Four-Fold Increase in Direct Costs of Stroke Survivors With Spasticity Compared With Stroke Survivors Without Spasticity
The First Year After the Event

Erik Lundström, MD; Anja Smits, MD, PhD; Jörgen Borg, MD, PhD; Andreas Terént, MD, PhD

Background and Purpose—The prevalence of spasticity after first-ever stroke is approximately 20%, but there are no health economic studies on costs associated with spasticity after stroke. The objective of our study was to estimate direct costs of stroke with spasticity for patients surviving up to 1 year after the stroke event in comparison to costs of stroke without spasticity.

Methods—A representative sample of patients with first-ever stroke hospitalized at Uppsala University Hospital was eligible for our cross-sectional survey. All direct costs during 1 year were identified for each patient, including costs for hospitalization (acute and rehabilitation), primary health care, medication, and costs for municipality services. Swedish currency was converted to Purchasing Power Parities US dollar (PPP$).

Results—Median age (interquartile range) was 73 years (18), and the proportion of women was 48%. The majority of the direct costs (78%) was associated with hospitalization, whereas 20% was associated with municipality services during 1 year after a first-ever stroke. Only 1% of all direct costs were related to primary health care and 1% to medication. The level of costs for patients with stroke was correlated with the presence of spasticity as measured with the modified Ashworth scale ($r_s=0.524$) and with the degree of disability as measured with modified Rankin Scale ($r_s=0.624$). The mean (median, interquartile range) direct cost for stroke patients with spasticity was PPP$ 84 195 (72 116, 53 707) compared with PPP$ 21 842 (12 385, 17 484) for patients with stroke without spasticity ($P<0.001$).

Conclusions—Direct costs for 12-month stroke survivors are 4 times higher than direct costs for patients with stroke without spasticity during the first year after the event. (Stroke. 2010;41:319-324.)

Key Words: cost of illness ■ medical economics ■ spasticity ■ stroke
The box plot demonstrates the lowest score (the bottom horizontal line on each plot) and the highest (the top horizontal line of each plot). The box (the tinted area) shows the middle 50% (interquartile range). A round circle (O) denotes an outlier, that is, between 1.5 box lengths and 3 box lengths from the end of the box. An asterisk (*) denotes an extreme, that is, >3 box lengths from the end of the box.

real costs. A group of patients with a specific disease is followed for a time period. Our patients were followed during 1 year after a first-ever stroke and all direct costs (both stroke- and nonstroke-related) were included. The Swedish currency (Swedish Krona (SEK)) was converted into Purchasing Power Parities (PPPs) at the exchange rate of 9.34 SEK for 1 PPPS (2003 value). Purchasing Power Parities (PPPs) are rates of currency conversion that eliminate the difference in price levels between countries. It is recommended to convert local currencies into PPPs because it eliminates the variation in monetary levels between countries. The PPPs are exchange rates for a given basket of goods and services. We have used the PPP exchange rate given by the Organisation for Economic Co-operation and Development in which a PPP$ equals the purchasing power of $1 in the United States (Supplemental Tables I and II). The Organisation for Economic Co-operation and Development describes PPP at their web site (www.oecd.org/stand/ppp).

Data Source Population, Population Size, Inclusion and Exclusion Criteria, and Recruitment

Patients were recruited from the Swedish Stroke Register. Stroke was defined according to the World Health Organization criteria. In Sweden, >95% of the patients with stroke are admitted to a hospital. A detailed description of the study sample has been reported previously. Briefly, those eligible for the study were patients with stroke hospitalized at Uppsala University Hospital between January 2003 and April 2004. This hospital is responsible for the population in 4 municipalities with a total of 244,000 inhabitants. Inclusion criteria for our study were as follows: (1) resident in the catchment area; (2) age >18 years; (3) a first-ever stroke (cerebral infarction or intracerebral hemorrhage) with survival of at least 1 year; and (4) ability to give informed consent. Exclusion criteria were as follows: (1) any other neurological disorder that might affect muscle tone; (2) transient ischemic attack; and (3) subarachnoid hemorrhage. One hundred forty patients were included and investigated 1 year after the stroke.

The national healthcare system in Sweden is tax-financed. Patients have the possibility to visit private healthcare providers. In 2003, the cost for health care in our county was 440 million PPPS with private health care providing 1.1% of the costs. There are no private hospitals in our country, but there are private primary healthcare centers.

### Table 1. Costs for All Patients (N=140) at Different Levels of Care

<table>
<thead>
<tr>
<th>Care Category</th>
<th>Costs per Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital costs</td>
<td></td>
</tr>
<tr>
<td>Intensive care</td>
<td>3866 per day</td>
</tr>
<tr>
<td>Intermediate care</td>
<td>1296–2017 per day</td>
</tr>
<tr>
<td>Stroke unit</td>
<td>771–836 per day</td>
</tr>
<tr>
<td>Ward</td>
<td>549–743 per day</td>
</tr>
<tr>
<td>Rehabilitation</td>
<td>531 per day</td>
</tr>
<tr>
<td>Outpatient clinic (doctor)</td>
<td>139–959 per visit</td>
</tr>
<tr>
<td>Outpatient, other</td>
<td>67–196 per visit</td>
</tr>
<tr>
<td>Out-of-hospital costs</td>
<td></td>
</tr>
<tr>
<td>Nursing home, community-based, mean (SD)</td>
<td>4274 (12821) for 1 year</td>
</tr>
<tr>
<td>Home help service, mean (SD)</td>
<td>2071 (5888) for 1 year</td>
</tr>
<tr>
<td>Adjustment of the home, mean (SD)</td>
<td>442 (2249) for 1 year</td>
</tr>
<tr>
<td>Transportation, mean (SD)</td>
<td>24 (84) for 1 year</td>
</tr>
<tr>
<td>Alarm, mean (SD)</td>
<td>18 (40) for 1 year</td>
</tr>
<tr>
<td>Food delivery, mean (SD)</td>
<td>76 (368) for 1 year</td>
</tr>
<tr>
<td>Other costs for municipality, mean (SD)</td>
<td>103 (1199) for 1 year</td>
</tr>
<tr>
<td>Medication, mean (SD)</td>
<td>249 (496)</td>
</tr>
<tr>
<td>Visit at general practitioner</td>
<td>137 per visit</td>
</tr>
<tr>
<td>Physiotherapist/occupational therapist/speech therapist/dieticians</td>
<td>40 per visit</td>
</tr>
</tbody>
</table>

*Hospital costs are for Uppsala University Hospital. Out-of-hospital costs are for different municipalities in Uppsala County. Costs are in PPPS (2003 value) and include costs for administration. 1 PPPS equals the purchasing power of $1 in the United States.

### Assessment Methods and Definitions

The following parameters and definitions were used: age; stroke type (ischemic versus hemorrhagic); gender; hypertension; diabetes; National Institutes of Health Stroke Scale, modified Rankin Scale (mRS), and the Modified Ashworth Scale (MAS).

Spasticity was assessed by MAS, a 6-point ordinal scale with documented reliability. Assessment included flexion and extension movements around upper (shoulder, elbow, wrist, and fingers) and lower extremity (hip, knee, and ankle) joints with the patient in a resting position. Spasticity was defined as a MAS score ≥1 at any of the passive movements.

Included in the estimations of direct cost was the following:

### Costs for Hospitalization

The patient administrative system at Uppsala University Hospital provided us the specific costs for each patient related to the hospitalization, for example, costs for medical personnel, diagnostic investigations, and medication and laboratory tests at all levels of care (Table 1). Costs for readmittances to the hospital during the first year after stroke were included.

### Costs After Discharge

#### Primary Health Care

We scrutinized the medical records of the primary health care (both community and private care) for each patient after discharge from the hospital and recorded all outpatient visits at general practitioners, district nurses, physiotherapists, occupational therapists, dieticians, and speech therapists. A general practitioner consultation equals PPPS 164, and the price for all other consultations and/or treatments was PPPS 48.

### Medication

All medications for each patient at 1 year after stroke were noted, and costs were calculated assuming that the same medication was used during the whole period.
Regional Human Ethics Committee (Ups. 03-595). The study was approved by the finance department of the 4 municipalities. Participants also consented to have their resource use data abstracted and to maintain their privacy. Informed consent was obtained from all patients or their legal representatives.

Statistics

Numeric variables were explored for normal distribution. Age, National Institutes of Health Stroke Scale, mRS, MAS, and direct costs had a nonnormal distribution; hence, we used median (interquartile range) values for comparison. For future health economic calculations, the mean is also reported.

Direct costs of patients with spasticity were compared with direct cost of patients without spasticity in our stroke cohort by univariate analysis. A sensitivity analysis was performed leaving out the hospital costs. Bootstrapping32 was also performed to give an alternative nonparametric analysis.

Costs were compared between patients with stroke and patients with stroke and spasticity using Mann-Whitney U test for age, National Institutes of Health Stroke Scale, mRS, MAS, and direct costs. In addition, we compared the direct costs for different patient groups regarding mRS and MAS with the Kruskal-Wallis test. We used Spearman correlation coefficient, rs, for bivariate correlation analyses between mRS and the direct costs and MAS and direct costs, respectively. A correlation coefficient between 0.5 and 0.75 was regarded as moderate to good. A probability value (2-tailed) <0.05 was set as significant. SPSS Version 16.0 for Macintosh (SPSS, Chicago, Ill) was used for statistical analyses.

Results

Study Sample

Median age (interquartile range) of the study sample was 73 years (18), 75 (20) for women and 73 (18) years for men. The proportion of women was 48%. The stroke subtype was ischemic in 89% and hemorrhagic in 11% of the patients. The frequency of spasticity was 18%. Patients with stroke with spasticity did not differ from patients with stroke without spasticity with respect to gender, stroke type, hypertension, and diabetes (Table 2).

Distribution of Costs

The majority of the costs, 78%, were caused by hospital care, whereas 20% were due to services provided by the municipalities. Only 1% of all costs were generated by primary health care and another 1% by medication. During the hospital stay, patients had full access to the whole stroke team, including doctors, nurses, physiotherapists, occupational therapists, dieticians, and speech therapists. The mean costs for all patients were PPP $32 976 (Table 3). Six patients had extremely high costs for hospital care (PPP $100 000).

Table 2. Clinical Characteristics of Patients With No Spasticity (n=115) and Patients With Spasticity (n=25)

<table>
<thead>
<tr>
<th></th>
<th>No Spasticity (n=115)</th>
<th>Spasticity (n=25)</th>
<th>P Value and Correlation Coefficient, rs (Where Appropriate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (interquartile, years)</td>
<td>73 (18)</td>
<td>73 (20)</td>
<td>0.64</td>
</tr>
<tr>
<td>Women, n (%)</td>
<td>52 (45%)</td>
<td>19 (80%)</td>
<td>0.18</td>
</tr>
<tr>
<td>Ischemic stroke,* no. (%)</td>
<td>102 (89%)</td>
<td>22 (88%)</td>
<td>0.92</td>
</tr>
<tr>
<td>Hypertension, no. (%)</td>
<td>58 (50%)</td>
<td>14 (56%)</td>
<td>0.61</td>
</tr>
<tr>
<td>Diabetes, no. (%)</td>
<td>22 (19%)</td>
<td>8 (32%)</td>
<td>0.16</td>
</tr>
<tr>
<td>NIHSS† median (minimum–maximum), points</td>
<td>1 (0–9)</td>
<td>10 (1–21)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>mRS 0, no. (%)</td>
<td>22 (19%)</td>
<td>1 (4%)</td>
<td>&lt;0.001, rs = 0.624</td>
</tr>
<tr>
<td>1, no. (%)</td>
<td>38 (33%)</td>
<td>1 (4%)</td>
<td>0.18</td>
</tr>
<tr>
<td>2, no. (%)</td>
<td>28 (24%)</td>
<td>4 (16%)</td>
<td>0.36</td>
</tr>
<tr>
<td>3, no. (%)</td>
<td>19 (17%)</td>
<td>8 (32%)</td>
<td>0.16</td>
</tr>
<tr>
<td>4, no. (%)</td>
<td>7 (6%)</td>
<td>8 (32%)</td>
<td>0.16</td>
</tr>
<tr>
<td>5, no. (%)</td>
<td>1 (1%)</td>
<td>3 (12%)</td>
<td>0.16</td>
</tr>
</tbody>
</table>

*Stoke was classified as ischemic or hemorrhagic. †National Institutes of Health Stroke Scale (NIHSS) was performed 1 year after the initial stroke, for example, at inclusion.

Municipality

The finance department of the 4 municipalities provided the total costs for each patient regarding home help service, residential and nursing home, adjustment of housing, transportation, food delivery, and home alarm (Table 1).

Before entering the study, the patients received written and oral information, and participation was based on informed consent. All participants also consented to have their resource use data abstracted from health finance systems. The study was approved by the Regional Human Ethics Committee (Ups. 03-595).

Statistics

Numeric variables were explored for normal distribution. Age, National Institutes of Health Stroke Scale scores, and direct costs had a nonnormal distribution; hence, we used median (interquartile range) values for comparison. For future health economic calculations, the mean is also reported.

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Table 3. Direct Costs for Patients*

<table>
<thead>
<tr>
<th></th>
<th>All Patients (N=140), Mean (Median, IQR)</th>
<th>No Spasticity (n=115), Median (Median, IQR)</th>
<th>Spasticity (n=25)</th>
<th>P Value (Patients With Versus Without Spasticity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All direct costs</td>
<td>32 976 (15 575, 33 087)</td>
<td>21 842 (12 385, 17 484)</td>
<td>84 195 (72 816, 53 707)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hospital</td>
<td>25 741 (13 632, 25 269)</td>
<td>17 882 (9 421, 14 489)</td>
<td>61 894 (45 737)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Primary care</td>
<td>361 (289, 440)</td>
<td>390 (337, 410)</td>
<td>227 (137, 381)</td>
<td>0.025</td>
</tr>
<tr>
<td>Medication</td>
<td>249 (71, 222)</td>
<td>257 (67, 222)</td>
<td>214 (93, 327)</td>
<td>0.79</td>
</tr>
<tr>
<td>Municipality</td>
<td>7010 (4, 4348)</td>
<td>3312 (0, 392)</td>
<td>24 018 (20 011, 38 043)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Home help</td>
<td>2071 (0, 0)</td>
<td>1149 (0, 0)</td>
<td>6311 (119, 10 141)</td>
<td></td>
</tr>
<tr>
<td>Residential care</td>
<td>4274 (0, 0)</td>
<td>1725 (0, 0)</td>
<td>16 000 (10 291, 30 969)</td>
<td></td>
</tr>
<tr>
<td>Adjustment of housing</td>
<td>442 (0, 9)</td>
<td>335 (0, 0)</td>
<td>935 (700, 986)</td>
<td></td>
</tr>
<tr>
<td>Day care</td>
<td>103 (0, 0)</td>
<td>0 (0, 0)</td>
<td>579 (0, 0)</td>
<td></td>
</tr>
<tr>
<td>Transportation</td>
<td>24 (0, 0)</td>
<td>14 (0, 0)</td>
<td>67 (0, 0)</td>
<td></td>
</tr>
<tr>
<td>Alarm</td>
<td>18 (0, 6)</td>
<td>15 (0, 0)</td>
<td>34 (18, 44)</td>
<td></td>
</tr>
<tr>
<td>Food delivery</td>
<td>76 (0, 0)</td>
<td>73 (0, 0)</td>
<td>93 (0, 0)</td>
<td></td>
</tr>
</tbody>
</table>

*Costs are in PPPS. 2003 value/patient, for the first year. 1 PPPS equals the purchasing power of $1 in the United States. IQR indicates interquartile range.
due to long or complicated hospitalization, including intensive care.

Costs for Outpatient Care

The outpatient care at the primary health centers varied considerably; 38% of the patients had one or 2 visits to their general practitioner, and 27% had one or 2 visits to the district nurse during the first year after stroke. Only 4% visited a physiotherapist, 2% an occupational therapist, 1% a dietician, and no visits were recorded at a speech therapist after discharge from the hospital.

Costs for Stroke With Spasticity Compared With Stroke Without Spasticity

Direct costs for hospital care, primary care, and municipality services community health care as well as the sum of direct costs were higher for spastic patients than nonspastic patients (Table 3; Figure 1). The mean direct cost for patients with stroke with spasticity was PPP$ 84 195 compared with PPP$ 21 842 for other patients with stroke ($P<0.001$).

Costs were strongly associated with functional ability (Figure 2) with increasing costs for each mRS level ($r_s=0.624, P<0.001$). Costs were also associated with spasticity (Figure 3) with higher costs for increasing MAS scores ($r_s=0.524, P<0.001$).

Sensitivity Analyses

A sensitivity analysis, by excluding hospital costs, showed 5-fold higher costs (mean values) for patients with spasticity. Bootstrapping, using data from the patients with spasticity ($n=25$), showed a somewhat higher mean value and wider confidence interval with PPP$ 99 329 (95% CI, 49 517 to 182 475).

Discussion

Our study reports a 4-fold increase in direct costs for patients with stroke with spasticity compared with patients with stroke without spasticity. We found a substantial increase of both costs for hospital care and for municipality services in the patient group with spasticity. The costs for medication and primary health care, on the other hand, were low in relation to other costs and did not differ between patients with spasticity and patients without spasticity.

Reliable estimates of the costs of stroke are crucial for allocation of resources. Due to differences in national health financial systems, specific estimations are probably needed for different countries and have to be regularly updated as new treatments become available. In a recent review of the costs for stroke, the average costs ranged from PPP$ 7342 to PPP$ 146 149 for a 12-month follow-up between different countries. The large variation that was found was mainly attributed to differences in population, method, and in the

Figure 2. Direct costs for stroke by RS scores. A round circle (O) denotes an outlier, that is, between 1.5 box lengths and 3 box lengths from the end of the box. An asterisk (*) denotes an extreme, that is, $>3$ box lengths from the end of the box.

Figure 3. Direct costs for stroke by MAS scores. Ashworth maximum 1 stands for a maximum MAS score of 1 in any of the tested joints. A round circle (O) denotes an outlier, that is, between 1.5 box lengths and 3 box lengths from the end of the box. An asterisk (*) denotes an extreme, that is, $>3$ box lengths from the end of the box.
costs that were included in the calculations. Differences in costs were also found within some countries; for example, in the United States, the costs varied 20-fold.

All patients in our study received standard medical care, including access to a multiprofessional team at the stroke unit and during early inpatient rehabilitation. The frequency of outpatient follow-up depended on local resources and contacts with therapists were surprisingly few. Although 20% (5 of 25) of patients with spasticity were prescribed benzodiazepines for various indications, no patient received baclofen, dantrolene, or tizanidine. Botulinum toxin was considered an exclusion criterion, but no patient was excluded for that reason.

It must be pointed out that our study does not provide evidence that spasticity as such is responsible for the increase of costs. However, our results indicate that spasticity reflects a more severe motor disorder that is clearly associated with disability, as illustrated by the MAS and the mRS running almost in parallel. Our data may provide a baseline for further studies of the cost-effectiveness of interventions, including botulinum toxin, and may be used to calculate the total costs for stroke with spasticity. The incidence rate of first-ever stroke in Sweden is 250 per 100 000 inhabitants,\(^3\) and two thirds of the patients survive the first year after the event.\(^3\) Assuming that 20% of these stroke survivors is afflicted by spasticity, direct costs for stroke with spasticity would amount to PPP$ 4209 750 per 100 000 inhabitants/year, including unavoidable cost (for initial intensive care) as well as potentially avoidable costs (for rehabilitation and municipality services).

The strength of the present study is that estimations are based on real costs using the bottom-up method. Previous studies of costs for stroke with spasticity\(^16\)–\(^18\) have been based on Delphi panels, and this type of top-down estimate is subject to bias with the risk of inaccuracy. A limitation is that our sample only includes patients who survived the first year after first-ever stroke; hence, we excluded costs associated with care of patients who died during this period. It is likely that patients who died during the first year after stroke had a more severe stroke. Another limitation is that we omitted indirect costs such as loss of income by reduced work capacity. Although the majority of Swedish patients with stroke (80%)\(^3\) are >65 years of age, this is probably an important factor. Finally, the estimated costs were not separated with regard to costs derived from stroke versus nonstroke. Specification of disease-related costs is difficult to make and would have required closer monitoring of the patients.

In conclusion, our findings indicate that direct costs the first year after stroke are huge and approximately 4 times higher for patients who develop spasticity after stroke compared with stroke without spasticity. Our data may be used as a baseline for cost-effectiveness studies of therapeutic interventions of spasticity after stroke in Sweden.

Acknowledgments
We thank all the patients who participated in this study, the staff at the Stroke Unit at Uppsala University Hospital, and Oskar Åsberg, BBA.

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Disclosures
None.

References


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