Resource Utilization and Costs of Stroke Unit Care Integrated in a Care Continuum: A 1-Year Controlled, Prospective, Randomized Study in Elderly Patients

The Göteborg 70+ Stroke Study

Lisbeth Claesson, OTR, MSc; Gunilla Gosman-Hedström, OTR, MSc; Magnus Johannesson, PhD; Björn Fagerberg, MD, PhD; Christian Blomstrand, MD, PhD

Background and Purpose—The aim of the present study was to examine resource utilization during a 12-month period after acute stroke in elderly patients randomized to care in an acute stroke unit integrated with a care continuum compared with conventional care in general medical wards. A secondary aim was to describe costs related to the severity of stroke.

Methods—Two hundred forty-nine consecutive patients aged ≥70 years with acute stroke within 7 days before admission, living in their own homes in Göteborg, Sweden, without recognized need of care were randomized to 2 groups: 166 patients were assigned to nonintensive stroke unit care with a care continuum, and 83 patients were assigned to conventional care. There was no difference in mortality or the proportion of patients living at home after 1 year. Main outcomes were costs from inpatient care, outpatient care, and informal care.

Results—Mean annual cost per patient was 170 000 Swedish crowns (SEK) (equivalent to $25 373) and 191 000 SEK ($28 507) in the stroke unit and the general medical ward groups, respectively (P=NS). Seventy percent of the total cost was for inpatient care, and 30% was for outpatient and informal care. For patients with mild, moderate, and severe stroke, the mean annual costs per patient were 107 000 SEK ($15 970), 263 000 SEK ($39 254), and 220 000 SEK ($32 836), respectively ($P<0.001$). There was no statistical difference in age or nonstroke diagnosis.

Conclusions—The total costs the first year did not differ significantly between the treatment groups in this prospective study. The total annual cost per patient showed a very large variation, which was related to stroke severity at onset and not to age or nonstroke diagnoses. Costs other than those for hospital care constituted a substantial fraction of total costs and must be taken into account when organizing the management of stroke patients. The high variability in costs necessitates a larger study to assess long-term cost effectiveness. **(*Stroke*. 2000;31:2569-2577.)**

Key Words: costs and cost analysis ■ elderly ■ stroke units ■ Sweden

Stroke is a major public health problem associated with high mortality, disability, and cost. Therefore, it is important to develop effective treatment strategies for this health problem. The Stroke Unit Trialists' Collaboration[1] concludes from the meta-analyses data that stroke unit care improves survival and health status after a stroke.[1–3] However, there is a lack of evidence concerning economic evaluations of stroke unit care versus conventional care.[1] It has been emphasized that economic evaluations of stroke care are not easy to perform because of the complexity of costs.[4] This increases the need for prospective studies with reliable data concerning the impact of stroke unit care.

Thus, when cost implications of acute stroke unit care are examined, many factors in the study design may improve the quality of the outcome measures, eg, screening procedure of background population when recruiting patients, randomization, prospective approach to data collection, and inclusion of all costs related to the studied patients.

So far, no study has considered all these aspects, and only one research group[5,6] has studied the costs of stroke unit care; however, that study did not use a randomization procedure. The other studies have not been focused on stroke unit care.[7–26] Some studies have been based on data collected retrospectively and not prospectively.[14,19,21] Many reports do not provide information on costs for outpatient care,[5,6,8,10,13,14,19,25] social services,[5,6,8,10,13,14,19,25] and informal care.[5–21,23–26] In some studies, data on costs have not been registered for individual patients but for categories of patients.[8,16,18,23]

Received June 24, 2000; final revision received June 24, 2000; accepted June 29, 2000.

From the Institute of Clinical Neuroscience, Neurological Disease Section (L.C., G.G.-H., C.B.), and the Department of Medicine (B.F.), Sahlgrenska University Hospital, and the Department of Occupational Therapy and Physiotherapy, College of Health and Caring Science (L.C., G.G.-H.), Göteborg University, Göteborg, Sweden, and the Centre for Health Economics, Stockholm School of Economics (M.J.), Stockholm, Sweden.

Correspondence to Prof Christian Blomstrand, Institute of Clinical Neuroscience, Neurological Disease Section, Sahlgrenska University Hospital, SE 413 45 Göteborg, Sweden. E-mail cbl@neuro.gu.se

***Stroke* is available at http://www.strokeaha.org**

We have performed a 1-year randomized study comparing treatment outcome at an acute stroke unit with a care continuum with the outcome of conventional treatment and have prospectively collected all types of costs for these patients. A care continuum implies an acute stroke unit linked to continued care in geriatric stroke units when a long rehabilitation period is needed. The clinical results have been reported elsewhere and showed no overall significant difference in proportions of patients living at home or in patient mortality or functional ability between the 2 treatment groups after 1 year.[27] However, our data indicate that stroke unit care reduced mortality or the need for institutional care in the short-term perspective, especially among those with severe stroke (95% CI −32% to 9%) or in patients with cardiac disease (95% CI −40% to −3%), supporting the results of the Stroke Unit Trailists' meta-analysis[1] and a previous Swedish study.[28]

If the health effects are identical for the 2 treatments, an economic evaluation can be carried out as a comparison of the total costs of the treatments. Such an analysis is often referred to as a cost-minimization analysis in the health economics literature.[29]

The primary aim of the present study was to identify and analyze costs associated with the treatment of elderly patients with acute stroke by using the experimental setup of a randomized study of care in a stroke unit and conventional care referred to above. Detailed data on resource consumption were collected prospectively during the study. A secondary aim was to estimate the total costs of stroke during the first year after its occurrence in relation to the severity of the stroke.

Subjects and Methods

The design was a randomized prospective study with 2 parallel groups followed for 1 year in Sahlgrenska University Hospital in Göteborg, Sweden, the Göteborg 70+ Stroke study. Patients aged ≥70 years (n=249) were randomized after informed consent in connection with acute admission to a stroke unit (SU group) integrated with a care continuum to geriatric wards or to a general medical ward (GW group) between February 1, 1993, and May 17,1994. The randomization was a 2:1 ratio of stroke unit to conventional treatment at general medical wards.[30] A 2:1 randomization to the SU groups was applied to obtain a continuous input of patients to these units. At the acute hospital, the stroke unit consisted of 2 wards, 1 in a general medical ward and 1 in a neurological ward. The SU group was composed of 166 patients; the GW group was composed of 83 patients. There were no significant differences between the groups at entry with regard to sex: 66% (n=110) of the SU group and 54% (n=45) of the GW group were women. The mean age of the SU and GW groups was 80.1 and 79.7 years, respectively. There was no difference in living conditions: 59% (n=96) of the SU group and 48% (n=39) of the GW group were living alone. Concerning the medical history, there were no differences; however, angina pectoris was significantly ($P>0.05$) more common in the SU group. Furthermore, the groups were comparable with regard to neurological score at entry, with a median score of 45 in the SU group and 46 in the GW group. The side of predominant neurological deficit was the right side for 45% (n=74) in the SU group and 42% (n=35) in the GW group and the left side for 51% (n=85) and 45% (n=37), respectively. Speech disorder occurred in 48% (n=79) of the SU group and 49% (n=41) of the GW group.

Two patients in each group did not fulfill the criteria for acute cerebrovascular disease.[27]

Intervention

A nonintensive stroke unit[28,31] was organized in a care continuum with 2 acute stroke units and 2 stroke units at geriatric wards working according to identical principles. The treatment program was built on the principle of stroke unit care with a teamwork concept for nursing and rehabilitation. The program was standardized with regard to diagnostic evaluation, observation, acute treatment, mobilization, and rehabilitation. All staff at the acute wards and at the geriatric wards had a continuous educational program. The acute and geriatric stroke units collaborated in terms of treatment principles, training, and work procedures. Support and information to relatives was an important part of the program, as was the focus on the patients' needs and participation in the treatment. Patients in need of prolonged rehabilitation were transferred to geriatric stroke units. The patients in the general ward received conventional acute medical care, physiotherapy, and occupational therapy, although not within the framework of a structured stroke unit care approach. At the stroke unit, the patients received significantly more occupational and physical therapy.[27]

Measurements

Two registered occupational therapists not involved in the design of the study and the treatment of the patients made all evaluations of the study outcome. The assessments were performed 0 to 3 days after randomization and after 3 weeks, 3 months, and 12 months. The assessments were made at the hospital, in nursing homes, and/or in the patients' homes by means of interviews. If there were any doubts about ability, the patients were asked to perform the activity. Patients were randomly assigned to the occupational therapists, who evaluated them during follow-up. The occupational therapists were experienced and well-trained in assessing activities of daily living (ADL).[27] Established methods were used to assess neurological status (Scandinavian Stroke Study Group[32]), the ability to perform daily life activities (Barthel index[33] and Sunnaas index of ADL[34,35]), and health-related quality of life (Nottingham Health Profile[36–38]). There were no differences between the groups regarding survival. The proportion of patients at home or in institutions did not differ between the groups after 3 or 12 months. At the 12-month assessment, 73% of the SU group and 77% of the GW group were alive, and 63% and 60%, respectively, were living at home. There were no significant differences between the groups regarding neurological score, ADL scores, or the 6 dimensions of the Nottingham Health Profile questionnaire at the 12-month assessment.[27] The study was approved by the ethics committee of the Sahlgrenska University Hospital.

Costs

All costs were estimated from the time of randomization to the end of the 12-month follow-up. The costs were divided into costs for hospitalization, institutionalized living, outpatient care, different kinds of support, and informal care provided by relatives. The costs of each of these units are shown in Table 1. The total cost was obtained by taking the sum of all separate units and multiplying them by their costs. All costs were estimated according to 1996 prices in Swedish crowns (SEK; exchange rate in 1996, $1=6.70 SEK and £1=10.50 SEK).

Data on all hospitalizations during the study were collected from hospital records. The costs were estimated separately for the initial hospitalization, and a distinction was made between acute hospitalization and nonacute hospitalization. For nonacute hospitalization (geriatric wards and postcare unit), unit costs per hospital day were taken from estimations made by the civic administration of the city of Göteborg. For acute hospitalization, the cost was divided into a "hotel cost" per hospital day and patient-related costs. The hotel cost per hospital day at different wards was based on the hotel costs at the Sahlgrenska University Hospital and included staff costs, rent costs, and overhead costs for food, drugs, cleaning, washing, and transportation. Patient-related costs included medical examinations and treatments related to each individual patient. The internal transfer payments used at the Sahlgrenska University Hospital were considered (as judged by the hospital administration to reflect the actual

TABLE 1. Unit Costs Used in Analysis, 1996 Prices (SEK)

Item	Cost per Item, SEK
Initial hospitalization for index stroke*	
Stroke unit, hotel cost per day	2987
General ward, hotel cost per day	2671
Geriatric ward, per day	1900
Acute hospitalizations after initial hospitalization to 12 mo	
Medicine ward, hotel cost per day	2473
Cardiology ward, hotel cost per day	3279
Orthopedic ward, hotel cost per day	2432
Surgery ward, hotel cost per day	3324
Neurology ward, hotel cost per day	2659
Audiology ward, hotel cost per day	2985
Oncology ward, hotel cost per day	2432
Gynecology ward, hotel cost per day	2245
Nonacute hospitalizations from discharge to 12 mo	
Geriatric ward, per day	1900
Postcare unit, per day	1021
Institutionalized living from discharge to 12 mo	
Nursing home, per day	898
Home for the elderly, per day	668
Assisted living, per day	441
Outpatient care from discharge to 12 mo	
Physician visit, per visit	500
Other medical visit,† per visit	320
Outpatient rehabilitation, per day	444
Anticoagulation treatment, per visit	142
Different kinds of support from discharge to 12 mo	
Home assistance, per hour	187
Taxi service for the disabled, per 1-way trip	69
Safety alarm, per month	220
Other costs from discharge to 12 mo	
Informal care, per hour	38

The costs of prescription drugs, assistive devices, and housing adaptations were also estimated, but the unit costs for these resources are not shown (because the prices varied between different drugs, different types of assistive devices, and different types of housing adaptations; see the text for the estimation of these costs).

*The cost for initial hospitalization and costs of acute hospitalizations from discharge to 12 mo were divided into hotel costs and patient-related costs. Unitary costs used to estimate patient-related costs are not shown because of the large number of unit costs used in these estimations. See text for estimation of patient-related costs. Hotel cost per day at the stroke unit includes hotel cost per day at a general ward plus costs for an occupational therapist, a physiotherapist, and a nurse on the stroke team.

†Nurse, occupational therapist, physiotherapist, speech therapist.

costs) as unit costs for these medical examinations and treatments. The stroke unit in the internal medicine ward had a stroke nurse (full time), an occupational therapist (part time), and a physiotherapist (part time) as extra medical staff in the team. The cost of this extra medical staff was added to the hotel cost at this stroke unit.

The number of days of institutionalized living (nursing home, home for the elderly, and assisted living) was obtained from hospital records. Unit costs per day were taken from estimations made by the civic administration of the city of Göteborg.

Structured interview questionnaires at 3- and 12-month assessments were used to collect data concerning use of outpatient care. If the client was unable to answer, the questions were posted to relatives and/or medical staff. Outpatient care included the following: use of prescription drugs; visits to physicians, nurses, occupational therapists, physiotherapists, and/or speech therapists; outpatient rehabilitation; and visits for anticoagulation treatment. Unit costs for these types of visits were taken from estimations made by the civic administration of the city of Göteborg. To estimate the cost of prescription drugs, official Swedish retail prices were used.[39]

In the structured interview questionnaires at 3 and 12 months, data about different kinds of support were also collected. Data were collected concerning hours of home assistance, the number of 1-way taxi trips for disabled people, and the use of safety alarms, assistive devices, and housing adaptations required after stroke. From estimations made by the civic administration of the city of Göteborg, the unit costs for these resources were derived. Costs for housing adaptations and assistive devices varied according to the type of housing adaptation and assistive devices.

The final cost component estimated was the informal care provided by relatives. The number of hours of informal care was collected in the structured interview questionnaires at 3 and 12 months. Thirty-eight SEK per hour was used as the unit cost of informal care. This corresponds to 35% of the gross wage rate, and this cost has been used as the cost of leisure time in previous economic evaluations of health care in Sweden.[40,41]

No costs for outpatient care, different forms of support, and informal care were estimated for patients who died before 3 months. For patients who died 3 to 12 months after randomization, the units from the 3-month assessment were used to estimate the consumption of these utility resources until the date of death.

Statistical Analyses

The analyses were performed according to the intention-to-treat principle.[42] Differences in use of resources and costs were compared by use of a Mann-Whitney nonparametric test for continuous variables, and a x^2 test was used for categorical variables. In addition to testing for whether the costs differed between the 2 treatment groups, a Kruskal-Wallis test was also made to determine whether the costs differed between mild, moderate, and severe stroke.[43] The classification of stroke into mild, moderate, and severe was based on the Barthel index score within the first 3 days after randomization according to a definition used by the Stroke Unit Trialists' Collaboration. Mild, moderate, and severe stroke were defined as Barthel scores 50 to 100, 15 to 45, and 0 to 10, respectively.[44,45] There were no differences in the number of patients with mild, moderate, and severe stroke allocated to the stroke unit and general ward. A value of $P<0.05$ (2-sided) was considered significant.

Results

The use of resources per patient during the study are shown in Table 2, and the costs per patient during the study are shown in Table 3. The costs did not differ significantly between the groups for any of the cost components. The mean total costs per patient were numerically somewhat lower for the SU patients than for the GW patients (170 000 SEK [$25 373] versus 191 000 SEK [$28 657], respectively), but the difference was not significant. The total costs per patient ranged from 5032 SEK ($751) to 717 905 SEK ($107 150) for the SU patients and from 5661 SEK ($845) to 815 673 SEK ($121 742) for the GW patients.

Table 4 shows the costs for mild, moderate, and severe stroke. The mean total costs per patient were 107 000 SEK ($15 970) for mild stroke, 263 000 SEK ($39 254) for moderate stroke, and 220 000 SEK ($32 836) for severe stroke. There was a significant difference ($P<0.001$) in total costs

TABLE 2. Use of Resources During Study

Item	SU Group (n=166) Mean	Median	25th–75th Percentile	GW Group (n=83) Mean	Median	25th–75th Percentile	*P**
Initial hospitalization for index stroke†							
Acute hospital, days per patient	10.92	8.50	5.0–15.0	9.10	8.0	5.0–12.0	0.170
Geriatric ward, days per patient	17.35	0	0–23.25	26.65	0	0–23.0	0.863
Acute hospitalizations from discharge to 12 mo,† days per patient	5.01	0	0–5.25	5.20	0	0–6.0	0.643
Nonacute hospitalizations from discharge to 12 mo							
Geriatric ward, days per patient	4.49	0	0–0	4.72	0	0–0	0.817
Postcare unit, days per patient	2.06	0	0–0	2.06	0	0–0	0.779
Institutionalized living from discharge to 12 mo							
Nursing home, days per patient	19.39	0	0–0	17.19	0	0–0	0.283
Home for the elderly, days per patient	1.23	0	0–0	13.40	0	0–0	0.003
Assisted living, days per patient	6.54	0	0–0	5.63	0	0–0	0.813
Outpatient care from discharge to 12 mo							
Physician visits per patient	3.48	2.50	0–5.0	3.24	2.0	0–4.0	0.399
Other medical visits per patient‡	10.71	1.0	0–10.0	7.46	1.50	0–10.0	0.859
Outpatient rehabilitation, days per patients	2.55	0	0–0	1.69	0	0–0	0.493
Anticoagulation treatment, visit per patient	2.72	0	0–0	1.84	0	0–0	0.980
Different kinds of support from discharge to 12 mo							
Home assistant, hours per patient	95.73	0	0–63.75	79.08	0	0–28.0	0.796
Safety alarm, months per patient	2.57	0	0–2.0	2.19	0	0–2.0	0.980
Taxi service for disabled, 1-way trip per patient	30.70	2.0	0–27.0	24.41	4.0	0–27.0	0.958
Assistive devices, no. of devices per patient	2.8	2.0	0–4.0	3.12	2.0	0–4.0	0.951
Housing adaptations, % of patients with modifications	4.8			6.0			0.765
Other costs from discharge to 12 mo							
Informal care, hours per patient	427.48	50.0	0–360.50	653.54	51.0	0–479.0	0.723

Data on consumption of prescription drugs were also collected in study, but quantity of each drug consumed is not shown because of the variety of drugs used (see text for estimation of cost of prescription drugs).

*Mann-Whitney test was used for all variables, except for housing adaptations, for which the χ^2 test was used.

†Data on use of patient-related resources were also collected at initial hospitalization and at acute hospitalizations from discharge to 12 months. Because of the many different resources used, these resources are not shown in table. See text for estimation of patient-related costs.

‡Nurse, occupational therapist, physiotherapist, speech therapist.

for mild, moderate, and severe stroke. The total costs for mild stroke were lower than the costs for moderate and severe stroke, and the highest total costs were shown in moderate stroke. The bulk of the lower costs of mild stroke were the result of lower costs at the initial hospitalization and lower costs of institutionalized living. There were no statistical differences between patients with mild, moderate, or severe stroke in age, sex, living arrangements, or nonstroke diagnosis (Table 5).

A problem in the comparison of the costs of mild, moderate, and severe stroke during the first year after the stroke was that the mortality differed for these groups. After 1 year, 13%, 34%, and 45% of the patients had died in the mild, moderate, and severe groups, respectively. Because mortality differed depending on the severity of the stroke, we also estimated the costs for the patients that were alive at the end of the study; these results are shown in Table 6. For patients who survived, the mean total costs per patient were 101 000 SEK ($15 075) for mild stroke, 283 000 SEK ($42 239) for moderate stroke, and 331 000 SEK ($49 403) for severe stroke. There was a significant difference ($P<0.001$) in total costs for mild, moderate, and severe stroke. The total costs for mild stroke were lower than the costs for moderate and severe stroke, and the highest total costs were shown in severe stroke.

Discussion

To our knowledge, this is the first randomized controlled trial of acute stroke unit care with a care continuum that prospectively collected comprehensive data about resource consumption in elderly patients with acute stroke. There was no effect on the number of patients living at home after 1 year, but a beneficial effect was found after 3 months of stroke unit care on mortality and need of institutional care among those with concomitant heart disease. There were no significant differences between the groups regarding neurological score, ADL

TABLE 3. Cost per Patient During Study

	Cost per Patient, SEK						
	SU Group (n=166)			GW Group (n=83)			
Item	Mean	Median	25th–75th Percentile	Mean	Median	25th–75th Percentile	*P**
Initial hospitalization for index stroke							
Acute hospital, hotel cost	32 623	25 390	14 935–44 805	24 296	21 368	13 355–32 052	0.015
Acute hospital, patient-related costs	3 896	2 897	2 211–4 302	3 266	2 414	1 883–3 836	0.007
Geriatric ward	32 964	0	0–44 175	50 636	0	0–43 700	
Total	69 483	43 926	20 825–93 644	78 199	31 603	17 590–81 096	0.280
Acute hospitalizations from discharge to 12 mo							
Hotel cost	14 479	0	0–14 784	15 786	0	0–14 592	
Patient-related costs	3 400	0	0–1 820	3 412	0	0–2 370	
Total	17 879	0	0–18 782	19 198	0	0–16 563	0.895
Nonacute hospitalizations from discharge to 12 mo							
Geriatric ward	8 527	0	0–0	8 973	0	0–0	
Postcare unit	2 104	0	0–0	2 091	0	0–0	
Total	10 631	0	0–0	11 065	0	0–0	0.812
Institutionalized living from discharge to 12 mo							
Nursing home	17 408	0	0–0	15 439	0	0–0	
Home for the elderly	825	0	0–0	8 950	0	0–0	
Assisted living	2 885	0	0–0	2 481	0	0–0	
Total	21 118	0	0–0	26 870	0	0–0	0.673
Outpatient care from discharge to 12 mo							
Physician visit	1 741	1 250	0–2 500	1 620	1 000	0–2 000	
Other medical visits†	3 427	320	0–3 200	2 387	320	0–3 200	
Outpatient rehabilitation days	1 131	0	0–0	744	0	0–0	
Anticoagulation treatment visits	386	0	0–0	262	0	0–0	
Prescription drugs	3 520	2 340	769–4 836	3 108	1 743	459–3 757	
Total	10 206	6 147	1 883–12 571	8 120	6 376	1 240–10 232	0.416
Different kinds of support from discharge to 12 mo							
Home assistant	17 901	0	0–11 888	14 787	0	0–5 236	
Safety alarm	566	0	0–440	482	0	0–440	
Taxi service for disabled	2 119	138	0–1 863	1 684	276	0–1 863	
Assistive devices	3 474	495	0–3 301	4 153	542	0–4 122	
Housing adaptations	1 053	0	0–0	2 068	0	0–0	
Total	25 113	6 485	151–21 020	23 174	3 971	0–18 385	0.644
Other costs from discharge to 12 mo							
Informal care	16 244	1 903	0–13 699	24 847	1 943	0–18 202	0.648
Total costs	170 674	113 371	54 842–249 379	191 473	121 106	50 995–320 969	0.811

SEK exchange rate in 1996 was $1=6.70 SEK and £1=10.50 SEK.
*Mann-Whitney test was used to test significance of all variables.
†Nurse, occupational therapist, physiotherapist, speech therapist.

scores, or the 6 dimensions of the Nottingham Health Profile questionnaire at the 12-month assessment.[27] During the 12 months of follow-up, detailed data about inpatient care, institutional living, outpatient care, social services, and informal care were collected. According to the results of the present study, the total costs per patient did not differ significantly between patients randomized to a stroke unit and patients randomized to a general medicine ward. A secondary aim of the present study was to estimate the costs of stroke in relation to the severity of the stroke (mild, moderate, and severe stroke). This analysis showed that the costs increase with the severity of the stroke; this was not explained by differences in age or in comorbidity. This is in accordance with Jörgensen et al,[6] who found that comorbidity did not increase the length of hospital stay in stroke patients. The costs were substantially lower among patients with mild stroke. The lower costs at the initial hospitalization and the lower costs of institutionalized living explain the total lower costs of mild stroke. A previous study has demonstrated a similar finding, although the comorbidity was not reported.[7]

TABLE 4. Cost per Patient During Study According to Mild, Moderate, and Severe Stroke

	Cost per Patient, SEK									
	Mild Stroke (n=111)			Moderate Stroke (n=59)			Severe Stroke (n=75)			
Item	Mean	Median	25th–75th Percentile	Mean	Median	25th–75th Percentile	Mean	Median	25th–75th Percentile	*P**
Initial hospitalization for index stroke										
Acute hospital, hotel cost	21 301	18 697	11 948–29 870	37 303	34 723	20 909–50 799	36 895	29 870	16 026–50 779	
Acute hospital, patient-related costs	3 317	2 756	2 137–4 058	4 236	2 972	2 182–5 232	3 492	2 578	1 971–3 836	
Geriatric ward	8 028	0	0–0	63 859	26 600	0–91 200	66 703	34 200	0–115 900	
Total	32 646	21 918	13 860–35 685	105 399	71 918	38 741–149 182	107 089	73 012	34 583–173 817	<0.001
Acute hospitalizations from discharge to 12 mo										
Hotel cost	16 583	0	0–20 102	18 741	2 671	0–22 400	10 233	0	0–0	
Patient-related costs	4 259	0	0–2 885	4 543	0	0–2 752	1 423	0	0–0	
Total	20 842	0	0–25 055	23 283	6 400	0–28 804	11 656	0	0–0	0.002
Nonacute hospitalizations from discharge to 12 mo										
Geriatric ward	7 343	0	0–0	11 658	0	0–0	8 765	0	0–0	
Postcare unit	2 235	0	0–0	3 842	0	0–0	640	0	0–0	
Total	9 578	0	0–0	15 499	0	0–17 100	9 405	0	0–0	0.129
Institutionalized living from discharge to 12 mo										
Nursing home	1 360	0	0–0	11 217	0	0–0	44 720	0	0–19 756	
Home for the elderly	1 053	0	0–0	10 631	0	0–0	1 808	0	0–0	
Assisted living	2 046	0	0–0	7 131	0	0–0	494	0	0–0	
Total	4 499	0	0–0	28 980	0	0–0	47 022	0	0–37 716	<0.001
Outpatient care from discharge to 12 mo										
Physician visit	2 153	1 500	1 000–3 000	1 873	1 000	0–2 500	947	0	0–1 500	
Other medical visits†	3 589	1 280	0–3 840	4 648	640	0–5 120	1 173	0	0–640	
Outpatient rehabilitation	440	0	0–0	1 264	0	0–0	1 658	0	0–0	
Anticoagulation treatment visits	528	0	0–0	325	0	0–0	98	0	0–0	
Prescription drugs	3 491	2 220	991–4 197	4 817	3 769	1 240–6 540	2 186	1 133	181–3 226	
Total	10 201	8 220	3 495–11 876	12 927	8 845	3 246–16 905	6 062	2 100	230–8 641	<0.001
Different kinds of support from discharge to 12 mo										
Home assistance	10 288	0	0–9 537	35 178	0	0–30 134	12 657	0	0–0	
Safety alarm	599	0	0–440	746	0	0–1 980	302	0	0–0	
Taxi service for disabled	2 005	0	0–1 863	2 231	828	0–2 484	1 780	0	0–1 656	
Assistive devices	1 634	297	0–1 167	6 719	2 598	664–8 810	4 580	297	0–7 024	
Housing adaptations	441	0	0–0	3 908	0	0–0	892	0	0–0	
Total	14 967	2 640	151–18 385	48 782	13 493	2 860–43 595	20 211	6 485	0–18 596	<0.001
Other costs from discharge to 12 mo										
Informal care	14 690	3 963	467–18 202	28 424	2 709	0–16 036	18 866	0	0–9 641	<0.001
Total costs	107 423	75 379	42 350–133 261	263 294	224 678	100 714–381 335	220 311	185 509	58 392–397 951	<0.001

SEK exchange rate in 1996 was $1=6.70 SEK and £1=10.50 SEK.
*Kruskal-Wallis test was used to test significance of all variables.
†Nurse, occupational therapist, physiotherapist, speech therapist.

The costs per patient varied greatly depending on the severity of stroke; they also varied within each severity class. This great variability in costs affected the statistical power to find a significant difference in costs between the treatment groups. The power calculations of the present study, and thus the sample size, were based on detecting a difference in the proportion of patients discharged to their own homes. The result of the present study can be used for sample-size calculations of future studies of the costs of stroke. Our data indicate that ≈400 patients must be recruited to obtain sufficient statistical power to show a 25% reduction in costs the first year after stroke. The present study included 249 patients, and it had a limited statistical power in demonstrating a significant difference in costs between the treatment groups.

An advantage of this randomized study was that patient-specific data on both costs and outcomes were collected

TABLE 5. Baseline Characteristics According to Mild, Moderate, and Severe Stroke

	Mild Stroke (n=111)	Moderate Stroke (n=59)	Severe Stroke (n=75)
Female sex, n (%)	69 (62)	39 (66)	45 (60)
Age (mean), y	79.2	80.4	80.7
Living alone, n (%)	58 (53)	37 (65)	38 (51)
Medical history,* n (%)			
Myocardial infarction	22 (20)	10 (17)	14 (19)
Intermittent claudication	2 (2)	4 (7)	6 (8)
Atrial fibrillation	26 (23)	13 (22)	23 (31)
Chronic heart failure	19 (17)	6 (10)	11 (15)
Diabetes mellitus	28 (25)	10 (17)	28 (25)
Hypertension	42 (38)	19 (32)	26 (35)
Angina pectoris	29 (26)	14 (24)	13 (17)
Cancer	16 (14)	9 (15)	9 (12)
Chronic respiratory disease	4 (4)	6 (10)	6 (8)
Gastrointestinal disease	7 (6)	1 (2)	4 (5)
Other diagnosis	12 (11)	10 (17)	17 (23)
No other diagnosis	67 (60)	34 (58)	44 (59)

*Patients can be represented in several of the diagnosis groups.

prospectively, indicating a high internal validity. Increased reliability was considered by the fact that the 2 occupational therapists responsible for evaluations were experienced and independent with respect to the treatment of the patients. All data on resource consumption were also scrupulously collected prospectively within the trial. It has been pointed out that a weakness in this type of study could be a lower degree of external validity.[29] However, this randomized study has been based on generally accepted clinical practice, which decreases the problem of external validity. The patients recruited to the study are also likely to be representative of elderly patients treated for stroke in Sweden. An alternate method might be to predict long-term costs from functional status.[46] Lifetime costs for persons suffering from stroke is another method of expressing costs.[16,18] There are also studies that have estimated costs for stroke care during 1 calendar year.[8,23]

The present data are not directly comparable to the results of previous studies, because the present study is the only one to have used a design of prospectively collected data on all types of costs in a randomized clinical trial based on a representative elderly stroke population. Accordingly, these results cannot be directly compared with any previous studies. However, many previous studies have estimated the costs of stroke.[5–26] Most of them have concentrated on the costs of inpatient care and institutional living,[5,6,8,10,13,14,19–21,25] and costs for outpatient care, social services, and informal care were not included. The total costs found in the present study are of the same order as those estimated in a thorough analysis of costs of stroke in Sweden,[11] but the relative costs for nonhospital care are higher in the present study. The present study showed that inpatient care and institutional living constituted 70% of the total costs for patients randomized to the SU group and 71% of the total costs for patients randomized to the GW group. Twenty percent of the total costs in the SU group were costs of outpatient care, and 10% were costs of informal care. In the GW group, these shares were 16% and 13%, respectively. Thus, one third of the total costs during the year of follow-up were costs that were not associated with inpatient care and institutionalized living, which indicates the importance of comprehensive prospective studies on stroke care. It is also likely that the fraction of these costs would increase further with longer follow-up, because the initial hospitalization determined a large fraction of the costs during the first year after the stroke. It should also be pointed out that the costs of informal care were conservatively estimated, inasmuch as it was assumed that the informal care reduced the leisure time rather than the working time of the caregivers. Leisure time was also valued rather conservatively at 38 SEK per hour (35% of the gross wage rate). Doubling the value of leisure time to 76 SEK per hour would increase the share of total costs for informal care to ≈20%.

The present study showed that the total costs after stroke increased with the severity of the stroke. A possibly better stroke unit effect for patients with severe stroke corresponds with the findings of other studies, which have shown that the severity of stroke influences the length of hospital stay[6,21] and the pattern of total utilization of both hospital and nonhospital care.[7,17] Furthermore, Stroke Unit Trialists' Collaborations' meta-analytic data indicate a more marked effect of stroke unit care for patients with severe stroke versus mild stroke.[44]

In conclusion, the present study showed that the total costs the first year did not differ significantly between the treatment groups. The total annual cost per patient showed a very large variation, which was related to stroke severity at onset and not to age or nonstroke diagnoses. Costs other than those for hospital care constituted a substantial fraction of total costs and must be taken into account when organizing the management of stroke patients. The high variability in costs necessitates a larger study to assess long-term cost effectiveness.

Acknowledgments

This study was supported by the Vårdal Foundation, Trygghetsfonden, the Swedish Stroke Association, John and Brit Wennerström's Foundation for Neurological Research, Felix Neuberg Foundation, Rune and Ulla Amlöv's Foundation for Neurological Research, Hjalmar Svensson Research Foundation, and King Gustav V and Queen Viktoria Foundation. Prof Birgitta Lundgren-Lindquist (present address La Trobe University, Melbourne, Australia) generously provided us with resources and support. We are grateful for the cooperation of Dr Ulla Hallhagen (Högsbo Hospital) and Dr Michaela Holmdahl (previously Vasa Hospital, now Department of Geriatrics, Sahlgrenska University Hospital). We would like to thank Dr Lena Bokemark (Department of Medicine), who helped us to collect necessary data from the medical records. We would also like to thank Agneta Hallén and Henrik Siverbo, who helped us with the data administration, and Stefan Granbom for valuable help with statistics. A special thanks to the staff at the stroke units and the physicians and staff at the Emergency Department who assisted in randomizing the patients.

TABLE 6. Cost per Patient Who Survived During Study According to Mild, Moderate, and Severe Stroke

	Cost per Patient, SEK									
	Mild Stroke (n=97)			Moderate Stroke (n=45)			Severe Stroke (n=41)			
Item	Mean	Median	25th–75th Percentile	Mean	Median	25th–75th Percentile	Mean	Median	25th–75th Percentile	*P**
Initial hospitalization for index stroke										
Acute hospital, hotel cost	21 176	18 697	11 948–29 870	38 977	35 844	22 632–50 779	42 363	37 394	23 896–54 929	
Acute hospital, patient-related costs	3 360	2 828	2 103–4 191	3 762	2 883	2 182–4 801	3 864	2 745	2 046–4 432	
Geriatric ward	8 286	0	0–0	70 258	28 500	0–95 950	96 020	79 800	17 100–142 500	
Total	32 822	21 902	13 831–35 285	112 997	74 429	44 859–156 817	142 246	136 050	52 275–201 703	<0.001
Acute hospitalizations from discharge to 12 mo										
Hotel cost	10 800	0	0–12 758	18 151	0	0–24 555	17 694	0	0–13 617	
Patient-related costs	3 141	0	0–1 845	4 937	0	0–2 670	2 328	0	0–1 302	
Total	14 020	0	0–14 547	23 088	0	0–25 956	20 022	0	0–15 724	0.335
Nonacute hospitalizations from discharge to 12 mo										
Geriatric ward	5 249	0	0–0	8 993	0	0–0	12 976	0	0–0	
Postcare unit	2 453	0	0–0	4 311	0	0–0	1 170	0	0–0	
Total	7 702	0	0–0	13 304	0	0–18 760	14 146	0	0–1 021	0.014
Institutionalized living from discharge to 12 mo										
Nursing home	1 546	0	0–0	6 765	0	0–0	68 839	0	0–171 069	
Home for the elderly	1 205	0	0–0	13 939	0	0–0	3 307	0	0–0	
Assisted living	1 896	0	0–0	7 634	0	0–0	904	0	0–0	
Total	4 647	0	0–0	28 338	0	0–0	73 050	0	0–171 069	<0.000
Outpatient care from discharge to 12 mo										
Physician visit	2 330	1 500	1 000–3 500	2 322	1 500	500–3 500	1 683	1 500	500–2 500	
Other medical visits†	3 711	1 280	320–4 160	6 066	1 600	0–7 840	2 146	320	0–3 200	
Outpatient rehabilitation	504	0	0–0	1 658	0	0–0	3 032	0	0–222	
Anticoagulation treatment visits	605	0	0–0	388	0	0–0	180	0	0–0	
Prescription drugs	3 469	2 398	1 040–4 383	5 464	4 037	1 717–8 774	3 638	3 226	1 251–5 585	
Total	10 618	8 491	4 462–12 185	15 898	10 469	4 924–20 138	10 680	7 631	3 697–10 999	0.098
Different kinds of support from discharge to 12 mo										
Home assistance	11 480	0	0–14 586	39 414	0	0–38 522	23 153	0	0–19 662	
Safety alarm	662	0	0–1 980	900	0	0–2 310	553	0	0–1 320	
Taxi service for disabled	2 272	138	0–1 863	2 827	1 104	276–4 416	3 256	1 518	414–3 623	
Assistive devices	1 806	351	0–1 263	8 073	4 271	913–11 487	7 676	6 485	373–9 110	
Housing adaptations	505	0	0–0	5 124	0	0–0	1 632	0	0–0	
Total	16 725	3 771	293–18 385	56 338	16 447	4 308–71 569	36 270	18 385	7 087–40 527	<0.001
Other costs from discharge to 12 mo										
Informal care	14 421	3 963	796–18 202	32 849	2 964	117–13 072	34 510	2 302	0–50 915	0.950
Total costs	100 956	72 566	39 028–121 201	282 813	257 120	102 466–399 186	330 925	382 386	186 692–441 238	<0.001

SEK exchange rate in 1996 was $1=6.70 and £1=10.50 SEK.

*Kruskal-Wallis test was used to test significance of all variables.

†Nurse, occupational therapist, physiotherapist, speech therapist.

References

1. Langhorne P, Dennis M. *Stroke Units: An Evidence-Based Approach.* London, UK: BMJ Books; 1998.
2. Stroke Unit Trialists' Collaboration. How do stroke units improve patients outcomes?: a collaborative systematic review of randomized trials. *Stroke*. 1997;28:2139–2144.
3. Stroke Unit Trialists' Collaboration. Collaborative systematic review of the randomised trials of organised in-patient (stroke unit) care after stroke. *BMJ*. 1997;314:1151–1159.
4. Gladman JRF. Stroke units: are they cost effective? *Br J Hosp Med*. 1992;47:91–93.
5. Jörgensen HS, Nakayama H, Raaschou HO, Larsen K, Hubbe P, Skyhöj Olsen T. The effect of stroke unit: reductions in mortality, discharge rate to nursing home, length of hospital stay, and cost: a community-based study. *Stroke*. 1995;26:1178–1182.
6. Jörgensen HS, Nakayama H, Raaschou HO, Skyhöj Olsen T. Acute stroke care and rehabilitation: an analysis of direct cost and its clinical and social determinants: the Copenhagen Stroke Study. *Stroke*. 1997;28:1138–1141.
7. 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.
8. Isard PA, Forbes JF. The cost of stroke to the national health service in Scotland. *Cerebrovasc Dis*. 1992;2:47–50.
9. Young J, Forster A. Day hospital and home physiotherapy for stroke patients. a comparative cost-effectiveness study. *J R Coll Physicians Lond*. 1993;27:252–258.
10. Bowen J, Yaste C. Effect of stroke protocol on hospital costs of stroke patients. *Neurology*. 1994;44:1961–1964.
11. Terént A, Lars-Åke M, Asplund K, Norrving B, Jonsson E, Wester P-O. Costs of stroke in Sweden: a national perspective. *Stroke*. 1994;25: 2363–2369.
12. Gladman J, Whynes D, Lincoln N. Cost comparison of domiciliary and hospital-based stroke rehabilitation. *Age Ageing*. 1994;23:241–245.
13. Webb D, Fayad P, Wilbur C, Thomas A, Brass LM. Effects of specialized team on stroke care: the first two years of Yale Stroke Program. *Stroke*. 1995;26:1353–1357.
14. Smurrawska L, Alexandrov A, Bladin C, Norris J. Cost of acute stroke in Toronto, Canada. *Stroke*. 1994;25:1628–1631.
15. Hui E, Lum C, Woo J, Kay RLC. Outcomes of elderly stroke patients: day hospital versus conventional medical management. *Stroke*. 1995;26: 1616–1619.
16. Bergman L, van der Meulen JH, Limburg M, Habbema DF. Costs of medical care after first-ever stroke in the Netherlands. *Stroke*. 1995;26: 1830–1836.
17. Hass U, Persson J, Brodin H, Fréden-Karlsson I, Olsson J-E, Berg I. Assessments of rehabilitation technologies in stroke. *Int J Technol Assess Health Care*. 1995;11:2:245–261.
18. Taylor TN, Davis PH, Torner JC, Holmes J, Meyer JW, Jacobson MF. Lifetime cost of stroke in United States. *Stroke*. 1996;27:1459–1466.
19. Wentworth DA, Atkinson RP. Implementation of an acute stroke program decreases hospitalization costs and length of stay. *Stroke*. 1996;27: 1040–1043.
20. Holloway R, Witter D, Lawton K, Lipscomb J, Samsa G. Inpatient costs of specific cerebrovascular events at five academic medical centers. *Neurology*. 1996;46:854–860.
21. Monane M, Kanter DS, Glynn RJ, Avorn J. Variability in length of hospitalization for stroke: the role of managed care in an elderly population. *Arch Neurol*. 1996;53:875–880.
22. Chiu L, Shyu W-C, Chen T-RJ. A cost-effectiveness analysis of home care and community-based nursing homes for stroke patients and their families. *J Adv Nurs*. 1997;26:872–878.
23. Evers S, Engel G, Ament A. Cost of stroke in the Netherlands from a societal perspective. *Stroke*. 1997;28:1375–1381.
24. McNamee P, Christensen J, Soutter J, Rodgers H, Craig N, Pearson P, Bond J. Cost analysis of early supported hospital discharge for stroke. *Age Ageing*. 1998;27:345–351.
25. Diringer M, Edwards D, Mattson D, Akins PT, Sheedy CW, Hsu CY, Dromerick AW. Predictors of acute hospital costs of treatment of ischemic stroke in an academic center. *Stroke*. 1999;30:724–728.
26. Beech R, Rudd A, Tilling K, Wolfe CD. Economic consequences of early inpatient discharge to community-based rehabilitation for stroke in an Inner-London teaching hospital. *Stroke*. 1999;30:729–735.
27. Fagerberg B, Claesson L, Gosman-Hedström G, Blomstrand C. Effect of acute stroke unit care integrated in a care continuum vs conventional treatment: a randomized 1-year study of elderly patients: the Göteborg 70+ Stroke Study. *Stroke*. 2000;31:2578–2584.
28. Strand T, Asplund K, Eriksson S, Hägg E, Lithner F, Wester PO. A non-intensive stroke unit reduces functional disability and the need for long term hospitalization. *Stroke*. 1985;16:29–34.
29. Drummond MF, O'Brien B, Stoddart GL, Torrance GW. *Methods for the Economic Evaluation of Health Care Programmes.* Oxford, UK: Oxford University Press; 1997.
30. Pocook SJ. *Clinical Trials.* Chichester, UK: John Wiley & Sons; 1993.
31. 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.
32. Scandinavian Stroke Study Group. Multicenter trial of hemodilution in ischemic stroke: background and study protocol. *Stroke*. 1985;16: 885–890.
33. Mahoney FI, Barthel DW. Functional evaluation: the Barthel index. *Md State Med J*. 1965;14:61–65.
34. Vardeberg K, Kolsrud M, Laberg T. The Sunnaas index of ADL. *World Fed Occup Ther Bull*. 1991;24:30–35.
35. Korpelainen JT, Niilekselä E, Myllylä VV. The Sunnaas index of activities of daily living: responsiveness and concurrent validity in stroke. *Scand J Occup Ther*. 1997;4:31–36.
36. Hunt S, McKenna S, McEwen J, Backet E, Williams J. A quantitative approach to perceived health status: a validation study. *J Epidemiol Community Health*. 1980;32:281–286.
37. Ebrahim S, Barer D, Nouri F. Use of Nottingham Health Profile with patients after stroke. *J Epidemiol Community Health*. 1986;40:166–169.
38. Wiklund I. *NHP*: *Swedish Version of Nottingham Health Profile* [in Swedish]. Göteborg, Sweden: Ofta Grafiska; 1992.
39. *The FASS 1996: The Catalogue of Pharmaceutical Specialities in Sweden.* 1996.
40. Johannesson M, Fagerberg B. A health-economic comparison of diet and drug treatment in obese men with mild hypertension. *J Hypertens*. 1992; 10:1063–1070.
41. Johannesson M, Agewall S, Hartford MTH, Fagerberg B. The cost-effectiveness of cardiovascular multiple-risk-factor intervention programme in treated hypertensive men. *J Intern Med*. 1995;237:19–26.
42. Bland M. *An Introduction to Medical Statistics.* Oxford, UK: Oxford University Press; 1996.
43. Altman DG. *Practical Statistics for Medical Research.* London, UK: Chapman and Hall; 1991.
44. Stroke Unit Trialists' Collaboration. Organised inpatient (stroke unit) care for stroke (Cochrane review). In: *The Cochrane Library*, issue 1, 1999. Oxford, UK: Update Software.
45. Wade DT, Langton Hewer R. Functional abilities after stroke: measurement, natural history and prognosis. *J Neurol Neurosurg Psychiatry*. 1987;50:177–182.
46. Caro JJ, Huybrechts KF. Stroke treatment economic model (STEM): predicting long-term costs from functional status. *Stroke*. 1999;30: 2574–2579.