

## Cost of Acute Stroke A Review

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### Abstract

The annual incidence of cerebrovascular diseases in Belgium is between 200 and 230/100,000 inhabitants. Mortality after stroke is about 21% and approximately 30% of stroke patients will be dependent on others. Cost is mainly related to the length of hospital stay but also to outpatient care. Length of stay is dependent on stroke severity at entry, stroke location (total infarct in the anterior circulation costs twice as much as small lacunar infarcts), and the social status (patients living alone or in a nursing home have a longer length of stay generating a higher cost). Stroke units by using rationalized acute stroke therapy (including thrombolysis) reduce death and disability and decrease the length of stay by acting on stroke severity and co-morbidities. Stroke units also facilitate early discharge by coordinating outpatient care with the general practitioners, rehab centers, and nursing home. A global stroke-based prospective payment should be implemented in Belgium.

**Key words :** Stroke ; cerebral ischemia ; cost ; economy ; stroke unit.

### Epidemiology

Cerebrovascular disease is the third most common cause of death in the USA and Europe with about 200,000 deaths per annum. The annual incidence of stroke rises with age and is greater than 1% per annum in those over 65 years old (Bamford *et al.*, 1988). Stroke is also a debilitating disease with long-term consequences which imposes a significant social and economic burden. Based on epidemiological studies, Hankey (Hankey and Warlow, 1999) calculated that in a population of 1 million inhabitants 2,400 patients will present each year a stroke (first-ever stroke, 1,800 ; recurrent stroke, 600) and 500 patients a transient ischemic attack. Of these 2,400 stroke patients, 480 (20%) will die during the first month and 1,300 (55%) will be dead (700) or dependent on others in daily activities (600) after 1 year. Among the 1,700 patients who survive, 1,100 will be independent and only 30% of them resume their previous activities. Two weeks after stroke up to 60% of patients require

some assistance in daily activity (Stroke prevention by the practitioner, 1999). The frequency of deficits are hemiparesis (70-80%), ambulation problems (70-80%), visual perception deficits (60-75%), dysarthria (55%), depression (40%), aphasia (20-35%), dysphagia (15-35%), and alteration of recent memory (10-20%). In a large population-based study (Malmgren *et al.*, 1989), 30% of the elderly ( $\geq 85$  years) and 16% of young patients ( $< 45$  years) were moderately or severely handicapped at 6 months after stroke, which indicates that age is correlated with the residual deficit.

### Economic burden : general considerations

The economic burden of stroke includes direct (acute hospitalization, rehabilitation, subsequent medical complications) and indirect (lost productivity and caregiver burden) costs. Policy makers require evidence on the costs and outcomes of stroke as well as the different ways of organizing stroke care. The survival, length of stay (LOS), and cost of stroke care varies across Europe because of differences in unit costs and resource use (Grieve *et al.*, 2000 ; Grieve *et al.*, 2001). Previous studies have shown that stroke is one of the disorders in the western hemisphere with the highest cost to society (Hartunian *et al.*, 1980). Current data indicate that strokes are responsible for 2 to 4% of total health expenditures in developed countries (Isard and Forbes, 1992 ; Evers *et al.*, 1997). In New Zealand, the annual direct costs ranged from \$93 million to \$140 millions and loss of production was between \$99 millions and \$154 millions (Scott and Scott, 1994). In the United States, the cost of hospitalization amounts to about 20% of the total direct cost of stroke management (Dobkin, 1995). In Europe, the cost of hospitalization represents about 25 to 45% of the sums spent during the first year after stroke (Thorngren and Westling, 1991 ; Terent *et al.*, 1994 ; Bergman *et al.*, 1995). The direct cost of stroke is largely determined by the LOS. An estimated 93% of the direct cost of

hospital treatment of stroke patients is accounted for by hospital overheads and nurses' salaries, while only the remaining 7% are accounted for by the salaries of physicians and therapists and the cost of investigations and drugs (Dennis and Langhorne, 1994). To achieve cost reduction, the governments make necessary a rational allocation of available resources by using different strategies to reduce cost.

The introduction of the diagnosis-related group (DRG)-based prospective payment in the US has significantly reduced the direct costs of hospital stay (Dobkin, 1995). This system is based on fixed reimbursements whatever the clinical features and severity of stroke. Even if this system does not seem to lower the quality of patient care in the US (Kahn *et al.*, 1990), it is also quite possible that pre-defined strong limitations of costs may be associated with more frequent discharges to a nursing home (to decrease the length of stay), less frequent referrals to a rehabilitation center (Retchin *et al.*, 1997), or a worse functional outcome after the stroke (Kramer *et al.*, 1997).

When cost implications of acute stroke unit care are examined, many factors may improve the quality of the outcome measures such as screening procedure of background population when recruiting patients, randomization, prospective approach to data collection, and inclusion of all costs related to the studied patients. Different economic aspects have been published in the literature : costs and disability after stroke, costs of stroke unit (SU) care, costs of SU care compared with conventional care, clinical and social predictors of acute hospital costs for treatment of ischemic stroke. Some studies evaluated the cost of SU but were not randomized (Jorgensen *et al.*, 1995a ; Jorgensen *et al.*, 1997). Some studies have not been focused on SU (Thorngren and Westling, 1991 ; Isard and Forbes, 1992 ; Young and Forster, 1993 ; Smurawska *et al.*, 1994 ; Gladman *et al.*, 1994 ; Terent *et al.*, 1994 ; Bowen and Yaste, 1994 ; Bergman *et al.*, 1995 ; Webb *et al.*, 1995 ; Hui *et al.*, 1995 ; Wentworth and Atkinson, 1996 ; Holloway *et al.*, 1996 ; Monane *et al.*, 1996 ; Evers *et al.*, 1997 ; Chiu *et al.*, 1997 ; McNamee *et al.*, 1998 ; Diringer *et al.*, 1999 ; Beech *et al.*, 1999). Others were retrospective and not prospective (Smurawska *et al.*, 1994 ; Wentworth and Atkinson, 1996 ; Monane *et al.*, 1996). Many reports do not provide data on costs for outpatient care or social services (Isard and Forbes, 1992 ; Smurawska *et al.*, 1994 ; Bowen and Yaste, 1994 ; Webb *et al.*, 1995 ; Jorgensen *et al.*, 1995a ; Wentworth and Atkinson, 1996 ; Jorgensen *et al.*, 1997 ; Diringer *et al.*, 1999), or on informal care (Thorngren and Westling, 1991 ; Isard and Forbes, 1992 ; Young and Forster, 1993 ; Smurawska *et al.*, 1994 ; Gladman *et al.*, 1994 ; Terent *et al.*, 1994 ; Bowen and Yaste, 1994 ; Bergman *et al.*, 1995 ; Webb *et al.*, 1995 ; Hui *et*

*al.*, 1995 ; Jorgensen *et al.*, 1995a ; Wentworth and Atkinson, 1996 ; Holloway *et al.*, 1996 ; Monane *et al.*, 1996 ; Jorgensen *et al.*, 1997). In some studies, data on costs have not been registered for individual patients but for categories of patients (Isard and Forbes, 1992 ; Bergman *et al.*, 1995 ; Evers *et al.*, 1997).

### Stroke Units

Different strategies have been already followed to improve use of diagnostic and therapeutic resources : stroke units, rehabilitation teams, and stroke protocols (Indredavik *et al.*, 1991 ; Odderson and McKenna, 1993 ; Bowen and Yaste, 1994 ; Webb *et al.*, 1995). Nursing supervision systems called *critical pathways* have been also created (Wentworth and Atkinson, 1996). The stroke teams direct medical management but also act to reduce LOS by expediting rapid diagnostic evaluation and discharge planning to home, home with assistance, nursing home, or rehab centers. The use of such specialized stroke teams is effective in reducing the LOS and cost (Wentworth and Atkinson, 1996).

Different studies have reported that SU reduced mortality, the LOS, or the need for institutional care in the short-term, and improved the health status. The Stroke Unit Trialists' Collaboration confirmed the findings by a meta-analysis of all available data (Stroke Unit Trialists' Collaboration, 1997). This meta-analysis indicated a more marked effect of stroke unit care for patients with severe stroke versus mild stroke (Stroke Unit Trialists' Collaboration, 1999).

### Costs and disability after stroke

The key issues for economic studies of stroke are the inclusion of a broad range of care services for outpatients, a reasonable duration of follow-up, the severity of handicap, and the social status. A survey of disability was conducted in England in the mid-1980s to examine service utilization and costs for more than 1,000 people who have had a stroke (Kavanagh *et al.*, 1999). Disability problems were common among stroke survivors, particularly in relation to locomotion, self-care and holding. Among people living alone, the major contributors to costs were in-patient care (£27 per week) and home help (£30 per week). Among people living with others, in-patient hospital care was also a major cost (£28 per week). Other services costing more than £5 per week were general practitioner consultations, hospital outpatient care and day center attendances. Costs were associated with the severity of disability, the time elapsed from stroke, and whether the person was living alone.

## Costs of Stroke Unit care

### HOSPITAL COSTS

A Canadian study (Smurawska *et al.*, 1994) calculated the cost of acute stroke care for all first admissions to a teaching hospital for 285 consecutive patients. The average cost per patient was \$27,500 Canadian, and strokes in men cost less than in women (\$23,000 vs. \$32,000 Canadian). More women died than men (34% vs. 17%,  $p < 0.02$ ), but because women stayed hospitalized longer, they cost more in the long term. The major factor determining cost was social support, and more men than women went home or to rehabilitation units ( $p < 0.02$ ). Family support was greater for men (82%) than women (39%,  $p < 0.0002$ ). These results are explained by the higher prevalence of stroke in women than men in the elderly and by the higher number of widowed women living alone in this range of age. The authors conclude that significant cost reductions are more likely to be achieved by altering discharge policies and improving social conditions for early return to home than by reducing laboratory or medical personnel costs.

The Copenhagen Stroke Study (Jorgensen *et al.*, 1997) evaluated what social and medical factors influence the LOS in the 1,197 acute stroke patients admitted in a stroke unit. Local non medical factors affecting the LOS, such as waiting time for discharge to a nursing home after completed rehabilitation or waiting time for aids at home, were accounted for in the analysis. The mean LOS was 37.4 days with 27% for local non medical reasons. After subtraction of time spent in waiting for a nursing home, the average LOS was 27.1 days (SD, 44.1; range, 1 to 193), including all acute care and rehabilitation, corresponding to a direct cost of \$12,150 per patient. The LOS increased with increasing stroke severity (6 days per 10-point increase on the Scandinavian Stroke Scale [SSS];  $p < 0.0001$ ) and decreased by almost 1 week with a reduction in initial severity by 5 SSS points in patients with a score  $\geq 25$  points. The LOS also increased with single marital status (3.4 days;  $p = 0.02$ ). Death reduced the LOS (22.0 days;  $p < 0.0001$ ), because it occurs more often early after stroke when the patient is still hospitalized (Silver *et al.*, 1984). Age, sex, the vascular risk factors (diabetes, hypertension, claudication, ischemic heart disease, atrial fibrillation, smoking, daily alcohol consumption), a history of stroke, the presence of other disabling co-morbidity, smoking, daily alcohol consumption and the type of stroke (hemorrhage vs. infarct) had no independent influence on the LOS. These data provided by the Copenhagen study are in accordance with other previous reports (Nakayama *et al.*, 1994; Jorgensen *et al.*, 1995b), and suggest that medical

therapy may reduce the LOS substantially and consequently the costs in moderate and mild strokes. Therefore, efforts to reduce costs should aim at reducing initial stroke severity or improving the rate of recovery (i.e. by using thrombolytic therapy in a higher number of patients).

An Italian study (Mamoli *et al.*, 1999) evaluated the direct costs of hospital care of acute ischemic stroke in 245 patients (cerebral hemorrhage and transient ischemic attacks were excluded). The mean LOS was  $13.1 \pm 7$  days. The mean total cost per patient was  $\$3,289 \pm 1,640$ , with a mean cost per day of \$251. Approximately 80% of total costs were due to the daily component (personal wage and general care) and 20% to the ancillary component (investigations and treatments). The univariate analysis of LOS showed that coming from residence other than one's home, a National Institute of Health Stroke Scale (NIH) score  $> 7$  at entry (higher is the score, greater is the severity), a Rankin scale score  $> 3$  at entry (dependent patients), a total anterior circulation stroke clinical syndrome at entry (infarct in the total middle cerebral artery territory), and discharge to a nursing home or rehab center rather than dying or going home were associated with a significantly higher LOS. A multiple linear regression model of LOS, which is the major component for the daily cost, showed that the Rankin score at entry, the clinical syndrome type, and the destination at discharge independently contributed to the LOS. The univariate analysis of ancillary costs showed that age  $\geq 65$  years, admission for a recurrent stroke, and in-hospital death were significantly associated with lower costs, whereas a LOS  $> 13$  days was associated with higher costs. A second linear regression model showed that younger age ( $\leq 65$  years) (probably by a higher number of investigations) and a longer LOS significantly increased the ancillary costs.

A US study (Diringer *et al.*, 1999) collected all the demographic and clinical data on 191 patients with acute ischemic stroke. The median LOS was 6 days (range, 1 to 63 days), and mortality was 3%. The median hospital cost per discharge was \$4,408 (range, \$1,199 to \$59,799). Fifty percent of costs were for room charges, 19% for stroke evaluation, 21% for medical management, and 7% for acute rehabilitation therapies. Sixteen percent were admitted to an intensive care unit (ICU). Length of stay accounted for 43% of the variance in total cost. Therefore, room charges related to the LOS account for the majority of costs, and attempts to reduce the cost of stroke evaluation would be of marginal value. Other independent predictors of cost included stroke severity (longer LOS, higher use of ICU), heparin treatment, atrial fibrillation (higher stroke severity, longer LOS), male sex (higher rate of previous stroke and co-morbidities), ischemic heart disease, and pre-morbid functional status. Also, total costs varied by discharge

location, with those discharged to nursing homes having the highest cost and those discharged to home the lowest cost.

#### SHORT-TERM COSTS INCLUDING SU AND OUTPATIENT CARE

A study (Caro and Huybrechts, 1999) calculated the costs (calculated in UK units) for the initial period (3 months) of stroke treatment through data provided by two randomized, double-blind, placebo-controlled phase III trials of lubeluzole for the treatment of acute (< 6 hours) ischemic stroke (Grotta for the US and Canadian Lubeluzole Ischemic Stroke Study Group, 1997 ; Diener for the European and Australia Ischaemic Stroke Study Group, 1998). Among the 13 participating countries, the USA accounted for 44% and each of the other countries for less than 10%. The mean LOS was 26 days. At 3 months, 21% of the patients had died, 46% had returned home, 10% had remained in hospital, 12% had been transferred to nursing homes and 11% to rehabilitation services. Among the 1,062 survivors, 47% had a major disability. Most survivors with a minor stroke returned home (81%) compared with only 30% of those with major stroke. The average short-term management cost was estimated to be £8,326 (\$13,649) per patient. Hospital stay was the major cost driver (73%) compared with rehabilitation center (16%), outpatient services at home or in a retirement home (7%), and use of a nursing home (4%). The total cost is largely influenced by the LOS ; general ward was the major cost component, accounting for 34% of the short-term costs, and intensive care and stroke wards were the next two important components (18% and 14%, respectively). Using a long-term economic module, for a patient who survived at the end of the trials, it is predicted that the subsequent cost amounts to £75,985 (\$124,564) for a major and £27,995 (\$45,893) for a minor stroke. This study shows that long-term costs account for more than 80% of the total costs and reducing disability by medical interventions decreases the short-term and long-term costs.

A Spanish study (Carod-Artal *et al.*, 1999) evaluated the health costs during a 1-year period in stroke patients admitted in a SU. The use of health resources depended on the severity of handicap (higher in dependent patients with a score < 60 on the Barthel scale), average SSS score (higher is the severity, higher is the cost), gender (higher cost in women), and the extent of infarct (total infarcts in the territory of the anterior circulation cost twice as much as small lacunar infarcts). This study concludes that cerebrovascular disease is expensive in terms of health-care. Fifty-four percent of the health-care expenses are incurred during the acute phase of stroke and the other 46% during the first year of follow-up.

#### Costs of SU care compared with conventional care

In Sweden, a study examined resource utilization during a 12-month period after acute stroke in elderly patients (> 70 years) randomized to SU care compared with conventional care in general medical wards (Claesson *et al.*, 2000). In this study, the SU care reduced mortality or the need for institutional care after 3 months, especially in those with severe stroke or in patients with cardiac disease. However, there was no difference in mortality or the proportion of patients living at home after 1 year (Fagerberg *et al.*, 2000). Main outcomes were costs from inpatient care, outpatient care, and informal care. The total mean annual costs the first year did not differ significantly between the treatment groups in this prospective study despite a trend toward a lesser cost for SU care (\$25,373 vs. \$28,507). Costs other than those for hospital care (inpatient care in rehab centers, 70% ; outpatient care 30%) constituted a substantial fraction of total costs and must be taken into account when organizing the management of stroke patients. The authors compared the costs of inpatient and outpatient care according to the location of hospitalization (SU vs. general ward [GW]). Inpatient care and institutional living constituted 70% of the total costs for SU patients and 71% for GW patients. Outpatient care represented 20% in SU patients and 16% in GW patients. The difference in costs between the two groups was not significantly different, but the number of patients (249) was too small to reach a sufficient statistical power.

#### Clinical and social predictors of acute hospital costs

Length of hospital stay (Jorgensen *et al.*, 1997 ; Caro and Huybrechts, 1999 ; Mamoli *et al.*, 1999 ; Diringer *et al.*, 1999) and initial stroke severity (Jorgensen *et al.*, 1997 ; Caro and Huybrechts, 1999 ; Carod-Artal *et al.*, 1999 ; Mamoli *et al.*, 1999 ; Diringer *et al.*, 1999 ; Claesson *et al.*, 2000) are the most powerful predictors of high total costs. Total infarct in the territory of the anterior circulation is another factor which increases costs because this type of infarct is related to a more severe handicap and higher LOS (Carod-Artal *et al.*, 1999 ; Mamoli *et al.*, 1999). The destination of patients at discharge influence also the total costs ; transfer to nursing homes or rehabilitation centers increase the costs while going back home decrease them (Mamoli *et al.*, 1999 ; Diringer *et al.*, 1999). A social support mainly coming from the family reduces the LOS and consequently the cost and perhaps this explains why in some studies shorter LOS are more often observed in men than in women (more frequently widowed at the time of stroke) (Smurawska *et al.*, 1994 ; Jorgensen *et al.*,

Table  
Epidemiological data in Belgium in 1988-1989

	Incidence / 100.000	Expected number / year	Mortality	Dependency
TIA	102	10,014		
Stroke	230	22,731		
Stroke < 60 years	30			
Stroke > 80 years	300			
Death < 24 hours			14.8%	
Death < 8 days			32.9%	
High dependency				30.4%
Low dependency				39.1%
No dependency				30.4%

Data issued from MOBIDAT (Van Casteren and Van der Veken, 1990)  
(<http://www.iph.fgov.be/epidemiomobidat/FR/MbFramFR.htm>)

1997 ; Carod-Artal *et al.*, 1999). Early death is associated with lower costs through a reduced LOS (Jorgensen *et al.*, 1997 ; Mamoli *et al.*, 1999). Age (Jorgensen *et al.*, 1997 ; Claesson *et al.*, 2000), except in the Italian study (Mamoli *et al.*, 1999), was not associated with higher costs. Co-morbidity, mainly the associated stroke risk factors, does not affect cost (Jorgensen *et al.*, 1997), but a history of atrial fibrillation or ischemic heart disease can increase it (Diringer *et al.*, 1999).

### Stroke in Belgium : what should be done ?

In Belgium, all patients with a transient ischemic attack (deficit < 24 hours) or stroke including cerebral hemorrhage and ischemia (deficit > 24 hours) were recorded during the period 1988 – 1989 in the MOBIDAT Data Base (Data base of morbidity in Belgium) (Van Casteren V. and Van der Veken J., 1990). The annual incidence of cerebrovascular diseases is about 200 – 230/100,000 inhabitants (Table) and is higher than that of Parkinson disease (4.5-21/100,000) (Tanner *et al.*, 1997), dementia (127/100,000 over 60 years) (Lerner and Whitehouse, 1994), multiple sclerosis (3.4-12.2/100,000) (Pryse-Phillips *et al.*, 2001), and epilepsy (26-70/100,000) (Hauser and Annegers, 1993). Mortality after stroke is about 21% (Monica Project). About 1/3 of stroke patients will be dependent on others. Based on epidemiological studies, we can extrapolate that each year the disease approximately yields 3,450 deaths and 7,000 handicapped patients with different degrees of severity.

In Belgium, cost of stroke during the acute phase has been estimated to be 44,600 Euro (oral communication, S. Blecic). In Scotland, about 7% of hospital-bed days are accounted for by stroke patients, who represent 2% of hospital discharges {Isard & Forbes 1992 2743 /id}. Unfortunately, we have no prospectively collected financial data related to stroke management in Belgium, making impossible any comparison with other frequent

neurological diseases such as epilepsy, Parkinson disease, or dementia. However, due to the higher incidence of stroke and the number of investigations needed to manage cerebrovascular disease, we can expect a higher total cost for stroke than for other neurological diseases. A study, with a financial support, should be launched to evaluate the economic burden of stroke in Belgium.

According to the published studies, length of hospital stay and initial stroke severity, leading to a greater residual handicap, are the most powerful predictors of high total costs. A policy aiming at accelerating discharge is thus likely to reduce the costs considerably, but this leads to a transfer onto another budget, such as inpatient and outpatient rehabilitation centers or families. Reducing the LOS by just one day would probably pay for all of the average patients' investigations and drugs. Several studies have shown that stroke units decrease the neurological handicap and the risk of medical complications in bedridden patients. Early intravenous thrombolysis also significantly decreases the number of dependent patients {Marler, Brott, et al. 1995 848 /id}, and the average LOS was shorter in alteplase-treated patients, who were more likely to be sent home rather than being discharged to a nursing home or to inpatient rehabilitation centers {Fagan, Morgenstern, et al. 1998 2914 /id}. Thrombolysis and stroke units, with the support of an integrated social service, facilitate a earlier discharge reducing the LOS and consequently the total cost. The Belgian Stroke Council published a proposal of Guidelines for stroke units and acute stroke treatment (<http://www.neuro.be/bsc/>) (Desfontaines *et al.*, 2002 ; Peeters *et al.*, 2002). A global stroke-based prospective payment for stroke units should be implemented in Belgium to support all the costs related to an interdisciplinary stroke management. Such a financial acknowledgement of medically qualified stroke units should take into account the number of inhabitants for each area as well as the distance to

cover to reach the closest stroke center in order to reduce the transfer time for early thrombolysis.

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