

# COSTS OF HEALTH CARE AND SOCIAL SERVICES DURING THE FIRST YEAR AFTER ISCHEMIC STROKE

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## Abstract

**Objectives:** Knowledge of resource use and costs can be useful when evaluating existing services or planning new services. This study investigates the use of health care and social services during the first year after a stroke. Total costs are calculated, costs are compared across subgroups of patients, and resource items of major importance for the total costs are identified.

**Methods:** The study is based on a database comprising data on all stroke patients admitted to a university hospital in Copenhagen, Denmark, over a 1-year period, 1994–95. Patients were followed for 1 year after the stroke, and data on resource use during and after hospitalization were collected prospectively at interviews. This paper focuses on a subset of 385 patients who were admitted because of cerebral infarct or unspecified stroke.

**Results:** The mean cost, based on all patients, of health care and social services during the first year was 142,900 DKK (US \$25,500). The hospital care until the first discharge, including acute care and rehabilitation, cost 101,600 Danish kroner (DKK) (US \$18,100), i.e., 71% of the total cost. Major resource items after discharge were nursing homes, readmissions, outpatient rehabilitation, and home help. The cost during the first year varied with a number of factors, with the most important being survival and degree of disability. Patients who survived the acute phase and who had severe disability (Barthel Activities of Daily Living [ADL] Index: 0–9) 7–10 days after admission had a total cost during the first year that was five times as high as patients with no disability (Barthel ADL Index: 20).

**Conclusion:** Costs of health care and social services during the first year after a stroke vary considerably. Disability as measured with the Barthel ADL Index is a stronger predictor of costs than Scandinavian Stroke Scale scores and other clinical and demographic variables.

**Keywords:** Economics, Cerebrovascular disorders, Hospitalization, Utilization, Denmark

The increasing focus on health technology assessment and related areas creates a need for knowledge about resource use and associated costs to supplement the

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evidence of clinical effectiveness. The treatment, care, and rehabilitation of stroke patients constitute significant resource use in the health care and social service sectors (4;10;12;13). Several studies have estimated the costs of stroke using different methodologies (18). However, understanding of the factors that determine the patterns of resource utilization, as well as determination of which cost items that are of major importance for the total costs, is still limited.

The purpose of this article is to present data about the resource use and costs for a Danish cohort of stroke patients. Total direct costs during the first year after stroke have been calculated, and the relative costs of services and the resource use for subgroups of patients have been identified. This provides a baseline against which costs of new technologies can be measured (11;19).

## METHODS

The study is based on the Hvidovre Hospital Stroke Database, which comprises data on resource use during and after all hospital stays because of stroke or transient ischemic attack (TIA) between November 1994 and November 1995. During this 12-month period there were 588 admissions, according to the diagnostic categories included in the database. Among these, 315 admissions (54%) had the discharge diagnosis of cerebral infarct, 90 admissions (15%) were diagnosed as intracerebral hemorrhage, in 106 admissions (18%) the stroke type was not specified (stroke without CT/MRI scan), and 77 admissions (13%) were due to TIA. Patients with subarachnoid hemorrhage were not included in the database. Patients who had more than one admission during the year of inclusions were classified according to the first event.

A recent article in *Stroke* that compared a selection of community-based studies found similar distributions of pathological types of stroke in all studies (20). The ratio of the incidence of cerebral infarctions to primary intracerebral hemorrhages among 45- to 84-year-old patients ranged from 4.8 (Aosta, Italy) to 10.3 (Frederiksberg, Denmark). Based on such findings, it was decided to analyze the patients in the database with cerebral infarcts and strokes without specification as one group, assuming that the majority of patients with unknown stroke type had infarcts. Analyzing the group of patients with unspecified stroke alone would have no clinical meaning, and refraining from analysis of this group would introduce a bias of the final results (14).

The principal data collection method was interviews with patients and relatives. Danish legislation requires that patients or relatives give informed consent before participating in research interviews and before collection of data that is not in the medical files and similar sources at the hospital. For some patients it was not possible to obtain informed consent (because of aphasia, disorientation, or death shortly after admission), and for these patients as much information as possible was collected from medical files and the internal computer information system at the hospital. A few patients did not want to participate in the study, and for these cases only basic information was collected. Patients who did not want to participate were not included in the analysis presented here because of insufficient information on resource use after discharge.

We investigated the direct resource use and associated costs from the societal perspective (7). The time horizon was the first year after the event. Interviews were

performed at admission and at 1 week, 3 months, and 12 months after admission. At each interview the resource use since the latest contact was registered. Some resource categories with a limited number of units used, such as visits to the outpatient clinic or the general practitioner (GP) and modifications of homes, were registered as the total resource use. Resources that were used more frequently and tend to vary over time, e.g., home help and medication, were registered as the use during the weeks before each interview, and the resource use estimate was based on the assumption of unchanged resource use from discharge until 3 months after stroke and unchanged resource use from 3 to 12 months.

The following resource categories at the hospital were registered for each patient: length of stay and type of department, physiotherapy, occupational therapy, speech therapy, neuropsychology, social worker assistance, consultations from other specialties, investigations (x-ray, clinical biochemistry, and clinical physiology), and medication. Costs of nursing and doctors' time, input from other staff (secretaries, porters), use of consumables and overheads (administration, cleaning, heating, etc.), and capital costs were allocated per bed-day. After discharge the following resource categories were registered: readmissions related to stroke, outpatient rehabilitation, visits to outpatient clinics (including further investigations), visits to general practitioners (GPs), medication (including anticoagulant treatment), nursing homes and sheltered housing, visits to day centers, home modifications, aids, home help and nursing, meals on wheels, transport help, and recuperation.

Only resource use that was directly related to the stroke was registered. When patients had already had a certain kind of help before the stroke and the amount of help was increased after the stroke because of increased disability (e.g., patients who had more hours of home help per week), it was the incremental resource use that was measured. Data were validated by means of different sources at the hospital and by contacts with the local authorities.

Resource use was registered primarily in natural units. Subsequently, unit costs were established according to the selected natural units. The microcosting approach was used, whenever possible, with separate costing of the components of the services (9). When disaggregation of the services into components was not possible or information on the costs of components was not available, other costing methods were used. Total costs and cost weights obtained from accounts were decided to be used as the first alternative. Besides, market prices were used in a few cases, such as medication and aids. Estimates were used as the last choice where detailed information was not available and market prices do not exist. This was the case for home help, clinical physiologic investigations, and hospital bed-days after transfer to another hospital and at readmissions. A variety of sources at Hvidovre Hospital and in the district of Copenhagen were used for establishing and validating costs. The costs used apply to 1995. In 1995 the average exchange rate was US \$100 = 560.25 DKK.

Some of the records in the database have missing values because the patients were not able to give exact information on their resource use. In this paper, resource use in natural units is explained as the proportion of patients who answered the questions about a resource type, who did have the resource, and when a median is given, it is the median of the patients who were able to quantify the amount (or for whom the data validation process quantified the resource use). The lowest proportion of answers relates to the questions about visits to GPs, which were answered by 206 patients among the 340 survivors (61%).

Concerning the cost estimates, comparisons of the groups of patients with and without missing values demonstrated that the patients with no missing values were

not representative of the total group of patients. Therefore, a model was constructed to enable cost estimations based on all patients (5). When it was known that a patient had a certain resource type but the amount of the resource was unknown, the mean cost of the resource was allocated to the patient. When it was not known whether a patient had a resource type, the proportion of patients who had used the resource type, multiplied with the mean cost of the resource, was allocated.

Information on clinical and social factors was collected at the same interviews. The outcome was described using the WHO model of impairment, disability, and handicap (26), by means of the Scandinavian Stroke Scale (16), Barthel ADL Index (6), and Oxford Handicap Scale (27). The case mix of patients was described using the Oxfordshire Community Stroke Project classification (OCSP) (3). The patients were classified on the basis of their maximal neurological impairment within the first 24 hours or, if they were not hospitalized within this period, when they were first examined.

Multivariate linear regression models were established to determine factors of independent influence on the costs per case. As the cost distributions have positive skewness, logarithms of the costs were used as dependent variables (1). Stepwise procedure was used (2). Significance level for inclusion of variables in the models was 0.05; significance level for exclusion was 0.10. Possible determinants in the models were age, sex, living conditions before the stroke (private address alone/private address not alone/institution), prestroke Oxford Handicap Scale score, level of consciousness at admission (normal/impaired), OSCP group, Scandinavian Stroke Scale score at admission, Scandinavian Stroke Scale score 7–10 days after admission, Barthel ADL Index score 7–10 days after admission, and death during stay at Hvidovre Hospital.

Data were entered in EPI INFO, version 6 (8). Statistical analysis was made in SPSS. Mann-Whitney test was used for continuous data. Wilcoxon's test was used for paired data:  $p < .05$  was considered significant.

The study was approved by the Ethics Committee of Copenhagen.

## RESULTS

### Patients

Among the admissions described in the database, 470 were "first admission in the period" with a diagnosis of stroke and with either consent or no answer to the question of participation in the project. Of these, 290 patients (62%) had cerebral scans that demonstrated signs of infarction or were normal and 85 patients (18%) had scans that showed intracerebral hemorrhage. Ninety-five patients (20%) did not have a scan.

Here the 385 patients with known cerebral infarct or unspecified stroke are investigated. In this group, 265 (69%) gave informed consent to participate in the study. The group of 385 patients had a median age of 74 years (90% central range, 47 to 90 years). The median age of the women, who constituted 52% of the patients, was 78 years, and the median age of the men was 70 years. The median age of patients with known infarcts (i.e., patients who had scans) was 71 years, contrasting with the median age of patients without scans, which was 83 years ( $p = .000$ ).

Before the stroke 16 patients (4%) lived in a nursing home. All others lived in private homes, 51% lived alone, 46% lived with somebody, 2% unknown. The vast majority (85%) of the patients were retired, 12% had paid work, and 3% were unemployed.

The OSCP classification was not applicable in 20% of the patients because of insufficient information about the status within the first 24 hours or at admission. Among the others, 16% had total anterior circulation syndromes (TACS), 36% had partial anterior circulation syndromes (PACS), 35% had lacunar syndromes (LACS), and 14% had posterior circulation syndromes (POCS).

At admission the total group of patients had a median Scandinavian Stroke Scale score of 48 points (maximum is 58 points). Patients with TACS had a median of 21 points, patients with PACS had a median of 50 points, and patients with LACS and POCS had medians of 48 and 55 points, respectively. The high median score of the patients with POCS reflects that the scale was constructed to measure signs of hemispheric dysfunction. Unclassified patients had a median score of 34 points.

Recurrent strokes accounted for 26% of the admissions. At admission, 13% of the patients had impaired consciousness, 32% had aphasia, and 68% had motor deficits.

Among the 385 patients, 45 (12%) died while at Hvidovre Hospital. Of the patients who died, 22 had cerebral infarcts and 23 had unspecified strokes. In the group of patients who were discharged alive 268 had cerebral infarcts (79%) and 72 had unknown stroke type (21%).

## Services

**Hospital Stays.** The median length of stay at Hvidovre Hospital was 14 days (mean, 22 days). Among the 340 patients who survived the acute phase, defined as the stay at Hvidovre Hospital, 42% received further treatment at a rehabilitation hospital. Thirty-two percent had rehabilitation as inpatients, with a median length of stay of 56 days; 29% received rehabilitation as day patients, with or without a preceding phase as inpatients. The median number of days as a day patient was 20. Transfer to other types of departments (for investigations, etc.) took place in 3% of the cases. The length of stay until the first discharge, including the acute phase at Hvidovre Hospital and further rehabilitation or other hospitalization, had a median of 18 days (mean 42 days) and a 90% central range of 1 to 152 days.

During the year following the stroke, 56 patients (16%) had readmissions as inpatients or day patients related to the stroke (for further rehabilitation, for social reasons, or because of another stroke). Three patients underwent carotid endarterectomy. No readmissions related to the stroke took place for 268 patients (79%). The information on the remaining 16 patients is insufficient. The patients who were readmitted as inpatients had a median length of stay of 7 days, and the day hospital patients had a median number of days of 17. For the whole group of 385 patients, the median length of stroke-related hospitalization during the first year was 19 days (mean, 44 days) with a 90% central range of 1 to 160 days.

**Other Health Care and Social Services.** After discharge from the hospital, 26% of the patients had further rehabilitation in an outpatient setting. The median number of sessions was 27. Forty-eight percent of the patients visited an outpatient clinic, in median once. The GP was consulted by 51% in relation to the stroke, in median twice during the year. Seventy-one percent of the patients had higher costs of medicine after the stroke than before.

During the year after the stroke, 11% of the patients moved to a nursing home. At the end of the year, none of these patients had left the nursing homes for private

homes. Only 1% of the patients moved to sheltered housing. Day centers were visited by 8%, with a median of 50 (extra) visits. Among the patients, 31% had home help related to the stroke, with a median of 76 (extra) hours during the year. The district nurse visited 16%, mainly for help with medication. They had a median of 10 (extra) hours of home nursing during the year. New aids were supplied to 50% of the patients and 25% had modifications to their homes. Meals on wheels were delivered to 8%, 8% used transportation services (minibus taxi service, available by subscription), and 6% were away for recuperation.

### Transport

A subset of 44 patients answered questions on transport to and from the hospital, when they were admitted and discharged, and when they visited the outpatient clinic. The mean cost of this “ambulance service” was 1,700 DKK per patient. Costs of transport to and from day hospitals and day centers were included in the costs of those services.

### Private Expenditures

At the interviews 3 and 12 months after stroke, the patients were asked questions about private expenditures. Fifty percent of the interviewed patients reported that they themselves or their relatives had expenses related to the strokes. Very few patients remembered prices of consumables or services, and calculation of private costs has not been possible. The most common expenditures were for transport, “alternative” medication/treatment, clothes/shoes, and expenses related to moving to a more suitable place of residence.

### Outcome

The 30-day case fatality was 10.4%. The 1-year case fatality was 24%. At 1 year, 291 patients were known to be alive. At that time 33 patients (11% of the survivors) lived in a nursing home, and 8 (3%) were hospitalized. The others lived in private homes (including sheltered housing). Thirty-eight lived alone, 44% lived with somebody; the housing arrangements of 18% are not known.

For 201 patients Oxford Handicap Scale scores were available for the prestroke situation as well as 1 year after stroke. Before stroke 145 patients (72%) were able to live independently (score 0–2) and 56 (28%) were dependent on help (score 3–5). The median score before stroke was one. One year after stroke 67 patients were independent (33%), and 134 (67%) were dependent. The median score was three. This difference is significant (Wilcoxon’s test,  $p = .000$ ).

### Costs

**All Patients.** The median total cost per patient of hospitalization, health care, and social services during the first year after stroke, based on all patients in the study, was 69,800 DKK (mean, 142,900 DKK). The cost of hospital care until the first discharge had a median of 49,300 DKK (mean, 101,600 DKK).

The median total cost of health care and social services during the first year for the patients who survived the acute phase was 82,500 DKK (mean, 157,300 DKK). The cost of hospital care until the first discharge had a median of 55,300 DKK (mean, 110,600 DKK). The median cost of health care and social services after discharge was 20,000 DKK (mean, 46,900 DKK). This means that for the patients who survived the acute phase, hospital care constituted 70% and health care and social services after discharge constituted 30% of the total cost.

The health care and social service costs after discharge had the following relative contributions: institutions (nursing homes and sheltered housing), 36%; readmissions, 20%; home help and nursing, 17%; outpatient rehabilitation, 14%; and aids and modifications of homes, 4%. Visits to outpatient clinics, visits to GPs, medication, visits to day centers, meals on wheels, transportation services, and recuperation contributed 2% or less each.

### **Regression Models**

Multivariate linear regression models were established to identify predictors of costs. Models were made for the following costs: costs of hospital care until first discharge for all patients, total costs in the first year after stroke for all patients, and costs of health care and social services after discharge (for patients surviving the acute phase only).

As demonstrated in Table 1, Barthel ADL Index (BI) score 7–10 days after admission was the most important predictor of all the costs considered. Survival was found to have independent influence on the costs of hospital care and of total costs, but inferior to BI.

Age, sex, living conditions before stroke, prestroke Oxford Handicap Scale score, OSCP group, level of consciousness at admission, and Scandinavian Stroke Scale score at admission and at 7–10 days were not significant predictors of costs in the multivariate models.

In univariate analysis, Scandinavian Stroke Scale score at admission and at 7–10 days, OSCP group, and living conditions before stroke were significant predictors of all cost categories; level of consciousness at admission was a significant predictor of costs after discharge and total costs; and prestroke Oxford Handicap Scale score was a predictor of costs of health and social care after discharge. Age and sex were not predictors of any of the costs.

### **Resource Use Stratified According to Barthel ADL Index Scores**

As Barthel ADL Index score 7–10 days after admission was found to be the strongest predictor of costs, the costs of hospital care and of health care and social services after discharge have been calculated for groups defined as BI: 0–9 (severe disability); BI: 10–14 (moderate disability); BI: 15–19 (slight disability); and BI: 20 (no disability) (28). Costs for patients discharged before day 7 and for patients who died while at Hvidovre Hospital have been calculated as well (Table 2).

The higher degree of disability (lower BI), the higher cost in all categories. Patients with BI 0–9 at days 7–10 had a total cost during the first year that was five times as high as the patients with BI 20 and eight times as high as the patients who were already discharged.

The higher the degree of disability, the larger proportion of the total resource use that took place in the hospital, ranging from 76% for patients with high disability to 55% for patients discharged within the first week.

### **Sensitivity Analysis**

As explained earlier, the calculations of costs were based on a model in order to use all available information, including information from patients with missing values. If only the patients without missing values had been included in the analysis, the cost estimates would have been too low. This is due to the fact that, in general, the more disabled the patients are, the poorer informants they become. At the

**Table 1.** Regression Models Predicting Costs<sup>a</sup>

	Variables in models	Coefficients	Standard errors	<i>p</i>	Adjusted R <sup>2</sup>
Log (hospital cost), all patients	Constant BI, days	10.41	0.436	0.000	0.55
	7–10, death acute phase	-0.123	0.009	0.000	
Log (total cost), all patients	Constant BI, days	2.694	0.460	0.000	0.47
	7–10, death acute phase	10.41	0.486	0.000	
Log (health + social cost), patients surviving acute phase	Constant BI, days	-0.155	0.010	0.000	0.16
		2.932	0.513	0.000	
	7–10	11.65	0.371	0.000	
		-0.124	0.024	0.000	

Abbreviations: log = logarithms to base e; BI = Barthel ADL Index.

<sup>a</sup> Logarithms of costs of hospital care, total costs during the first year, and costs of health care and social services after discharge are dependent variables.

<sup>b</sup> Death acute phase: death during acute phase is coded 0; survival of acute phase is coded 1.



**Table 2.** Mean Costs for Patients Surviving the Acute Phase, Divided in Groups According to Barthel ADL Index (BI) Days 7–10, for Patients Discharged before Day 7, and for Patients Who Died during the Acute Phase

BI, days 7–10, patients surviving acute phase	Number of patients	Hospital cost (DKK)	Health + social cost (DKK)	Total cost (DKK)	Cost at hospital (% of total)
0–9	45	265,900	82,300	348,100	76
10–14	37	150,800	50,800	201,500	75
15–19	58	85,800	46,800	132,600	65
20	65	41,300	26,000	67,300	61
Discharge be- fore day 7	61	25,200	20,800	46,000	55
Death during acute phase	45	34,400		34,400	

same time, they need more help and consume more resources. Excluding these patients would lead to underestimations of the total resource use of the group. Moreover, it is much easier to rule out resource items that were not applicable than to inform about resources that you had, as you, in that case, will be asked to provide supplementary information on time, amount, and reason.

The model is based on the two assumptions that: a) the patients, who had used a certain resource item but were unable to quantify this had the same mean cost of the resource item as the patients who were able to quantify it; and b) patients who were not able to give information about a resource item had the same probability of having the resource as the patients who could give information, and that they, in case they had the resource, had the same mean cost.

A sensitivity analysis was performed to investigate the consequence of the assumptions. We calculated the costs of the two alternative situations that: a) neither the patients who did not know if they had a resource item, nor the patients who were not able to quantify the amount, had the resource (cost, 0 DKK allocated); and b) all patients who were not able to tell whether they had a resource or to specify the quantity had the resource (mean cost of the resource allocated). The results of this exercise are shown in Table 3. The ranges between the low and the high estimates are rather wide, with the high estimate of total costs being 42% higher than the low estimate. This reflects the radical assumptions of nobody and everybody without clear data having the resource items.

**Table 3.** Sensitivity Analysis of the Average Costs Calculated by Means of the Substitution Model<sup>a</sup>

	Low estimate	Model estimate	High estimate
Hospital costs, all patients (DKK)	95,600	99,600	115,600
Health + social costs after discharge, survivors (DKK)	36,900	48,400	77,100
Total cost during 1 year, all patients (DKK)	126,000	139,400	178,300

<sup>a</sup> Assumptions of the model are varied, and low and high estimates were obtained.

## DISCUSSION

The findings of this study are potentially useful in future studies involving estimates of resource implications of new or changed services for stroke patients and for estimation of cost-effectiveness of preventive strategies. Studies of the economic consequences of altered services during hospitalization should involve estimates of costs after discharge. This study demonstrates that four resource categories— institutions, readmissions, home help, and outpatient rehabilitation—constituted the vast majority (87%) of the costs after discharge in Copenhagen in 1995. Measurement of these four resource categories would be sufficient for crude estimates of the overall resource consumption and for comparisons of resource use across groups. Of course, this strategy requires no or only minor changes of the services after discharge. This precondition could be investigated by describing a small case series or by discussions with experts.

Another useful result is the finding that the Barthel ADL Index is a stronger predictor of costs than the more complicated instruments, the Scandinavian Stroke Scale and Oxfordshire Community Stroke Project classification. This suggests that the Barthel ADL Index can be used as a case-mix indicator in future studies of resource utilization.

A few other studies have been made in this field. A Swedish study published in 1995 (12) focused in particular on the use of assistive devices, but calculated, as we have done, the costs of health care and social services during the first year and identified explanatory factors of costs. Initial functional ability, measured as Barthel ADL Index 5 days after admission, was found to be the strongest predictor of costs during the first year among a number of demographic and clinical variables. Age and sex had no influence on total costs. Resource items were divided into groups that are different from the groups in our study. Accommodation, including nursing homes and geriatric care, made up the vast majority of costs (70%) during the first year. Inpatient care and domestic services were the only other costs of major importance. Outpatient care, transport services, and assistive devices contributed with small shares.

Another Swedish study published in 1990-91 (24;25) analyzed the resource use during the first year after stroke and found that age influenced the utilization of resources, but not as much as the severity of the stroke (defined as minor/major stroke). Hospital care, including nursing homes, constituted 82% of the total costs. Most of the nonhospital resources were used for home help.

A 1996 study in the United States (15) investigated the utilization of acute care services during the first year after stroke and found stroke type and severity, measured with the Rankin Disability Scale, influenced the costs, whereas age, sex, and prestroke utilization of acute care had no significance.

In other studies from Sweden, the United States, and the Netherlands, the costs during the first year have been related to the lifetime costs of stroke (4;17;21;22;23). Different resource items were included in the calculations and the costs aggregated in different ways, which makes comparisons difficult. In all studies the inpatient hospital costs dominate.

In conclusion, we calculated the costs of hospital care as well as the costs of other health care and social services during the first year after stroke and found significant differences between groups of patients, mainly determined by survival

and degree of disability. The most important resource categories were the primary hospital stay, readmissions to hospital, nursing homes, outpatient rehabilitation, and home help.

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