

A Randomized Controlled Trial of Rehabilitation at Home After Stroke in Southwest Stockholm

L. Widén Holmqvist, RPT, PhD; L. von Koch, RPT; V. Kostulas, MD, PhD; M. Holm, RPT, MSc; G. Widsell, OT; H. Tegler, SLP; K. Johansson, SLP; J. Almazán, RN; J. de Pedro-Cuesta, MD, PhD

Background and Purpose—This study describes the methodology, patient outcome, and use of hospital and rehabilitation services at 3 months of a population-based randomized controlled trial. The purpose was to evaluate rehabilitation at home after early supported discharge from the Department of Neurology, Huddinge Hospital, for moderately disabled stroke patients in southwest Stockholm.

Methods—The patients were eligible if they were continent, independent in feeding, had mental function within normal limits, and had impaired motor function and/or aphasia 1 week after stroke. Patients were randomized either to early supported discharge with continuity of rehabilitation at home for 3 to 4 months or to routine rehabilitation service in a hospital, day care, and/or outpatient care. The home rehabilitation team consisted of two physical therapists, two occupational therapists, and one speech therapist; one of the therapists was assigned as case manager for the patient. The rehabilitation program at home emphasized a task- and context-oriented approach. The activities were chosen on the basis of the patient's personal interests. Spouses were offered education and individual counseling. A total of 81 patients were followed up for a minimum of 3 months. Patient outcome was assessed by the Frenchay Social Activity Index, Extended Katz Index, Barthel Index, Lindmark Motor Capacity Assessment, Nine-Hole Peg Test, walking speed over 10 m, reported falls, and subjective dysfunction according to the Sickness Impact Profile. Patient use of hospital and home rehabilitation service and patient satisfaction with care were studied.

Results—Overall there were no statistical significant differences in outcome. Multivariate logistic regression analysis suggested a systematic positive effect for the home rehabilitation group in social activity, activities of daily living, motor capacity, manual dexterity, and walking. A considerable difference in resource use during such a 3-month period was seen. A 52% reduction in hospitalization was observed: from 29 days in the routine rehabilitation group to 14 days in the home rehabilitation group. Patient satisfaction was in favor of the latter group.

Conclusions—Early supported discharge with continuity of home rehabilitation services for the majority of moderately disabled stroke patients during the first 3-month period after acute stroke is not less beneficial than routine rehabilitation and can be a rehabilitation service of choice if follow-up at 6 and 12 months confirms the suggested effectiveness and considerable reduction in use of health care. (*Stroke*. 1998;29:591-597.)

Key Words: clinical trials ■ stroke management ■ stroke outcome ■ stroke rehabilitation

In Sweden, because 95% of patients with acute stroke are admitted to a hospital,¹ most of the initial rehabilitation is centered around a time spent in the hospital. The cost of hospital and outpatient care and social service accounts for 76% of the overall Swedish stroke cost.² There is a rapidly growing body of data from randomized controlled trials on the effect of various aspects of stroke prevention and management. Although in recent years there has been an increasing emphasis on the importance of organizational aspects of stroke rehabilitation, as yet few cost analyses have been run with regard to gains in stroke rehabilitation.²

In randomized controlled studies,^{3,4} specialized rehabilitation units have been shown to achieve faster and better functional

outcome than general medical wards. Several authors^{5,6} have suggested that there should be more emphasis on home rehabilitation. However, the rationale of this proposal is still unclear. In the United Kingdom, the Domino Study Group⁷ reported no difference in outcome but cheaper hospital-based outpatient rehabilitation, and the Bradford cost-effectiveness study⁸ suggested that home physiotherapy is more effective and cheaper.

The optimum combination of inpatient, outpatient, and/or home rehabilitation is not known. The development of cost-effective strategies in the area of stroke rehabilitation together with targeting of patients will likely benefit from different organizational forms of rehabilitation. A stroke service

Received September 19, 1997; final revision received December 9, 1997; accepted December 9, 1997.

From the Unit of Neuroepidemiology and Health Services Research, Division of Neurology, Karolinska Institute, Huddinge University Hospital (L.W.H., L. von K., V.K., K.J., J. de P.-C.), the Department of Physical Therapy, Karolinska Institute (L.W.H., L. von K.), and Departments of Physical Therapy (M.H.), Occupational Therapy (G.W.), Geriatric Medicine, Huddinge University Hospital (H.T.), Stockholm, Sweden, and the Department of Applied Epidemiology, National Centre for Epidemiology, Carlos III Institute of Health (J.A., J. de P.-C.), Madrid, Spain.

Correspondence to Lotta Widén Holmqvist, Unit of Neuroepidemiology and Health Services Research, Division of Neurology, Karolinska Institute, Huddinge University Hospital, S-141 86 Huddinge, Sweden.

E-mail lotwid@ki.se

© 1998 American Heart Association, Inc.

Selected Abbreviations and Acronyms

ADL = activities of daily living
 HRG = home rehabilitation group
 OR = odds ratio
 RRG = routine rehabilitation group
 SIP = Sickness Impact Profile

based on short-term admission to a hospital, followed (where appropriate) by early supported discharge with continuity of rehabilitation in the community, seems to have several advantages, as it guarantees continuity both in time and personnel and is possibly less expensive, as shown by our pilot study.^{9,10} In a recent randomized controlled study in Newcastle upon Tyne,¹¹ where a total of 80 patients were followed up for 1 year after stroke, a similar scheme was found to be feasible, yielding a saving in bed-days. To our knowledge, no study has reported on the benefit of early discharge and continuity of rehabilitation maintained in the community.

At the Department of Neurology at Huddinge Hospital in southwest Stockholm, we have estimated the population-based need for late therapy intervention after stroke¹² and developed an organizational model of home rehabilitation for moderately disabled stroke patients hospitalized at the Department of Neurology, Huddinge Hospital, which implied early supported discharge with continuity of rehabilitation at home based on task-specific activities, during a 3- to 4-month period with a team that included physical, occupational, and speech therapists.^{9,10}

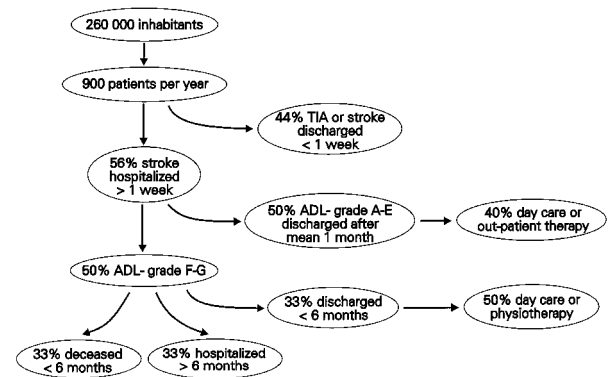
We conducted a population-based, randomized controlled trial to determine whether the home rehabilitation model as developed at the Department of Neurology was more effective and/or resource efficient than current, organizationally diverse rehabilitation in a hospital or day care or through outpatient care. In this article, methodological aspects and patient outcome at 3 months, together with patient satisfaction and initial hospitalization and use of home rehabilitation services, are reported.

Subjects and Methods

Patient Selection and Baseline Assessment

A graph (depicted in Fig 1) of the flow chart and caring chain for patients hospitalized at the Department of Neurology with a diagnosis of transient ischemic attack or stroke over a 1-year period was drawn up on the basis of data from our previous studies in southwest Stockholm.¹³ The patients in this study were recruited during the period from September 1993 through March 1996, from the group of patients who, according to the Katz ADL index (grades A-E),¹⁴ were continent and independent in feeding 1 week after a first or recurrent acute stroke and had an expected average hospitalization time of 4 weeks in routine care.⁹ During the study period, residents in the Huddinge Hospital catchment area with suspected transient ischemic attack or acute stroke were admitted to the Emergency Department at Huddinge Hospital and, in general, transferred that same day or the following day to the stroke unit at the Department of Neurology. In cases where the stroke unit was filled to capacity, patients were admitted to two adjacent neurological wards. Diagnosis of stroke was based on the medical history and clinical examination of the patient and defined according to World Health Organization criteria.¹⁵ All patients routinely underwent a CT scan.

Eligible patients with first as well as recurrent stroke were screened for inclusion in the study and had their baseline assessment performed



Flow chart and caring chain of patients hospitalized at the Huddinge Hospital Department of Neurology with a diagnosis of transient ischemic attack (TIA) or stroke during a 1-year period. ADL indicates activities of daily living.

5 to 7 days after stroke onset. Inclusion/exclusion criteria used are shown in Table 1. Regarding baseline assessment, the research physical therapist administered the Mini-Mental State Examination¹⁶ and assessed the motor capacity.^{17,18} Patients with clinical signs of dysphasia were evaluated¹⁹ by the research therapist on the basis of how they performed in comparison with a reference sample of aphasia patients. The speech therapist also estimated whether mental functions were within normal limits for the dysphasic patients who were unable to perform the examination. Information regarding demographic characteristics, independence in personal and instrumental ADL,²⁰ and frequency of activities²¹ before stroke were obtained by interviewing the patients. Medical history, investigations performed, and clinical diagnoses were identified from patients' medical records at the Department of Neurology. Walking capacity²² and manual dexterity²³ were tested by the research physical therapist. Neurological function²⁴ was rated by the senior neurologist responsible for the patient in question. Coping capacities of the patients and their spouses were tested with use of the shortened version of the Sense of Coherence Scale²⁵ at 6 and 12 months after stroke. Before randomization, the patients were managed in the wards according to existing practice. The trial was approved by the Huddinge Hospital Ethical Committee.

TABLE 1. Entry Criteria for the Patients to the Study

Inclusion criteria	
Acute stroke	
Independence in feeding and continence according to Katz index of ADL ¹⁴	
Mini-Mental State Examination score ¹⁶ of >23	
Impaired motor capacity according to the Lindmark scale ^{17,18} and/or	
Dysphasia according to the Reinvang Aphasia Test ¹⁹	
Exclusion criteria	
Discharged before 5 days of hospitalization	
Progressive stroke	
Subdural hematoma	
Subarachnoid hemorrhage	
Clinical sign of massive perceptual deficit	
Renal, heart, or respiratory failure	
Nonstroke epilepsy	
Alcoholism	
Psychiatric disease	
Other comorbidity likely to shorten length of life dramatically	

Randomization

Immediately after informed consent was obtained, the patients were randomized 1:1, either to the HRG or to the RRG blocks of two or four individuals, by a computerized random procedure and sealed numbered envelopes. The same person (J.P.C.) designed and carried the randomization procedure, which remained unknown by the evaluators until the last patient at 1-year follow-up was examined.

Rehabilitation at Home

Two physical therapists, two occupational therapists, and one speech therapist associated with the stroke unit formed the team of the home rehabilitation outreach service. A social worker was attached to the team on a consulting basis. One of the therapists was assigned as a case manager for the patient, which implied that she coped with a wider domain of function than is currently in vogue and that she constituted the link between hospital and outpatient care. In each case, the case manager was responsible for coordination of the discharge procedure, most of the at-home therapy, coordination between therapists in the home rehabilitation team, and contact with the neurologist responsible. A program approximately 3 to 4 months in duration was tailored for each patient. The frequency of therapy contacts for the patients receiving rehabilitation at home was decided by the providing therapist in consultation with the patient and his or her family. The frequency of home visits was gradually reduced until the therapist discharged the patient. Two half-hour meetings per week were scheduled for coordination purposes by the home rehabilitation team. If continued rehabilitation was required after such a period, the patient was referred to routine outpatient rehabilitation.

The intervention strategy was based on prior experience.⁹ The home rehabilitation program emphasized a task- and context-oriented approach, which implies that the patient performs guided, supervised, or self-directed activities in a functional and familiar context. The choice of activities was based on patients' personal interests, and adherence to structured training between therapy sessions was promoted. The spouse, when available, was encouraged to be an active participant in the rehabilitation process. Individual counseling, which focused on education, applying information learned in practical situations, and solving problems occurring in the home, was offered to the spouse if needed. The duration and type of therapy were recorded in a protocol by the therapists. Patients were asked to keep diaries between therapy sessions on time and type of training.

Routine Rehabilitation

The control group consisted of the stroke patients who received routine rehabilitation service. All patients in this group were also admitted to the Department of Neurology. If required (and after evaluation by specialists from geriatric or rehabilitation clinics) the patients were transferred for continued inpatient rehabilitation and/or day care. In this context, routine rehabilitation denotes a heterogeneous set of interventions ranging from the best established in the hospital, day care, and/or outpatient care, to others introduced during the study period, such as daily afferent sensory stimulation by low-frequency transcutaneous electrical nerve stimulation and home-based rehabilitation initiated by the Department of Geriatrics.

Follow-up

Follow-up visits were scheduled at 3, 6, and 12 months after stroke. All the patients and the spouses were interviewed and/or evaluated at home by an external assessor, a research physical therapist (L. von K.). In addition, the patients with dysphasia were assessed by a research speech therapist (K.J.). The assessors were blinded with respect to group assignment and were not involved with randomization or organization of treatment, nor did they have contact with any of the participating rehabilitation staff during patient treatment periods. The same assessor conducted all subsequent assessments. The feasibility of administering all the tests except the aphasia test in a single home visit was verified in the pilot study.^{9,10}

The different outcome measures^{17-23,26,27} spanned the domains of impairment, disability, handicap, and subjective health-related quality of life. Resource use for different health-related cost items for patients

TABLE 2. Baseline Characteristics of Patients in the HRG and RRG

Variable	HRG (n=41)	RRG (n=40)	P
Mean±SD age, y	70.8±7.6	72.6±8.9	.6751
Men/women	22/19	22/18	.9188
Living with spouse	30	26	.5787
Swedish/other origin	36/5	37/3	.7371
Basic/higher education	35/6	38/2	.2640
Work/retired or other	4/37	4/36	.7371
Affluent economic situation	22	24	.7251
Coping capacity (range, 13–91)	72 (65–82)†	81 (74–85)†	.0400
Before stroke			
Frequency in lifestyle activities (0–45)	29 (24–32)†	27 (21–31)†	.3995
Independence in instrumental ADL	32	31	.8353
Medical history			
Stroke	7	4	.5454
Transient ischemic attack	11	2	.0176
Ischemic heart disease	19	15	.5613
Cardiac insufficiency	9	8	.9543
Hypertension	20	15	.4235
Diabetes	9	2	.0571
Musculoskeletal disorder	9	7	.8228
Respiratory disorder	4	5	.9686
CT abnormal on admission	31	21	.0527
Clinical diagnosis			
Infarction/hemorrhage	38/3	39/1	.6259
Right/left hemisphere	15/24	23/14	.0574
One week after stroke			
Independence in Katz ADL	17	20	.5836
MMSE (0–30)	27 (26–29)†	28 (26–28)†	.7160
Motor capacity			
Arm (0–57)	50 (25–55)†	45 (32–56)†	.7508
Leg (0–36)	34 (28–36)†	34 (29–36)†	.9450
Coordination (0–12)	8 (6–11)†	8 (5–10)†	.3024
Mobility (0–27)	25 (22–27)†	25 (24–27)†	.7484
Balance (0–21)	15 (11–18)†	15 (12–17)†	.8831
Total score (0–153)	131 (102–138)†	124 (100–138)†	.6638
Able to perform Peg Test	19	15	.5612
Able to walk 10 m			
Without/with aid	33	33	.9578
Median walking time	14 (10–22)	14 (10–22)	.9488
Neurological score (0–58)	49 (45–51)†	50 (45–53)†	.2364
Presence of aphasia	11	5	.1801
Aphasia quotient (0–100)	24 (13–45)†	51 (49–53)†	.2818

Mini-Mental State Examination (MMSE) score is based on 29 patients in the HRG and 34 patients in the RRG; coping capacity score is based on 39 patients in the HRG and 36 in the RRG.

†Median (interquartile range).

was collected by consulting the computerized register at the Stockholm County Council for hospital inpatient and outpatient care, rehabilitation at home, primary care, day care, rehabilitation at home and visits to private caregivers, and as a complementary tool, by interviewing both patients and caregivers. The frequency of individual

TABLE 3. Outcome of Patients in the HRG and the RRG at 3 Months

Variable (Range of Scores)	HRG (n=41)	RRG (n=40)	P
After discharge			
Independent in personal ADL	22	24*	.6267
Independent in instrumental ADL	2	3*	.6714
At 3 months			
Independent in personal ADL	36	32	.5131
Independent in Barthel ADL	28	25	.7532
Independent in instrumental ADL	16	12	.5351
Frequency of lifestyle			
activities (0–45)	20 (16–27)†	18 (11–25)†	.1632
Motor capacity			
Arm (0–57)	56 (53–57)†	55 (51–57)†	.3214
Leg (0–36)	36 (35–36)†	36 (35–36)†	.3957
Coordination (0–12)	11 (9–12)†	10 (8–11)†	.0491
Mobility (0–27)	27 (26–27)†	26 (26–27)†	.2996
Balance (0–21)	18 (16–20)†	17 (16–19)†	.4199
Total score (0–153)	146 (141–150)†	145 (134–148)†	.1761
Able to perform Peg Test	35	32	.7303
Able to walk 10 m			
Without aid/with aid/not able to walk	38/3/0	34/5/1	.4253
Median walking time	12 (8–15)†	12 (10–16)†	.4510
Aphasia quotient (0–100)	67 (33–93)†	91 (71–93)†	.4260
Reported one/recurrent falls			
	10/4	6/5	.6841
Falls resulting in injuries			
Soft parts	3	3	.8949
Fractures	0	2	.1833

*One patient in the RRG was not discharged at 3-month follow-up.

†Median (interquartile range).

therapy (including home visits) and group therapy contacts per patient during hospitalization was collected from the patients' therapy records at the Department of Neurology and other hospital facilities to which the patients had been referred and by identifying visits to day care facilities and therapists in primary care from the previously mentioned computerized register. Information on use of home service and other help (eg, transportation service, technical aids, installation of supporting handles and other structural alterations to the patients' homes) was collected by interviewing the patients and spouses.

The spouses' subjective health-related quality of life²⁷ was measured: time spent by spouses in helping patients with personal and instrumental ADL²⁰ after discharge and at the time of follow-up, or regular help from other family caregivers and/or other persons were recorded.

Differences in patient satisfaction with care in the HRG and the RRG were recorded with use of a questionnaire. The questionnaires,¹⁰ presented at the follow-up visit 3 months after stroke, were to be completed and returned to the Department of Neurology at Huddinge Hospital by mail. In addition, the patients' self-reported frequency of falls and possible complications was studied.

Study Size and Power

The power requirements for demonstrating differences in cost were considerably lower than those for showing statistically significant differences in effect. We concluded that a study size of 130 patients would allow for indication of possible moderate positive effects and demonstrate important differences in secondary effects (odds ratio of >3), as well as savings of a magnitude that could motivate changes in health care policy and so yield an acceptable balance of results. Because of financial and manpower restrictions, for speech therapists in

particular, we were able to include only 83 patients, yielding a lower proportion of aphasics than expected.

Statistical Analysis

Statistical significance for intergroup differences in outcome was assessed by the Fisher exact test, χ^2 test, and Mann-Whitney test.

Through use of logistic regression, an attempt was made to quantify the contribution of different factors to patient functional outcome. Thirteen variables deemed to constitute determinants of outcome and potential confounders and others representing outcomes (all listed in "Results") were categorized arbitrarily from professional experience or median values. An interim data analysis was performed when the first 50 patients had been assessed at 3 months.¹³

Results

In total, 220 patients were screened for inclusion. Eighty-six patients fulfilled the inclusion criteria; of those, 83 gave their informed consent for participation. Since 1 patient in the HRG withdrew for personal reasons the day after discharge from the hospital and another in the RRG was diagnosed with a hepatic carcinoma after inclusion in the study and died 2 months after his acute stroke, the final number of patients recruited to the HRG and RRG and followed up 3 months after stroke totaled 41 and 40, respectively.

The baseline characteristics of the HRG and RRG patients followed up 3 months after stroke onset are summarized in

TABLE 4. Median, and Range Scores for Subjective Dysfunction As Assessed by SIP in Patients in the HRG and the RRG at 3 Months

Category	HRG		RRG		P
	Median	IQR	Median	IQR	
Overall SIP	16.6	11.1–25.3	14.6	19.3–19.6	0.2944
Physical dimension	14.9	5.5–25.1	15.6	9.5–21.4	0.5870
Ambulation	25.1	10.6–37.4	24.2	12.3–34.2	0.7872
Mobility	22.4	0.0–39.1	16.3	3.8–33.1	0.8414
Body care and movement	9.6	2.1–16.9	10.3	4.9–21.6	0.5195
Psychosocial dimension	16.6	8.7–29.1	10.0	6.1–15.6	0.0164
Social interaction	15.0	8.4–26.1	10.7	3.6–18.8	0.0624
Alertness behavior	9.7	0.0–35.5	8.8	0.0–19.8	0.3934
Emotional behavior	17.6	0.0–31.3	0.0	0.0–19.7	0.0233
Communication	18.0	9.2–30.3	9.7	0.0–21.5	0.0150
Independent categories					
Sleep and rest	22.0	11.6–33.7	11.7	0.0–26.1	0.1205
Eating	5.2	0.0–11.3	5.2	0.0–11.3	0.5205
Work	0.0	0.0–0.0	0.0	0.0–0.0	1.0000
Home management	28.4	9.3–53.7	32.8	14.7–46.6	0.6807
Recreation and pastime	28.4	10.2–40.0	29.8	10.2–43.7	0.4664

IQR indicates interquartile range.

Table 2. The socioeconomic situation of the patients in the HRG and the RRG were very similar. Mean age was 72 years, 54% were male, and almost one third of the patients lived alone. The great majority of patients were born in Sweden, had only a basic education, and were retired by the time of stroke onset. Most of the patients were already restricted in their activities before stroke. Almost one fourth were dependent in ADL, and the average level of frequency of activities reached 62%. The health status of the majority of the patients was affected before stroke: according to medical records, the mean number of associated diseases per patient was 1.8. Uneven distributions by several patient characteristics were found. HRG patients had a 10% lower coping capacity; a higher frequency of associated diseases ($P=.0535$), especially transient ischemic attack and diabetes; and higher frequencies of abnormal CT scan results on admission and left hemisphere lesions.

Almost half of the patients were independent in personal ADL according to the Katz index, and the average score for cognitive function of patients able to cooperate with the Mini-Mental State Examination was 27. The assessment of the patients revealed that most dysfunction was in the motor capacity of the upper extremity and in manual dexterity and least dysfunction was in motor capacity of the lower extremity and walking; even so, mean gait velocity was reduced. The aphasia quotient for all the dysphasic patients averaged 32, indicating that 32% of the reference sample of aphasic patients perform worse and 80% perform better. In the HRG, there were more patients with better upper extremity function on the affected side, and more had aphasia with more severe symptoms, but the differences were not statistically significant.

Independence in ADL after discharge and outcome at 3 months for patients in the HRG and RRG are shown in Table 3. One patient in the RRG was still hospitalized at 3 months after stroke. After discharge from the hospital, most patients were still

dependent in instrumental ADL, to an even higher degree in the HRG than the RRG. At 3 months, the patients generally showed moderate to almost complete recovery vis-à-vis personal ADL, total motor capacity, manual dexterity, walking, and linguistic ability; however, independence in higher ADL functions was attained by only 35% of the group, and gait velocity remained lower. With regard to frequency of activities, there was an 18% decrease compared with the situation before stroke. In general and save for the aphasia score, better outcomes were found in the HRG in the above-mentioned measures, but differences between the groups were not statistically significant. Thirty-one per cent of the patients reported first or recurrent falls. An almost twofold higher, statistically nonsignificant frequency of nonrecurrent falls was observed in the HRG. In the case of 2 patients in the RRG, the falls resulted in fractures.

Subjective dysfunction as assessed by SIP of HRG and RRG patients at 3 months is presented in Table 4. The median score of total SIP (range, 0 to 100) for all patients in the study was 16.0, with greater disability observed in physical than in psychosocial functioning. Patients reported particularly high levels of dysfunction in Household Management, followed by Recreation and Pastime and Ambulation. No significant differences in subjective dysfunction were found between the HRG and RRG patients, except for Communication and Emotional Behavior, where those in the HRG perceived significantly more dysfunction.

Shown in Table 5 are the comparative effects of rehabilitation at home as seen for different patient outcome variables from the crude and multivariate analyses. Although no statistically significant effects of home rehabilitation were found, a pattern of associations was seen in both analyses: (1) for patient outcomes tested by the therapist for total motor capacity, manual dexterity, and walking, a systematic, positive, modest

TABLE 5. Comparative Effects of Rehabilitation at Home and Other Factors for Different Patients Outcome from Logistic Regression Analysis

Variable	OR (95% CI)	
	Rehabilitation at Home (Crude)	Rehabilitation at Home (Adjusted)
High frequency of activities	1.06 (0.40–2.80)	2.36 (0.86–6.51)
Independence in extended ADL	1.49 (0.53–4.21)	1.55 (0.60–4.01)
Independence in Barthel ADL	1.29 (0.46–3.61)	1.18 (0.56–2.48)
High motor capacity	1.57 (0.59–4.18)	1.09 (0.41–2.84)
Good manual dexterity	1.46 (0.40–5.47)	1.13 (0.56–2.28)
Walking without aid	2.24 (0.44–12.54)	1.13 (0.56–2.26)
SIP Total	0.52 (0.19–1.40)	0.84 (0.38–1.90)
SIP Communication	0.45 (0.16–1.26)	0.65 (0.25–1.72)
SIP Emotional	0.47 (0.17–1.27)	0.59 (0.24–1.45)

effect (from a mean OR of 1.76 in crude to a mean OR of 1.12 in multivariate analysis) was seen; (2) in patient-reported outcomes for frequency of lifestyle activities and ADL, a systematic, positive, modest effect (from a mean OR of 1.28 in crude to a mean OR of 1.70 in multivariate analysis) was also observed; and (3) for SIP Total and selected SIP Communication and SIP Emotional Behavior, systematic negative effects (ranging from an OR of 0.45 to an OR of 0.84) were seen.

Mean total time for initial hospitalization was 14 days in the HRG and 29 days in the RRG, which implies a considerable reduction (52%; $P=.0008$) in duration of hospital stay. After discharge, HRG patients received a mean of 10 home visits per patient by therapists. Reported patient satisfaction with different dimensions of care was 66% to 98% for all patients. The only statistically significant difference was for active participation in treatment program planning ($P=.0209$), and this was in favor of the HRG.

Discussion

This study focuses on moderately disabled stroke patients who, in line with prior experience, are those who might benefit most from specific interventions.^{28,29} Difficulties inherent in the use of randomized controlled techniques to evaluate poststroke rehabilitation, such as sample size and/or blindness,³⁰ may have limited the validity of the result of this study. Nevertheless, the study demonstrated that early supported discharge following acute stroke, with continuity of rehabilitation at home by a team associated with the Department of Neurology, implied a considerable reduction in bed-days and showed that early supported discharge with continuity of rehabilitation at home of moderately disabled stroke patients in southwest Stockholm did not account for large differences in patient outcome, as seen from tested functions of total motor capacity, manual dexterity, and walking, or self-reported independence in ADL, frequency of activities, and health-related quality of life. Minor differences suggested that higher effectiveness in the HRG versus the RRG might be present for total motor capacity, manual dexterity, walking, and independence in ADL as well as in frequency of activities. The suggested negative comparative impact of the home rehabilitation program on SIP Total, and particularly on SIP Communication

and SIP Emotion, are more difficult to interpret. The small difference in SIP Total scores between the HRG and RRG, which translated as a considerable difference on categorization in the logistic regression analysis, may thereby have been artifact generated and negligible, since most patients aggregated around the cut-off value.

The applicability of logistic regression as a complementary tool for assessing the intervention effect can be questioned. First, it is possible that considerable collinearity, the association of independent variables, may be present: eg, coping capacity with civil status, comorbidity with social activity,³¹ or ADL capacity with motor function. Second, loss of information in the dichotomization procedure is an important consideration.

Patient selection induced by the criteria and inefficient randomization may have caused the uneven distribution of some confounders. For instance, it is likely that exclusion of patients with severe perceptual deficits and the small study size resulted in exclusion of severe right posterior (parietal or occipital) lesions, with an ensuing high frequency of aphasics and anterior (eg, frontal) lesions in the HRG.

It is difficult to evaluate possible bias introduced by imbalance in the Sense of Coherence Scale scores, which implied a higher coping ability in the RRG. The fact that this score has been found to be associated with health variables³¹ may explain the overrepresentation in the HRG of patients with a higher burden of cardiovascular comorbidity and more severe lesions, and it may in part explain the higher SIP scores in the HRG, modestly improved by the multivariate analysis.

Compared with recurrent falls, the health status relevance of nonrecurrent falls has been deemed low, yet the similar, albeit quite sparse, frequency of such falls in the HRG and RRG remains as a possible negative effect of home rehabilitation. The fact that falls were generally infrequent can be explained by selection criteria that excluded patients with low cognitive function, a factor associated with falls.³²

Our patient selection criteria corroborate the suggestions by Duncan³³ that early staging of patients by good cognition, continence of bowel and bladder, and mild to moderate hemiplegia guides expected patient outcome, as measured by moderate to complete neurological recovery and independence in most activities. The generalizability of our results to other stroke populations might be affected by the selection of patients with moderate disabilities and exclusion of those with severe perceptual deficits. The SIP profile seen in our group was similar to that observed in the study by de Haan et al,³⁴ with the highest impact in the area of Household activities, followed by Recreation and Pastime, Ambulation, and Mobility. This may suggest that as regards the effect of rehabilitation at home, the result could be extrapolated to other populations.

Some functional aspects of our study sample were not studied before stroke and have a remarkable profile, eg, besides a good neurological recovery, as seen from the motor and walking capacity, walking speed was slow—only 60% of patients reached the usual gait velocity for their age.³⁵ This may suggest that the potential impact of concomitant cardiac disease³⁶ on certain outcomes was important and that it is therefore important for rehabilitation of such non-stroke-related aspects to be included in the program under discussion. Similarly, aphasia rehabilitation was not addressed here and should be.

Despite reported limitations in measuring patient satisfaction,³⁷ overall HRG patients were more satisfied with care, especially with active participation in the planning of their rehabilitation program.

Since the 3-month period after stroke encompasses the majority of the time of the home rehabilitation program and functional recovery of patients, it is logical to assume that patient outcome and resource utilization results at 3 months would be crucial for the evaluation of the total cost-benefit ratio at 12 months of the program of early discharge with continuity rehabilitation at home.^{9,10}

From the results of this study, we tentatively conclude that this type of intervention is comparatively beneficial and, taking into account the important differences of hospital and rehabilitation services, could be routinely implemented for selected patients in southwest Stockholm if further experimental evaluation of the midterm effects of the HRG does not dramatically modify differences in patient health status or cost. The pooling of our data with those of ongoing trials¹¹ would allow for more accurate estimations of the effects of home rehabilitation programs on stroke patients.

Acknowledgments

This study was supported by the Swedish Medical Research Council (K91-27Å-09764-02); by grants from The Swedish Society for Multiple Sclerosis (NHR), 1987-Foundation for Stroke Research, The Swedish Stroke Association, Clas Groschinsky's Foundation, National Board of Health and Welfare, and Foundation Solstickan; and by funds from the Karolinska Institute and the Carlos III Institute of Health in Madrid. We should like to thank Paul Bach-y-Rita, Department of Rehabilitation Medicine, University of Wisconsin-Madison Medical School, for his contribution in developing the stroke rehabilitation project in Southwest Stockholm County; A. Fyrby (Department of Physical Therapy), M. Linde (Department of Occupational Therapy), and I. Öhlund (Department of Geriatric Medicine) for training the patients at home; P. Diener, B. Höjeberg, and licensed and practical nurses (Department of Neurology, Huddinge Hospital) for assistance in recruitment and baseline evaluation of the patients; and K. Jansson-Halme for home evaluation of patients and spouses at 3 months.

References

1. Stegmayr B, Asplund K. Measuring Stroke in the population: quality of routine statistics in comparison with a population-based stroke registry. *Neuroepidemiology*. 1992;11:204-213.
2. Terént A, Marké L-Å, Asplund K, Norrving B, Johnsson E, Wester P-O. Cost of stroke in Sweden. *Stroke*. 1994;25:2363-2369.
3. Indredavik B, Bakke F, Solberg R, Rokseth R, Lund Haaheim L, Holme I. Benefit of a stroke unit: a randomized controlled trial. *Stroke*. 1991;22:1026-1031.
4. Kalra L. The influence of stroke unit rehabilitation on functional recovery from stroke. *Stroke*. 1994;25:821-825.
5. Wade DT, Langton Hewer R, Skilbeck C, Bainton D, Burns-Cox C. Controlled trial of home care service for acute stroke patients. *Lancet*. 1985;1:323-326.
6. Brocklehurst JC, Morris P, Andrews K, Richards B, Laycock P. Social effects after stroke. *Soc Sci Med*. 1981;15A:35-39.
7. Gladman J, Whyne D, Lincoln N, for the Domino Study Group. Cost comparison of domiciliary and hospital-based stroke rehabilitation. *Age Ageing*. 1994;23:241-245.
8. Young J, Forster A. Day hospital and home physiotherapy for stroke patients: a comparative cost-effectiveness study. *J R Coll Physicians Lond*. 1993;27:3:252-258.
9. Widén Holmqvist L, de Pedro-Cuesta J, Holm M, Kostulas V. Intervention design for rehabilitation at home after stroke. A pilot feasibility study. *Scand J Rehabil Med*. 1995;27:43-50.
10. Widén Holmqvist L, de Pedro-Cuesta J, Möller G, Holm M, Sidén Å. A pilot study of rehabilitation at home after stroke: a health economic appraisal. *Scand J Rehabil Med*. 1996;28:9-12.
11. Rodgers H. *Development of an Early Supported Discharge Policy Following Acute Stroke: An Evaluation* [final report]. Newcastle upon Tyne, UK: University of Newcastle; 1997.
12. de Pedro-Cuesta J, Sandström B, Holm M, Stawiarz L, Widén Holmqvist L, Bach-y-Rita P. Stroke rehabilitation: identification of target group and planning data. *Scand J Rehabil Med*. 1993;25:107-116.
13. Widén Holmqvist L, de Pedro-Cuesta J, Sidén Å. A research model for stroke services development. In: Proceedings of WHO-Europe 3rd International Conference of Health Promoting Hospitals; June 1-2, 1995; Linköping, Sweden.
14. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. The index of ADL: a standardized measure of biological and psychosocial function. *JAMA*. 1963;185:914-919.
15. WHO Special Report. Stroke-1989: recommendation on stroke prevention, diagnosis, and therapy. *Stroke*. 1989;20:1407-1431.
16. Folstein MF, Folstein SF, Mc Hugh PR. Mini-Mental State: a practical method for grading cognitive state of patients for clinicians. *J Psychiatr Res*. 1975;12:189-198.
17. Lindmark B, Hamrin E. Evaluation of functional capacity after stroke as a basis for active intervention: presentation of a modified chart of motor capacity assessment and reliability. *Scand J Rehabil Med*. 1988;20:103-109.
18. Lindmark B, Hamrin E. Evaluation of functional capacity after stroke as a basis for active intervention: validation of a modified chart for motor capacity assessment. *Scand J Rehabil Med*. 1988;20:111-115.
19. Reinvang I, Engvik H. *Håndbok. Norsk Grunntest for Afasi*. Oslo, Norway: Universitetsforlaget; 1980.
20. Hulter Åsberg K, Sonn U. The cumulative structure of personal and instrumental ADL. *Scand J Rehabil Med*. 1989;21:171-177.
21. Wade D, Leigh-Smith J, Langton Hewer R. Social activities after stroke: measurement and natural history using Frenchay Activities Index. *Int Rehabil Med*. 1985;7:176-181.
22. Wade DT, Wood WA, Heller A, Maggs J, Langton Hewer R. Walking after stroke: measurement and recovery over first 3 months. *Scand J Rehabil Med*. 1987;19:25-30.
23. Wade DT. Nine hole peg test. In: *Measurement in Neurological Rehabilitation*. Oxford, UK: Oxford Medical Publications; 1992:171.
24. Scandinavian Stroke Study Group. Multicenter Trial of Hemodilution in Ischemic Stroke: background and study protocol. *Stroke*. 1985;16:885-890.
25. Antonovsky A. *Unraveling the Mystery of Health*. San Francisco, Calif: Jossey-Bass; 1987.
26. Collin C, Wade DT, Davis S, Horne V. The Barthel ADL index: a reliability study. *Int Disabil Stud*. 1988;10:61-63.
27. Sullivan M, Ahlmen M, Archenholtz B, Svensson G. Measuring health in rheumatic disorders by means of a Swedish version of Sickness Impact Profile: results from a population study. *Scand J Rheumatol*. 1986;15:193-200.
28. Sunderland A, Fletcher D, Bradley L, Tinson D, Langton Hewer R, Wade DT. Enhanced physical therapy after stroke: a one year follow up study. *J Neurol Neurosurg Psychiatry*. 1994;57:856-858.
29. Jeffery DR, Good DC. Rehabilitation of the stroke patient. *Curr Opin Neurol*. 1995;8:62-68.
30. Ottenbacher KJ, Janell S. The result of clinical trials in stroke rehabilitation research. *Arch Neurol*. 1993;50:37-44.
31. Winqvist M. "Att simma i förgiftat vatten." Om hälsa och ohälsa bland de allra äldsta. Stockholm, Sweden. Rapport/er/Stiftelsen Stockholms läns äldrecentrum; 1995.
32. Nyberg L, Gustavsson Y. Patient falls in stroke rehabilitation: a challenge to rehabilitation strategies. *Stroke*. 1995;26:838-842.
33. Duncan P. Stroke disability. *Phys Ther*. 1994;74:399-407.
34. de Haan RJ, Limburg M, van der Meulen JHP, Jacobs HM, Aaronson NK. Quality of life after stroke: impact of stroke type and lesion location. *Stroke*. 1995;26:402-408.
35. Aniansson A, Rundgren A, Sperling L. Evaluation of functional capacity in activities of daily living in 70-year-old men and women. *Scand J Rehabil Med*. 1980;12:145-154.
36. Roth EJ. Heart disease in patients with stroke, part II: impact and implications for rehabilitation. *Arch Phys Med Rehabil*. 1994;75:94-101.
37. Larsson G, Wilde B. Är patienten nöjd? *Läkartidningen*. 1995;92:1587-1590.