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**Stroke Rehabilitation : A Cost-Effectiveness
Analysis of a Placement Scheme**

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DISCUSSION PAPER 140

**STROKE REHABILITATION:
A COST-EFFECTIVENESS ANALYSIS
OF A PLACEMENT SCHEME**

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ABSTRACT

The Leeds Stroke Rehabilitation Placement Scheme (SRPS) provides short-term intensive support for vulnerable stroke patients on discharge from hospital. A previous study at one year post stroke established the benefits of this community support, demonstrating that patients involved in the scheme were more likely to maintain their three-month post stroke functional ability than patients discharged directly home, as is conventional.

Given the scarcity of resources, however, it is important to demonstrate not only the effectiveness of an intervention but also the cost-effectiveness, in order to ensure that resources are allocated efficiently. The aim of this study was to combine the previously reported effectiveness data with newly gathered cost information, to carry out a cost-effectiveness analysis of the SRPS.

The results show that the SRPS attained a unit increase in functional ability, as given by the Barthel Activities of Daily Living Index, at lower cost (£586.85) than the alternative of discharging patients directly home (£5859.48). Although methodological problems and limitations in the data allow only tentative conclusions to be made, the study does highlight the practical problems encountered in the field of cost-effectiveness analysis and makes a number of recommendations to guide future evaluations of stroke rehabilitation services.

INTRODUCTION

Stroke, or cerebrovascular accident (CVA), is a common disorder which is responsible for considerable mortality and morbidity. It is a debilitating disease, resulting from a disturbance of the blood supply to a section of the brain, with symptoms including hemiparesis (loss or impairment of use of a limb), hemiplegia (paralysis of one side of the body), speech disorders, balance problems, visual and perceptual problems, incontinence, depression, and loss of memory.^{1,2} The rehabilitation of stroke victims focuses on the resulting disabilities and aims to restore the patients to their fullest possible physical, psychological and social capability, in order to maximise life satisfaction for both the patients and their carers.^{2,3}

Conventionally, stroke patients referred to the Chapel Allerton Hospital in Leeds for intensive rehabilitation receive medical care and physical, occupational and speech therapy, as required. They also have access to a social worker. When staff at the unit believe that patients have gained as much benefit from their treatment as possible, and when suitable arrangements have been made, they are discharged. The majority return to their homes but some, whose progress has been exceptionally poor, are referred back to acute hospitals or enter nursing homes. Once home, patients are followed-up in resettlement clinics and by health visitors, and receive hospital and community services where necessary.

The Stroke Rehabilitation Placement Scheme (SRPS), implemented in 1983 and funded from joint finance, is an addition to this conventional treatment, providing patients with short-term, intensive community support upon discharge from the rehabilitation unit. The scheme is aimed at the more vulnerable sufferers of stroke who no longer require coordinated inpatient rehabilitation but whose condition is felt likely to deteriorate if discharged directly home, such as those living alone. In the absence of the SRPS, such patients may be kept in the rehabilitation unit longer than necessary until suitable arrangements for their discharge are made. This imposes unnecessary costs on the health service and prevents the allocation of their bed to someone in greater need. The SRPS is managed by the SRPS Occupational Therapist (SRPS OT),

who is responsible for recruitment and training of scheme carers, organisation, monitoring and guidance of placements, and is on-call 24 hours a day. The SRPS OT acts as a link between the hospital and the community, extending the influence of the rehabilitation unit.

SRPS participants are discharged into the home of a trained scheme carer for a period of placement, before returning to their own homes. In general, these placements aim to consolidate techniques needed to achieve maximum independence, discover and rectify potential problems patients may face upon return home, and provide both practical and emotional support for patients who, for the first time, may have to cope with physical disability, communication problems and impaired intellectual functioning away from the security of hospital. At the end of a placement, the carer may visit the patient at home, to help them settle in and to minimise any problems which may be encountered. In some instances, if a patient is unwilling to stay with a carer or if a full placement is felt unnecessary, the carer may be required to visit a patient who has been discharged directly home, with no actual placement taking place.

A prospective, controlled study by Geddes et al⁴⁻⁶ established the benefits of the SRPS compared to patients who were discharged directly home, demonstrating that placed patients were more likely to maintain their three-month post stroke functional ability, as given by the Barthel Activities of Daily Living Index, than were the control group. The experimental group showed a statistically significant increase in Barthel score between three and 12 months post stroke (mean scores 73.0 and 87.0 respectively), whilst the control group showed no significant improvement (mean scores 74.4 and 75.7 respectively). The authors did not employ a randomised study design but carried out a pragmatic study of actual service provision. Randomisation would have caused ethical problems relating to the exclusion of individuals who, in the absence of the trial, would have been eligible for placement on the SRPS. The authors state that, "While recognising the limitations of this small study, it is suggested that the use of trained lay carers and a key worker can maximise the benefits gained by intensive hospital rehabilitation."⁵

This gain in outcomes, however, can only be achieved with increased expenditure and, since NHS resources are finite, the provision of the SRPS must be associated with opportunities forgone elsewhere. In order to ensure that resources are being directed towards those services which generate the greatest benefit, adequate cost-effectiveness information is needed. The aim of this study was to combine the outcome data published by Geddes et al with retrospectively collected cost data, to undertake a CEA and determine whether or not the SRPS is more cost-effective than discharging patients directly home.

ECONOMIC EVALUATION

Burden of Disease

"No single medical measure would make such a contribution to the quality of life in old age as the prevention of stroke. The continuing decline in the incidence of stroke might suggest that we are on the road to achieving this. But this has not been accompanied by a change in prevalence which has remained more or less constant over the past several decades as a result of major improvements in long term survival following cerebral infarction."⁷

The Oxford Community Stroke Project⁸ reported a total annual incidence of 2.2 per 1,000 population, including recurrent cases, and an annual incidence of first ever stroke of 1.95 per 1,000 population, approximately 100,000 new cases each year. Prevalence estimates suggest that 3 to 4 times that many people in the community are suffering from the after-effects of stroke at any one point in time.⁹ Stroke is the third leading cause of death in the UK, accounting for approximately 12% of mortality from all causes in England and Wales, yet the major social and economic burden of stroke arises from the resulting disability, with survivors requiring intensive, time-consuming and expensive rehabilitation in an attempt to improve their independence.^{1-3,10}

It has been estimated that stroke accounts for approximately 4% of all NHS expenditure each year.² Isard & Forbes,⁹ in a study of stroke in Scotland in 1988, estimated that CVA was responsible for 5.5% of total hospital costs and 4.3% of total

NHS costs in Scotland. The Office of Health Economics found, in 1985, that 3.9% of the total NHS budget was spent on CVA. Their calculations, however, do not include expenditure on community support or anti-hypertensive drugs, so this figure can be taken as a minimum.¹¹ Stroke patients occupy approximately 12% of general medical ward beds and an estimated 12% of stroke survivors are in institutional care one year post stroke.^{2,12} The incidence of stroke increases with age, with 75% of strokes occurring in those over 65 years of age.^{1,2} This heavy burden on hospital and community services is, therefore, likely to increase given the increasing number of elderly persons in the population and the increasing survival after stroke.^{13,14} Expenditure on this scale needs to be justified.

Cost-Effectiveness Analysis

Cost-effectiveness analysis (CEA) is concerned with technical efficiency - the maximisation of output from a given level of resources. It involves the systematic comparison of the costs (in monetary units) and the outcomes (in 'natural' units) of alternative health care interventions, providing information to enable priorities to be set and resources to be allocated efficiently between competing services. Alternatives which generate the greatest benefit for a given level of resources should take priority over those that generate less.¹⁵⁻¹⁷

The economic burden of stroke, which falls on the health service, the patients and their families, and society as a whole, is substantial, yet there is little cost-effectiveness evidence to ensure that value for money is being obtained.^{2,3,18-20} Wade et al²¹ in a controlled trial of a home care service available for the first six months post acute stroke, whilst not considering costs, clearly demonstrated the need to evaluate new services. The authors found that the trial group (n=440) utilised more hospital bed days and demonstrated functional recovery and emotional adjustment to stroke equal to that of the control group (n=417). The extra expenditure allocated to the home care service appeared to have been an unnecessary use of resources and they conclude that, "Care should be taken before expanding domiciliary services to decrease hospital use."

A BIDS search was undertaken for articles, written in the English language and published between 1981 and 1993. Key words: *stroke rehabilitation, cost, economics*. The majority of articles which evaluated the cost of stroke examined national resource use only, as summarised above. Only six articles were found to have evaluated the costs of specific rehabilitation interventions, three US studies²²⁻²⁴ two Swedish^{25,26} and one study in New Zealand.²⁷ No UK studies were found.

Methodological problems weakened most of these six studies and it was not possible to compare them with each other or with the SRPS as they varied greatly, providing differing services, evaluating different costs and outcomes, being based in a number of different settings and being provided by a range of different professionals. They do, however, help to highlight the severe lack of good quality cost-effectiveness information in the area of stroke rehabilitation, particularly in the UK, and the need for more standardised analysis to allow comparisons to be made.

METHODOLOGY

Study Design

An economic evaluation was carried out comparing the costs and outcomes of patients discharged onto the SRPS with those of patients discharged directly home, as is conventional. The study combined outcome data prospectively collected by Geddes et al^{4,5} for patients admitted to the rehabilitation unit between December 1984 and March 1986 (group X), and cost data retrospectively collected for patients discharged from the unit between April 1992 and March 1993 (group Y). This requires the assumption that the two patient groups, X & Y, both containing cases and controls, are similar in all respects. Group Y involved patients *discharged* from the unit, rather than *admitted* as used by Geddes et al, because summary information held at the unit was presented by discharge, rather than admission, date.

Two categories of patient were identified by Geddes et al. Category 1 patients are those who have yet to return home following their stroke. They are referred to the rehabilitation unit from the acute hospital they were admitted to following the onset

of stroke. Category 2 patients are those who have returned home but who have been referred back to the hospital sector for further rehabilitation because they have suffered a set-back or have been unable to cope at home. Geddes et al included only category 1 patients who were admitted to the unit diagnosed with stroke, and who were available for one year post stroke follow-up. Of a total of 92 group X stroke patients, 10 placed patients and 61 unplaced patients were found to be eligible for inclusion. Following the same eligibility criteria, of a total of 56 group Y stroke patients, eight placed patients and 41 unplaced patients were found to be eligible. A further group Y placement was included because, although discharged from the unit before April 1992, a proportion of the patient's placement fell into the period under study, giving a total of nine placements.

Costs

In order to calculate the cost of alternative interventions under study, all resources used by study participants must be recorded and combined with the relevant unit costs. The resources used by stroke patients will include those associated with hospitalisation, rehabilitation, long-term institutional care and community services. The SRPS is likely to influence the use of such resources in a number of ways. The scheme may result in decreased lengths of stay at the rehabilitation unit and, by improving the functional ability of patients, it may bring about lower demand for community services, lower re-admission rates, and less need for long-term institutional care, than would otherwise have been the case. Alternatively, decreased lengths of stay may be associated with an increase in the use of community services or an increase in the burden placed on patient's families. It is important, therefore, to evaluate not just the resources required to provide the scheme itself, but also to track resource use at the rehabilitation unit and after discharge.

To cost group Y, resources explicitly considered in this study were inpatient days at the rehabilitation unit, use of remedial therapy services at the unit (speech, occupational, and physiotherapy), and use of the SRPS by the placement group. The aim was to calculate the total expenditure on each patient, from the point of admission

to the unit to the point of discharge, for unplaced patients, or to the end of placement, for placed patients. Individual use of remedial services was calculated to enable a more detailed comparison of resource use at the unit, rather than employing a flat rate cost per day for patients who may require very different amounts of care. Longer term analysis proved impossible, given the time available (three months), and the retrospective nature of the study.

As well as recording the direct costs of a service, economic evaluations should include measures of indirect and intangible costs. Indirect costs refer to productivity losses as a result of premature death or disability and intangible costs refer to the pain and suffering associated with disease. For many stroke studies it is reasonable to assume that indirect costs will be relatively insignificant given that 75% of stroke victims are over the age of 65 and, therefore, no longer in productive employment.¹⁸ Although the rehabilitation unit does not normally admit patients over the age of 65, it is still reasonable to assume that such costs will be relatively small because mortality rates, and therefore production losses, are lower in younger stroke patients. It is also true that changes in indirect and intangible costs will be picked up in the measurement of outcomes, for example any improvement in the pain or suffering of a patient (decrease in intangible costs) will be shown as an increase in benefits, and hence such costs are not considered explicitly in this paper.

Outcome Measures

A variety of outcome measures are used to evaluate the success of stroke rehabilitation, with activities of daily living (ADL) being the most common. A patient's ADL functioning is of great importance because of the influence it has upon many factors in a patient's life, including accommodation requirements, social activities, and employment capabilities. Of the many ADL scales in existence, the Barthel Activities of Daily Living Index (BI) is considered the best global measure of functional ability for classification purposes.²⁸⁻³¹ The BI has been formally tested and found to be valid and reliable as compared to other ADL scales.³²⁻³⁷

Geddes et al measured the BI score of all group X study patients at three and twelve months post stroke. The first measurement was taken at three months in an attempt to control for the fact that most survivors of stroke make some 'spontaneous' improvement during the first three months following a stroke, regardless of whether or not they receive formal rehabilitation.^{2,3,38}

The BI, however, does not adequately cover all outcome variables relevant to the measurement of improvement after stroke.^{31,39} Stroke has a considerable impact on many dimensions of life, not just on ADL, and ideally physical, social, and psychological functioning should be assessed. In order to capture a wider range of outcomes, Geddes et al analysed social activities pre stroke and one year post stroke using the Frenchay Activities Index,^{28,40} and frequency of depression on admission and one year post stroke using the Wakefield Depression Inventory.⁴¹ They reported no evidence of any statistically significant differences in outcome between the placed and unplaced patients, on either of the two scales. The major affect of the SRPS was seen in the area of physical functioning and hence it was felt valid to concentrate on the BI as the measure of outcome.

RESULTS

Patients

Group X and group Y patients were compared to determine whether it is reasonable to assume that the two groups are similar in all respects. The percentage of patients placed on the SRPS, mean length of stay at the unit, and the percentage of patients living alone did not differ substantially. There was a large difference in mean age, with group X being on average much older than group Y (mean age 68 and 53 respectively). This may reflect policy changes adopted since Geddes et al undertook their study. The unit tends to admit relatively young patients (65 years and under) classified as moderately/severely disabled. It does not generally admit the most severe cases or those who are too frail, since neither group would benefit from intensive rehabilitation. It is possible that some of the more elderly patients admitted in the past gained little from their stay and the unit has since admitted fewer patients in that age

group. A smaller percentage of male patients was found in group X than in group Y (48% and 62% respectively). In general more men than women suffer strokes, so the proportion of men in group Y is reasonable. Women, however, with greater life expectancy than men, tend to suffer more strokes much later in life and, therefore, it is possible that there is a more even split in group X due to the higher mean age.

In order to be able to attribute changes in outcome to the intervention under study, it is necessary to ensure that the experimental and control groups are similar in all respects apart from the intervention. Comparing cases with controls in both group X and group Y revealed only one important difference. A greater percentage of cases (60% group X, 78% group Y) than controls (18% group X, 17% group Y) were living alone. This, however, is only to be expected given that living alone is one criteria for referral to the SRPS. Geddes et al state that, "Although representing a biased sample of the stroke population, there was no suggestion that the rehabilitation outcome of these patients was expected to be particularly favourable, rather the reverse."⁵

Costs - Group Y

Gross salaries (including national insurance and superannuation) and the average inpatient day cost at the rehabilitation unit were provided by the Leeds General Infirmary. The hourly pay for each grade of therapist was calculated on the basis of a 36 hour week and a 46 week year and applied to data on patient contacts, giving an average cost for remedial therapy of £1,019.93 per unplaced patient and £823.59 per placed patient. The average cost of an inpatient day at the unit was £92.66 after adjustment to exclude remedial therapy staff costs and so avoid double counting.

For unplaced patients, mean length of stay at the unit was 71.2 days giving an average inpatient cost of £6597.39 per patient. Adding average remedial therapy staff costs of £1,019.93 gives an average cost of £7,617.32 per unplaced patient, for the period from admission to the unit until discharge.

The costs generated by the nine placed patients were provided by Leeds Social

Services and are shown in table 1. The SRPS overhead costs include the SRPS OT's salary and the cost of advertising to recruit scheme carers. These costs are apportioned between 14 placements since this was the total number of placements supervised by the SRPS OT during the 1992/3 financial year. Table 1 shows that the average cost per placed patient, from admission to the unit until discharge from placement, was £8,215.85, only 8% higher than the cost of the unplaced patients.

Table 1 Total cost of each placed patient (£)

	Place- ment	Travel expenses	Over- heads	Reme- dial therapy	Inpatient stay	Total cost per patient
1	432.08	9.20	707.40	823.59	2872.46	4844.73
2	176.66		707.40	823.59	7412.80	9120.45
3	678.40	158.03	707.40	823.59	4262.36	6629.78
4	651.56	370.18	707.40	823.59	7320.14	9872.87
5	882.94		707.40	823.59	3521.08	5935.01
6	132.00		707.40	823.59	6393.54	8056.53
7	370.47		707.40	823.59	6115.56	8017.02
8	370.47		707.40	823.59	8154.08	10055.54
9	1057.74	19.25	707.40	823.59	8802.70	11410.68
Total cost	4752.32	556.66	6366.60	7412.31	54854.72	73942.61
Average cost	528.04	61.85	707.40	823.59	6094.97	8215.85

Outcomes - Group X

Geddes et al found that the experimental group showed a statistically significant increase in Barthel score between three (B3) and twelve (B12) months post stroke, whilst the control group showed no significant improvement. Statistical analysis was carried out using the Wilcoxon Matched Pairs Signed Rank Test and the Wilcoxon Test for two independent samples. Mean BI scores are given in table 2.

Table 2 Barthel scores - Group X

	Unplaced	Placed
Mean B3	74.4	73
Mean B12	75.7	87

Cost-Effectiveness Analysis

When comparing two or more interventions, if the most effective programme is the least costly then it takes priority. This was not the case for the SRPS, which generated greater benefit but cost more than the alternative. It can be shown, however, that the scheme generated, on average, a unit increase in BI score at a cost of only £586.85, as compared to £5859.48 for the unplaced group (table 3).

Table 3 Costs and outcomes combined

	Unplaced	Placed
Mean cost (group Y)	£7617.32	£8215.85
Mean change in BI (group X)	1.3	14
Mean cost per unit increase in BI	£5859.48	£586.85

DISCUSSION

The result that the SRPS generated a unit increase in BI score at lower cost than the alternative, does not prove the scheme's cost-effectiveness. Problems with the methodology of the study and the lack of comprehensive data weaken the ability to reach any conclusions. Combining outcome data with cost data derived from different

sets of patients is questionable, particularly given the differences found between the two patient groups. The retrospective collection of cost data is problematic, since there is no guarantee that the information obtained from medical records is accurate or complete. Both group X and Y involved inadequate sample sizes, particularly for the placed groups, and with only 10 to 15 patients undertaking a placement each year the problem of sample size can only be improved by increasing the study period. The exclusion of data on outpatient therapy services, other community services and long term institutional care is an important omission given that one potential advantage of the SRPS is the reduction in need for such services following discharge from placement.

To improve upon the methodological problems encountered in this study and to ensure that all relevant costs and benefits are included, future studies need to assess costs and benefits simultaneously, prospectively, and over a reasonable length of time. This would enable more accurate data collection and more detailed follow-up, to better assess longer-term resource use and the indirect and intangible costs incurred. The ideal study design would be a randomised controlled trial which, with costs prospectively collected alongside, would enable both the clinical and cost-effectiveness of a service to be established.

CEA provides valuable information for both purchasers and providers of a service. A provider who is able to present evidence of the cost-effectiveness of their service will be better equipped, when attempting to sell to purchasers, than competitors who have no such evidence. Proof of cost-effectiveness will help to ensure that efficient

providers are selected and inefficient providers rejected, thereby enhancing the overall efficiency with which NHS resources are allocated. Evaluations should take into consideration the problems of this study and the recommendations made, to ensure cost-effectiveness can be adequately demonstrated.

REFERENCES

1. Meredith S. Stroke: mishap's crippling consequences. *Hospital Doctor*. 20 February 1992.
2. Department of Health. *Stroke rehabilitation*. Effective Health Care Bulletin No 2. University of Leeds, 1992.
3. Langton Hewer R. Rehabilitation after stroke. *Q J Med* 1990; **76**: 659-674.
4. Geddes JML, Clayden AD, Chamberlain MA. *The Leeds Family Placement Scheme for stroke patients*. Leeds: Rheumatology and Rehabilitation Research unit, 1987.
5. Geddes JML, Clayden AD, Chamberlain MA. The Leeds Family Placement Scheme: an evaluation of its use as a rehabilitation resource. *Clin Rehabil* 1989; **3**: 189-197.
6. Geddes JML, Chamberlain MA, Bonsall M. The Leeds Family Placement Scheme: principles, participants and postscript. *Clin Rehabil* 1991; **5**: 53-64.
7. Garraway M. Stroke rehabilitation units: concepts, evaluation, and unresolved issues. *Stroke*. 1985;16:178-181.
8. Bamford J, Sandercock P, Dennis M, et al. A prospective study of acute cerebrovascular disease in the community: the Oxfordshire Community Stroke Project 1981-1986. 1. Methodology, demography and incident cases of first-ever stroke. *J Neurol Neurosurg Psychiatry*. 1988;51:1373-1380.
9. Isard PA, Forbes JF. The cost of stroke to the National Health Service in Scotland. *Cerebrovasc Dis*. 1992;2:47-50.
10. Bonita R. Epidemiology of stroke. *Lancet*. 1992;339:342-347.
11. Notes and News. The cost of treating stroke. *Lancet*. 1988;30 July:291-292.
12. Legh-Smith J, Wade DT, Langton-Hewer R. Services for stroke patients one year after stroke. *J Epidemiol Community Health*. 1986;40:161-165.
13. Dombrov ML, Sandok BA, Basford JR. Rehabilitation after stroke: a review. *Stroke*. 1986;17:363-368.
14. Thorngren M, Westling B. Rehabilitation and achieved health quality after stroke. A population-based study of 258 hospitalized cases followed for one year. *Acta Neurol Scand*. 1990;82:374-380.

15. Drummond MF. *Principles of economic appraisal in health care*. Oxford Medical Publications, 1990.
16. Cohen D, Henderson J. *Health prevention and economics*. Oxford University Press, 1988.
17. Weinstein M, Stason W. Foundations of cost-effectiveness analysis for health and medical practices. *N Engl J Med* 1977; **203**: 937-938.
18. Drummond MF, Ward GH. The financial burden of stroke and the economic evaluation of treatment alternatives. In: Rose FC ed. *Stroke: epidemiological, therapeutic and socio-economic aspects*. International Congress and Symposium Series, No 99. London: Royal Society of Medicine Services, 1986: 147-162.
19. Johnston MV, Keith RA. Cost-benefits of medical rehabilitation: review and critique. *Arch Phys Med Rehabil* 1983; **64**: 147-154.
20. McKenna M, Maynard A, Wright K. *Is rehabilitation cost-effective?* York: Centre for Health Economics Discussion Paper 101, 1992.
21. Wade DT, Langton-Hewer R, Skilbeck CE, et al. Controlled trial of a home-care service for acute stroke patients. *Lancet*. 1985;1:323-326.
22. McGinnis GE, Osberg JS, Seward ML, et al. Total charges for inpatient medical rehabilitation. *Health Care Financing Rev*. 1988;9:31-40.
23. Albrecht GL, Harasymiw SJ. Evaluating rehabilitation outcome by cost function indicators. *J Chronic Dis*. 1979;32:525-533.
24. Osberg JS, Haley SM, McGinnis GE, DeJong G. Characteristics of cost outliers who did not benefit from stroke rehabilitation. *Am J Phys Med Rehabil*. 1990;69:117-125.1.
25. Thorngren M, Westling B. Utilization of health care resources after stroke. A population-based study of 258 hospitalized cases followed during the first year. *Acta Neurol Scand*. 1991;84:303-310.
26. Melin AL, Hakansson S, Bygren LO. The cost-effectiveness of rehabilitation in the home: a study of Swedish elderly. *Am J Public Health*. 1993;83:356-362.
27. Blackbeard RR, Seeman HMI. Rehabilitation cost effectiveness of stroke. *New Zealand Med J*. 1990;14 March:109.

28. Wade DT. Assessing disability after acute stroke. In: Rose FC ed. *Stroke: epidemiological, therapeutic and socio-economic aspects*. International Congress and Symposium Series, No 99. London: Royal Society of Medicine Services, 1986: 101-114.
29. Wade DT. Evaluating outcome in stroke rehabilitation. *Scand J Rehabil Med* 1992; **26**: 97-104.
30. Mahoney FI, Barthel DW. Functional evaluation: the Barthel Index. *Md State Med J* 1965; **14**: 61-65.
31. Shah S, Vanclay F, Cooper B. Improving the sensitivity of the Barthel Index for stroke rehabilitation. *J Clin Epidemiol* 1989; **42**: 703-709.
32. Collin C, Wade DT, Davies S, Horne V. The Barthel ADL Index: a reliability study. *Int Disabil Stud* 1988; **10**: 61-63.
33. Wade DT, Langton Hewer R. Functional abilities after stroke: measurement, natural history and prognosis. *J Neurol Neurosurg Psychiatry* 1987; **50**: 177-182.
34. Gresham GE, Phillips TF, Labi MLC. ADL status in stroke: relative merits of three standard indexes. *Arch Phys Med Rehabil* 1980; **61**: 355-358.
35. Woolfe CDA, Taub NA, Woodrow EJ, Burney PGJ. Assessment of scales of disability and handicap for stroke patients. *Stroke* 1991; **22**: 1242-1244.
36. Shinar D, Gross CR, Bronstein KS et al. Reliability of the activities of daily living scale and its use in telephone interview. *Arch Phys Med Rehabil* 1987; **68**: 723-728.
37. Wade DT, Collin C. The Barthel ADL Index: a standard measure of physical disability? *Int Disabil Stud* 1988; **10**: 64-67.
38. Skilbeck CE, Wade DT, Langton Hewer R, Wood VA. Recovery after stroke. *J Neurol Neurosurg Psychiatry* 1983; **46**: 5-8.
39. Fletcher AE, Bulpitt CJ. Quality of life after a stroke. In: Rose FC ed. *Stroke: epidemiological, therapeutic and socio-economic aspects*. International Congress and Symposium Series, No 99. London: Royal Society of Medicine Services, 1986: 115-121.
40. Holbrook M, Skilbeck CE. An activities index for use with stroke patients. *Age Ageing* 1983; **72**: 166-170.
41. Wade DT, Legh-Smith J, Langton Hewer R. Effects of living with and looking after survivors of a stroke. *Br Med J* 1986; **293**: 418-420.