spatial relationships on the affected side.[33,34] With use of this approach in a case study, improvement had been reported not only on test performance but also in ADL function and was greater for willed rather than passive movements.[35]

Treatment of patients in each group was undertaken by different therapists of the unit to prevent "crossover" of treatment techniques. Assessments at entry and at 12 weeks in both groups were undertaken by an independent observer who was unaware of the type of treatment provided.

Assessments and Data Analysis

Outcome measures included mortality, Barthel Index score at discharge, and destination of discharge. The length of hospital stay and the duration of therapy input were also recorded as surrogate measures of resource use. The therapy times included the amount of time spent by a trained senior therapist in formal face-to-face treatment of the patient and excluded time spent in report writing, advice to patients and caregivers, and discussions or negotiations with other professionals or services. The time spent on informal therapy input by rehabilitation nurses implementing ongoing activities prescribed by the therapists was also not included. Comparisons were undertaken using the χ^2 test (with Yates' correction in small samples), Mann-Whitney U test, or t test where appropriate.

Results

Data were collected prospectively in 150 stroke patients meeting the inclusion criteria who were referred to specialist stroke services. Four patients were excluded from subsequent analysis because of stroke extension resulting in greater deficits (n=2) or assessments for visuospatial deficits that were considered inconclusive on review (n=2). Visual neglect was present in 47 of the 146 patients (32%) included in the study (Table 2). There were no significant differences in the demographic characteristics of the patients with or without visual neglect (Table 2), and all patients were previously independent with no significant functional disability or cognitive impairment before the stroke. The median duration between stroke and initial assessment was 8 days, with no differences between the two groups. The median initial Barthel Index score was significantly lower in patients with visual neglect despite comparable motor and cognitive scores (Table 2). A stepwise multiple regression analysis was undertaken on the whole patient group (n=146) using Barthel ADL score on admission as the dependent variable and age, sex, power, side of stroke, balance, proprioception, cognition, previous ADL status, and neglect as independent variables. Of these, only neglect showed a significant association with the initial Barthel ADL score at the time of commencement of rehabilitation ($\beta=-0.17$, $P=.011$, $R^2=.16$).

Although a higher proportion of stroke patients with visual neglect died during rehabilitation, this did not achieve statistical significance (Table 3). Clinical causes of death included pulmonary embolus (n=1), extension of stroke (n=3), and unrelated myocardial infarction (n=1). There were no differences in the discharge destination of survivors between the two groups, with equal proportions being discharged home or to institutional care (Table 3). The functional abilities of patients without visual neglect were significantly better than those with such deficits despite comparable motor recovery in both groups (Table 3). The length of hospital stay and the duration of therapy input were significantly greater in patients with visuospatial deficits (Table 3).

The randomized controlled study included 25 patients in each limb who were comparable for age, sex, and stroke characteristics (Table 4). There were no differences in initial impairments or disability between the two groups (Table 4). The median duration between the acute episode and randomization was 6 days (range, 2 to 14 days). Two patients in the conventional therapy group and 1 in the active intervention group died during the study. Of the 47 survivors, 23 were managed using conventional therapy intervention and 24 using the new approach involving spatiomotor cueing during limb activation and early emphasis on restoration of function. Outcome data was analyzed on an "intention-to-treat" basis and showed that there were no differences between the proportion of patients discharged home or going into institutional care between the two groups (Table 5). This remained true even in the "worst case scenario" when it was assumed that all patients who died would have required institutional care. Despite starting from the same baseline, retesting at 12 weeks showed a significant improvement in the intervention group on the body

TABLE 3. Comparison of Outcome and Therapy Use in Patients in Middle Prognostic Group With or Without Visual Neglect

	No Perceptual Deficits	Perceptual Deficits	*P*
Mortality, n (%)	2 (2)	3 (6)	NS
Discharge home, n (%)	65 (65)	28 (60)	NS
Institutional care, n (%)	32 (33)	16 (34)	NS
BADL in survivors			
Median at discharge	16	14	.01
Median change	10	10	NS
Median MRC at discharge			NS
Arm	2.9±1.8	2.9±2.3	
Leg	4.2±2.1	4.1±1.6	
Median length of hospital stay, d	36	64	.0001
Physiotherapy time per patient, h	18.4±5.7	29.8±6.1	.01
Occupational therapy time per patient, h	9.4±2.9	17.9±4.8	.01

MRC indicates Medical Research Council score; MTS, Abbreviated Mental Test score; and BADL, Barthel Index of activities of daily living.

image and cancellation subtests of the RPAB compared with the control group. Other subtest scores were generally higher in the intervention group, but this difference was not statistically significant. Although there was a trend toward better functional outcome in patients managed using the spatiomotor approach, this fell just short of achieving statistical significance (Table 5). The length of hospital stay was significantly shorter in patients receiving active intervention therapy. The total duration of therapy was not significantly different between the two groups, although patients in the intervention group received significantly less physiotherapy than patients managed using conventional therapy input (Table 5).

Discussion

This study shows that patients with visual neglect have greater functional disability than other stroke patients and take longer to recover despite comparable stroke pathology and severity of motor impairment, even when treated in specialist settings. In contrast to previous studies showing greater institutionalization in these patients, the present data suggest that discharge destination in patients with visual neglect is comparable with that of other patients of equal stroke severity managed on a stroke unit. This is likely to be a result of better communication between professionals, patients, and caregivers, as well as better cooperation between hospital disciplines and community agencies in providing more innovative care packages after hospital discharge.[36,37] In addition, the results of the preliminary randomized investigation suggest that it also may be possible to improve functional recovery and reduce the length of hospital stay in patients with visual neglect by spatial cueing during motor activation and directing therapy toward restoration of function, in addition to concentrating of management of tone and movement patterns during early rehabilitation.

TABLE 4. Patient and Stroke Characteristics of Patients With Visual Neglect Included in Randomized Study on Therapy Intervention

	Control	Intervention	*P*
Patients, n	25	25	
Mean± SD age, y	76.1±9.9	77.9±8.6	NS
Men, n (%)	9 (36)	11 (44)	NS
Right hemisphere, n (%)	17 (68)	16 (64)	NS
Mean±SD power*			NS
Arm	2.1±2.6	2.3±1.9	
Leg	2.8±1.7	3.0±2.2	
Median OPS* (range)	4.4 (3.2-4.8)	4.4 (3.2-4.8)	NS
Median MTS* (range)	9 (7-10)	8 (7-10)	NS
Mean RPAB scores			
Overall (16 subtests)	184.57±43.61	176.8±52.83	
Body image subtest	10.32±1.76	10.21±2.47	NS
Cancellation subtest	31.62±11.33	29.16±15.24	NS
Median BADL (range)*	4 (2-7)	4 (2-12)	NS

MRC indicates Medical Research Council score; OPS, Orpington Prognostic score; MTS, Abbreviated Mental Test score; BADL, Barthel Index of activities of daily living; and RPAB, Rivermead Perceptual Assessment Battery.

*Assessments undertaken at the time of randomization.

The management of patients with visual neglect has presented a significant challenge in stroke rehabilitation. Several studies have shown that outcome is poor in these patients with higher levels of functional disability and institutionalization.[1-8] While some of this can be attributed to the greater severity of stroke in patients who have visuospatial deficits, there is also a probability that management in nonspecialist settings, where visuospatial problems may not be readily identified[24] or appropriately managed, is a significant contributory factor. Management of patients with visuospatial deficits on specialist units may not necessarily improve residual function after stroke because there are no proven therapies currently available for this deficit. There are, however, other mechanisms available on these units that reduce handicap by making it possible for these patients to function satisfactorily in their chosen environment using appropriate adaptations, support, and training for caregivers.[37] This also would explain why there were no differences in the proportion of patients being discharged home between the two groups in the randomized controlled study.

The type of therapy received by patients with visual neglect during their rehabilitation may also be an important consideration. Traditional therapy after stroke has concentrated on the restoration of normal tone and movement patterns, addressing functional recovery via motor activity.[31] This emphasis may be misplaced because there is evidence to suggest that the perceptual

TABLE 5. Comparison of Outcome and Therapy Use in Patients With Visual Neglect Randomized to Different Therapy Interventions

	Control	Intervention	P
Patients, n	25	25	
Mortality, n (%)	2 (8)	1 (4)	
Discharge home, n (%)	14 (56)	16 (64)	NS
Institutional care, n (%)	9 (36)	8 (32)	NS
Mean RPAB scores			
Overall (16 subtests)	199.44±64.87	224.32±55.38	
Body image subtest	9.72±1.33	13.19±1.47	.01
Cancellation subtest	30.12±18.45	37.19±13.10	.01
BADL in survivors			
Median at discharge	12.5 (4-16)	14 (9-18)	NS
Median change	8 (3-14)	10 (6-15)	NS
Median length of hospital stay	66 (24-81)	42 (7-73)	.001
Physiotherapy time per patient, h	22.6±8.0	17.1±4.9	.01
Occupational therapy time per patient, h	16.7±2.9	17.0±2.9	NS

RPAB indicates Rivermead Perceptual Assessment Battery; BADL, Barthel Index of activities of daily living.

component that precedes the motor response determines the success or failure of the motor act.[38] There have been a few studies on specific remedial interventions aimed at treating visual neglect that show some improvement in performance on perceptual test batteries, but this improvement does not translate into better performance on ADL tasks.[14-21,23] It is possible that overemphasis on motor recovery under conditions of "blocked practice" as in repetitive drill,[39] remedial visual or sensory stimulation not directed to functional tasks, and compartmentalization of therapy input may reduce the effectiveness of rehabilitation in patients with visual neglect, resulting in poor outcome. This hypothesis was tested in the randomized controlled study in which the novel approach combined the traditional philosophy of restoration of normal tone and movement with visual and sensory cueing to motor activity on the affected side,[33,34] as well as early emphasis on practical ADL skills during rehabilitation. This emphasis was directed toward activities related to feeding, toileting, personal grooming, and safe mobility. Despite the basic principles of spatiomotor activation being common to all patients in the intervention group, the therapy program was individualized to each patient's need to achieve maximum gain from therapy input. Results suggest that this approach, or its modification, may have the potential of improving functional outcome in stroke patients with visuospatial deficits without increasing therapy input or length of hospitalization.

It is difficult to determine the significance of the improvement in two of the 16 subtests of the RPAB seen in this study. There is a high possibility that this may be a statistical anomaly because of the large number of tests undertaken. On the other hand, it could be speculated that improvements in RPAB performance reflect improved appreciation of personal and extrapersonal space in these patients, which may be responsible for the trend toward better functional outcome. This hypothesis, however, cannot be sustained by the data presented, since there is no evidence to suggest that spatiomotor cueing is specifically effective in overcoming visual neglect. Further research is needed on developing better definitions of models to study the interactions between neglect, attentional activities, cueing, and appreciation of personal and extrapersonal space in stroke.

A limitation of this study is the relatively small size (n=50) of the randomized controlled component. It is important to remember that the study was a preliminary investigation with well-defined inclusion criteria for stroke pathology and impairments and that the sample size was dictated by the availability of appropriate eligible patients because of these well-defined criteria of inclusion. Although the new intervention had a sound theoretical basis, its feasibility, logistics, or acceptability in practice were not known at the beginning of the study. The size of expected effect due to the intervention also could not be estimated because of the lack of previous data. Another source of error is the possibility of "cross over" of interventions because these patients were managed in the same setting. Precautions were taken to reduce bias by using different teams, an independent observer for assessments and data collection, and a fixed assessment time point after stroke rather than outcome at discharge. Despite these limitations, it is important to remember that all previous studies have been undertaken as case studies or in sample sizes smaller than the present study.

The study provides valuable information which shows that although patients with visual neglect have greater functional disability after stroke, rehabilitation on a stroke unit enables an equal proportion of these patients to return home as those without such deficits. It also shows that spatiomotor cueing during active limb activation and early rehabilitation emphasis on functional recovery improves outcome and resource use in patients with visual neglect. The therapy, however, comprises a "black box" of interventions, and it is not clear from this study which of the individual components is responsible for the effects observed. Similarly, there continue to be questions about the specificity of the approach in managing visual neglect, which needs to be investigated further. The study nevertheless provides a basis for developing therapy techniques based on the "attentional-motor integration" model and provides background information necessary for designing future studies to evaluate the effectiveness of these interventions.

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