

## MANAGEMENT AND COST OF STROKE IN LATE NINETIES: PRAGUE UNIVERSITY HOSPITAL

Marie Havlovicova, Pavel Kalvach, Libor Svoboda, Lucie Spanila,  
Lukaš Adamko and Jan Mihula

Department of Neurology, 3<sup>rd</sup> Medical Faculty, FNKV, Prague, Czech Republic

**SUMMARY** – Analysis of 224 stroke admissions during the year 1997 was performed to contribute to the international comparisons in the management of acute stroke. The analysis revealed 83% of patients with cerebral hemorrhage and 37% of those with cerebral infarction to have spent at least several days in the intensive care unit (ICU). The mean length of the hospital stay of 12.7 days differed between men and women, while the mean length of ICU stay differed between cerebral hemorrhage and cerebral ischemia. The intervals between stroke onset and admission, and between stroke onset and computed tomography (CT) as well as the percentual employment of various diagnostic methods were evaluated in a subset of 156 cases. Hospital admission with a median of 4 hours and management in case of hemorrhage compared relatively well with international standards, whereas in case of cerebral infarction the use of CT was found to be insufficient, also showing a delay from hospital admission. The overall mortality rate of 10.7% revealed a relatively young mean age of our cohort (61.2 years). The expenses of stroke hospitalization of 1,390 USD were strikingly low as compared with other industrialized countries, which was mainly due to the current exchange rate.

**Key words:** *Cerebrovascular accident, economics; Cerebrovascular disorders, prevention and control; Treatment - outcome; Cost-benefit analysis; Czech Republic*

### Introduction

A considerable decline in stroke death rates in industrial countries, recorded over several decades, is believed to be a consequence of reduced case - fatality rates rather than a decrease in the stroke incidence<sup>1-4</sup>. Since the 1980s, a similar tendency has also been observed in Central and Eastern Europe. The improvement in stroke fatality is usually explained by two main factors: a shift in stroke hospital admissions to less severe forms and improvement in its management. However, there are rather great differences in acute care as well as in diagnostic complement among individual centers and countries<sup>5,6</sup>. Few data have hitherto been reported from the Czech Republic. Therefore, we performed analysis of our stroke admissions ac-

ording to the intervals from stroke onset to hospital admission, length of hospitalization, use of intensive care, and use of different decisive examinations. Then, the costs of hospital stroke diagnostics and treatment were calculated for our patient cohort.

### Patients and Methods

The analysis included all patients admitted to our University Department of Neurology between January 1 and December 31, 1997. There were 224 patients, 141 male and 83 female, with a diagnosis of I 60 - I 69 according to the International Classification of Diseases, 10<sup>th</sup> Revision. The admission to our Department referred to a catchment area of some 300,000 inhabitants, this time being limited to those below the age of 65. Older patients were referred (with some exceptions) to internal medicine departments, which has been regular practice at our hospital since 1997.

Correspondence to: *Pavel Kalvach, M.D., Ph.D.*, Department of Neurology, 3<sup>rd</sup> Medical Faculty, FNKV, Šrobárova 50, 100 34 Prague 10, Czech Republic. E-mail: kalvach fnkv.cz

Received February 28, 2001, accepted May 29, 2001

The total cohort of patients were analyzed according to age, mean duration of hospitalization, frequency and length of treatment in intensive care unit (ICU), proportion of stroke subtypes, overall hospital mortality, and sex differences for these parameters.

In a subset of 156 cases, we retrospectively analyzed the following data using standard medical documentation: interval between stroke onset and admission, proportion of admissions to ICU and regular ward, interval between admission and computed tomography (CT) examination, use of diagnostic methods, and rate of surgical treatment. When the exact time of initial symptoms could not be defined (recognition of first symptoms on waking up, finding the patient unconscious, etc.), the time of stroke onset was defined as the time when the patient had last been seen in normal state.

Hospitalization costs were calculated from the price of particular examinations, cost *per* day in ICU or regular

## Results

The main characteristics of our 224 patients are shown in Table 1. The male preponderance (almost two thirds) was associated with their mean age by 2.4 years younger than in females. The mean hospital stay was by 1.4 days longer in women. More than one third of patients spent at least several days at ICU, again with a higher percentage in men than in women. The ICU stay (9 days on average) was longer in women, with a difference of even 3 days. The relatively high prevalence of intracerebral hemorrhage (25%) in our cohort did not differ much between the two sexes, whereas subarachnoid hemorrhage (SAH) was more common in women. The overall hospital mortality rate was slightly above 10%.

A more detailed analysis could be carried out for 156 patients, i.e. 42 hemorrhage and 114 ischemic stroke cases. The search for the onset of symptoms to hospital admis-

Table 1. Main characteristics of stroke hospitalizations and stroke subtypes (ICD diagnosis I 60 - I 69)

Characteristic	Total	Male	Female
N	225	141 (62.9%)	83 (37.1%)
Mean age (yrs)	61.2 (range 18-90)	60.3	62.7
Mean hospitalization (days)	12.7	12.2	13.6
Hospitalization in ICU	93 (38.4%)	68 (44.7%)	25 (27.8%)
ICU only	51 (21.1%)		
ICU + regular ward	42 (17.4%)		
Mean ICU stay (days)	9.0	8.2	11.2
Proportion of stroke subtypes			
hemorrhage (I 60 - I 62)	25.0%	25.5%	24.1%
SAH	7.6%	6.0%	10.3%
ischemia (I 63 - I 67)	70.1%	68.1%	73.5%
poststroke disorders (I 69)	4.9%	6.2%	2.4%
Overall hospital mortality	10.7%	10.6%	10.8%

ICU=intensive care unit; SAH=subarachnoid hemorrhage

ward, and average expenses for medication and rehabilitation. The price of each diagnostic procedure was multiplied by its percentual usage in the whole cohort, and the cost of ICU or regular ward stay *per* day was multiplied by average duration of the respective patient stay in total. The expenses of surgical procedures were not included in this calculation. Neither were any rehabilitation procedures performed after discharge from our department taken in consideration.

sion interval revealed 81.8% of hemorrhage patients to be admitted within 24 hours, and 18.2% later than 24 hours from the onset of symptoms. In case of ischemic stroke, the respective intervals were recorded in 79.3% and 20.7% of patients. As hospital arrival of more than 24 hours from symptom onset was often due to some exceptional reason, these cases were excluded from further analysis. The remaining admissions occurred at a mean of 4.87 hours after the hemorrhage, with a median of 3 hours, and at a

mean of 4.47 hours after an ischemic event, with a median of 3.5 hours. Figure 1 shows the percentage of hospital admissions at intervals shorter than 2, 4, 6, 12 and 24 hours.

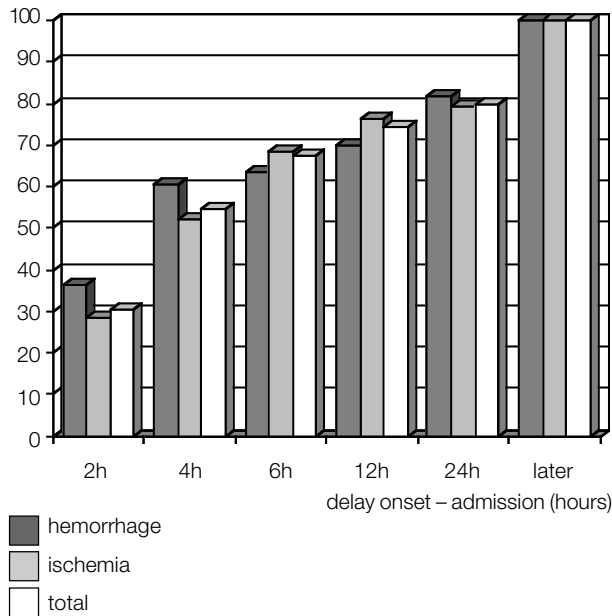


Fig. 1. Delay in stroke onset - hospital admission in acute cerebrovascular events (N=156)

Concerning CT examination as the initial tool for stroke confirmation and assessment of its type, our analysis included the admission to CT and stroke onset to CT intervals. These two intervals were considerably shorter in hemorrhagic stroke patients than in ischemic stroke patients. In hemorrhage patients admitted within 24 hours, the mean interval from admission to CT examination was 2.04 hours (median 0 h), yielding a mean of 7.14 hours (median 4 hours) from the onset of stroke to CT examination. The zero median was due to a substantial proportion of patients who underwent their CT examination even before their arrival to our neurology department.

In cerebral infarcts, the time elapsed was much longer. Out of those referred to CT at all (71.8%), only some more than a half (51.7%) were examined within the first 24 hours. The mean interval from admission to CT in patients admitted within 24 hours from the onset of symptoms was 2.21 days (median one day). The mean overall CT delay including the patients that had arrived later than 24 hours after initial symptoms was 2.93 days.

Thirty-five (83.3%) patients with cerebral hemorrhage were treated at ICU for a mean of 10.6 days. Out of 114 ischemic strokes, only 42 (36.8%) were admitted to ICU, with a mean duration of stay of 8.2 days. Also, 14.3% of

Table 2. Percentual frequency of imaging and other auxiliary methods in acute stroke patients (N=156)

Examination	Hemorrhage (n=42) %	Ischemia (n=114) %	Total (N=156) %
Computed tomography	90.48	64.91	71.79
Magnetic resonance imaging	4.76	7.02	6.41
SPECT	2.38	15.79	12.18
Ultrasonography	38.10	76.32	66.03
Angiography	21.43	12.28	14.74
Lumbar puncture	23.81	2.63	8.33
Blood lipids	21.43	69.30	56.41
PTT and/or APTT	83.33	57.02	64.10
EEG	38.10	66.67	58.97
ECG	78.57	71.93	73.72
Holter (24-h ECG)	0	3.51	2.56
Echocardiography			
transthoracic	7.14	19.30	16.03
transesophageal	0	1.75	1.28
Logopedia	9.52	13.16	12.18
Psychology	9.52	8.77	8.97

PTT=prothrombin time; APTT=partial thromboplastin time

our hemorrhagic patients underwent a surgical procedure. Neither the length of their surgical treatment nor its costs were included in the analysis.

A detailed overview of particular imaging and other auxiliary methods employed in our 156 patients is shown in Table 2.

The overall cost of stroke treatment *per* patient under the circumstances described above was 50,054 Czech crowns, an equivalent of 1,390 USD, 72.4% of it for ICU stay, 12.2% for regular ward stay, 7.1% for diagnostics, 6.9% for medication, and 1.5% for rehabilitation.

## Discussion

Although discussions about the best initial treatment for acute stroke are still under way, the fastest possible arrival of patients to the hospital is of paramount importance. The restoration of neurons in the state of ischemic penumbra loses chances with every minute of delay<sup>7</sup>. Admitting one half of our patients within less than 4 hours of the onset of symptoms we compare favorably with the studies from other countries, e.g., New Zealand<sup>8</sup>, Sweden<sup>9</sup>, the Netherlands<sup>10</sup>, Great Britain<sup>11</sup> and Spain<sup>12-14</sup>. Shorter intervals of 3 hours for a half of the patients have been reported from Italy<sup>15</sup> and USA<sup>16</sup>. Slightly longer intervals have been reported from Hong Kong<sup>17</sup> and Budapest (Nagy, personal communication). Considerable differences of as many as several hours between different hospitals often exist within a country, as reported from Newcastle and Manchester<sup>18,19</sup>. The best hospital referral has been reported from Houston, where stroke patients arrive at the emergency department within 115 minutes on an average, and within the next 123 minutes are seen by a neurologist<sup>20</sup>. It should be mentioned that at our hospital, neurologic examination is performed immediately upon admission.

Because of improving services in most centers, data used in reports before 5-8 years should now be considered obsolete. Educational campaigns directed to medical and ambulance personnel as well as to the public proved very valuable in delivering patients quickly to the hospital in North Carolina<sup>21,22</sup> and Mannheim<sup>23</sup>.

Our proportion of patients examined by CT was low (72%). This figure, in fact, did not apply anymore in 1999 and 2000, when improved CT availability yielded a somewhat better percentage. In 1997, however, the 90% CT coverage in hemorrhage and 65% in ischemia reflected the relation of CT indication to the severity of initial presentation.

Even more striking than the difference in CT usage

between hemorrhage and infarction was the respective difference in the admission to CT interval. This difference must have been influenced by the more pronounced and abrupt symptoms in hemorrhage. We expected a role to also be played by the patient age. However, close scrutiny of our patients revealed the age in the two stroke groups to differ by 2 years only, in favor of hemorrhage patients who were younger. Similarly, an earlier CT examination in hemorrhage compared with infarction has been reported from Auckland, where the median for ischemic stroke CT (66 hours) was almost 5 times longer than in hemorrhagic stroke (14 hours)<sup>24</sup>. SAH has everywhere been associated with shortest intervals, as expected.

Very successful shortening of the diagnostic protocol has been achieved in Milan, where 31.5% of stroke patients are admitted and submitted to CT examination within 3 hours, while the period from admission to clinical examination takes only 18 minutes and to CT next 81 minutes on an average<sup>15</sup>. Admission first to the emergency department have proved useful in shortening the imaging management<sup>20</sup>.

An important circumstance in the treatment of acute stroke is the availability of ICU. In the Czech Republic, more than a half of neurologic departments are equipped with ICU, however, these units serve many other diseases besides stroke. Patients in comatose states of different origin, those in myasthenic crisis and sometimes also those with traumas are hospitalized in these ICUs, thus their capacity left for stroke being only partial and irregular. Specific stroke units are rare, actually anticipated for some time in the future in most hospitals.

Patients with hemorrhage generally are more often and longer treated at ICU. This remains true despite the fact that most of those with SAH and some with intracerebral hematoma are early transferred to neurosurgery. The longer ICU stay for hemorrhagic stroke is often caused by secondary cardiac complications. A hemorrhagic event is frequently followed by arrhythmias and fluctuations of hypertension. On the other hand, the overall stay of stroke patients at regular ward is longer for cerebral infarctions. This also reflects the higher age of some ischemic patients, who often are precluded from their returning home by social inconveniences.

The length of in-hospital treatment varies considerably in different countries and cities. Our data are most similar to those from Sweden, however, reported from internal medicine departments. On neurologic wards in Sweden, the stay is usually longer (18 days), and differs between the patients discharged directly for home care (8.5

days) and those referred to other institutions (24.4 days)<sup>25</sup>. The shortest hospital stay has been reported from the USA<sup>26</sup>, where the stay of 8.7-11.9 days is associated with early transfer to rehabilitation centers. Longer hospitalization has been reported from Switzerland (2-3 weeks on regular ward after 1-5 days in ICU)<sup>27</sup>, and even longer from Japan (39-52 days)<sup>28</sup> and Canada (55 days for women and 39 days for men, when only survivors were considered)<sup>29</sup>. In Great Britain, 36 days are typical for London, whereas 43 days have been reported from Copenhagen, Denmark<sup>30</sup>.

The cost of acute stroke treatment in our conditions, making an equivalent to less than 1,400 USD, is very low in comparison with other industrialized countries. This may be in small part attributed to the fact that we did not take the cost of surgical treatment for SAH and for some intracerebral hematomas in consideration. However, a major part of this more than tenfold difference compared to American expenses is due to the current exchange rate. Relations of our expenses with local GNP *per capita* are far from being so strikingly high when compared with the relations in most developed countries. In Toronto, the average cost *per* stroke admission in 1991-1992 was 21,150 USD, differing between men and women (17,700 *vs.* 24,600 USD). The Canadian daily cost of 520 USD compares with almost one third of our overall stay expenses. The Toronto experience also differentiates the calculation for mild/moderate stroke from that for severe stroke, the latter being more than fivefold (11,550 *vs.* 61,500 USD). Our proportion for diagnostic tests in the total cost ranges similarly with that in Toronto (8%), whereas that for pharmacy is higher in Canada (4%). Our results refer to the period when thrombolysis had not yet been introduced in the Czech Republic. Its introduction would have increased our costs considerably.

The New Zealand experience estimated direct costs for an ischemic stroke in 1992 to 10,965 USD<sup>24</sup>. However, this total cost was obtained by different methodology, the more so, it also included continuing institutional care.

## References

- BONITA R, BEAGLEHOLE R. Monitoring stroke. An international challenge. *Stroke* 1995;26:541-2.
- BONITA R. Epidemiology of stroke. *Lancet* 1992;339:342-4.
- ASPLUND K. Epidemiology of stroke in Europe. In: Secondary prevention of stroke. Oxford: Oxford Clinical Communications, 1996:2-6.
- THORVALDSEN P, ASPLUND K, KUULASMAA K, RAJAKANGAS AM, SCHROLL M, for the WHO MONICA Project. Stroke incidence, case fatality, and mortality in the WHO MONICA Project. *Stroke* 1995;26:361-7.
- BRAININ M. Neurological acute stroke care: the role of European neurology. *Eur J Neurol* 1997;4:435-41.
- ASPLUND K, RAJAKANGAS AM, KUULASMAA K, THORVALDSEN P, BONITA R, STEGMAYR B, SUZUKI K, EISENBLATTER D. Multinational comparison of diagnostic procedures and management of acute stroke: The WHO MONICA Study. *Cerebrovasc Dis* 1996;6:66-74.
- EHLER E. Ischemicky polostin (the ischemic penumbra). *Ceska Slovenska Neurol Neurochir* 1999;62/95:187-91.
- ANDERSON NE, BROAD JB, BONITA R. Delays in hospital admission and investigation in acute stroke. *BMJ* 1995;311:162.
- WESTER P, RADBERG J, LUNGGREN B, PELTONEN M, for the Seek-Medical-Attention-in-Time Group. Factors associated with delayed admission to hospital and hospital delays in acute stroke and TIA. *Stroke* 1999;30:40-8.
- HERDERSCHEE D, LIMBURG M, HIJDRA A, BOLLEN A, PLUVIER J, WATER de W. Timing of hospital admission in a prospective series of stroke patients. *Cerebrovasc Dis* 1991;1:165-7.
- HEUSCHMANN PU, KOLOMINSKI-RABAS PL, NEUNDOERFER B, WOLFE ChDA, RUDD A, GIROUD M, MENASSA M. Factors influencing hospital admission after stroke in Europe: a comparison among three population-based stroke registers. *Cerebrovasc Dis* 1999;9 (Suppl 1):111.
- DAVALOS A, CASTILLO J, MARTINEZ-VILA E, for Cerebrovascular Diseases Study Group of the Spanish Society of Neurology. Delay in neurological attention and stroke outcome. *Stroke* 1995;26:2233-7.
- SANTOS S, MOSTACERO E. Factors associated with time of presentation after stroke. *Cerebrovasc Dis* 1999;9 (Suppl 1):111.
- SANTOS S, MOSTACERO E. Hospital arrival time in the first three hours from stroke onset: factors associated. *Cerebrovasc Dis* 1999;9 (Suppl 1):111.
- VILA A, BONACINA M, PAESE S, FRANZINI C, OMBONI E. Time of hospital presentation and intrahospital diagnostic course after stroke. *Cerebrovasc Dis* 1999;9 (Suppl 1):112.
- BARSAN WG, BROTT TG, BRODERICK JP, HALEY EC, LEVY DE, MARLER JR. Time of hospital presentation in patients with acute stroke. *Arch Intern Med* 1993;153:2558-61.
- KAY R, WOO J, POON WS. Hospital arrival time after onset of stroke. *J Neurol Neurosurg Psych* 1992;55:973-4.
- FORD GA, MASSEY A, HARBISON J, BARNETT L, HODGE D. Ambulance protocol for rapid admission of acute stroke patients. *Cerebrovasc Dis* 1999;9 (Suppl 1):112.
- CHANT H, WELSH S, CLARKE P, O'NEILL P, McCOLLUM CN. Ambulance transfer times for acute stroke patients in Manchester. *Cerebrovasc Dis* 1999;9 (Suppl 1):112.
- BRATINA P, GREENBERG L, PASTEUR W, GROTTA JC. Current emergency department management of stroke in Houston, Texas. *Stroke* 1995;26:409-14.
- ALBERTS MJ, BERTELS C, DAWSON DV. Analysis of time of presentation after stroke. *JAMA* 1990;263:65-8.
- ALBERTS MJ, PERRY A, DAWSON DV, BERTELS Ch. Effects of public and professional education on reducing the delay in presentation and referral of stroke patients. *Stroke* 1992;23:352-6.
- DAFFERTSHOFER M, BEHRENS S, LUIZ T, ELLINGER K, HENNERICI M. Efficacy of an educational program in acute stroke management. *Cerebrovasc Dis* 1998;8 (Suppl 4):45.

24. SCOTT WG, SCOTT HM. Ischaemic stroke in New Zealand: an economic study. *N Z Med J* 1994;107:443-6.
25. ASPLUND K, WESTER PO. Stroke management around the world – Sweden. *Cerebrovasc Dis* 1994;4:432-4.
26. MITCHELL JB, BALLARD DJ, WHISNANT JP, AMMERING CJ, SAMSA GP, MATCHAR DB. What role do neurologists play in determining the cost and outcomes of stroke patients? *Stroke* 1996;27:1937-43.
27. BOGOUSSLAVSKY J. Stroke management around the world – Switzerland. *Cerebrovasc Dis* 1994;4:431-2.
28. YAMAGUCHI T, OITA J. Stroke management around the world – Japan. *Cerebrovasc Dis* 1994;4:437-40.
29. SMURAWSKA LT, ALEXANDROV AV, BLADIN CF, NORRIS JW. Cost of acute stroke care in Toronto, Canada. *Stroke* 1994;25:1628-31.
30. GRIEVE R, PORSDAL V, WOLFE Ch. Stroke treatment and rehabilitation in London and Copenhagen: a comparison of resource use and outcome in the year following ischaemic stroke. *Cerebrovasc Dis* 1999;9 (Suppl 1):112.

#### Sažetak

### LIJEČENJE I TROŠKOVI MOŽDANOG UDARA U KASNIM DEVEDESETIM: SVEUČILIŠNA BOLNICA U PRAGU

*M. Havlovicova, P. Kalvach, L. Svoboda, L. Spanila, L. Adamko i J. Mibula*

Analiza 224 prijma zbog moždanog udara tijekom 1997. godine provedena je kao doprinos međunarodnim usporedbama liječenja akutnog moždanog udara. Analiza je pokazala da je 83% bolesnika s krvarenjem i 37% onih s moždanim infarktom provelo barem nekoliko dana u jedinici intenzivnog liječenja (JIL). Prosječna duljina boravka u bolnici od 12,7 dana razlikovala se između muškaraca i žena, a prosječna duljina boravka u JIL razlikovala se između bolesnika s krvarenjem i onih s ishemijom. Vremenski razmak od nastupa moždanog udara do prijma u bolnicu te između nastupa moždanog udara i pregleda pomoću kompjutorske tomografije (CT), kao i postotak primjene različitih dijagnostičkih metoda procijenjeni su u podskupini od 156 slučajeva. Prijam u bolnicu s medijanom od 4 sata i liječenje u slučaju krvarenja pokazali su se relativno povoljnima u usporedbi s međunarodnim standardima, dok se u slučaju infarkta naša primjena CT-a pokazala nedostatnom i zakašnjelom u odnosu na prijam u bolnicu. Sveukupna stopa smrtnosti od 10,7% odražava razmjerno mlađu prosječnu životnu dob naših bolesnika (61,2 godine). Izdaci za bolničko liječenje bolesnika s moždanim udarom od 1390 USD vrlo su niski u odnosu na industrijski razvijene zemlje, i to uglavnom zbog sadašnjeg valutnog tečaja.

*Ključne riječi: Cerebrovaskularni udar, ekonomičnost; Cerebrovaskularne bolesti, prevencija i suzbijanje; Liječenje – ishod; Analiza isplativosti; Češka Republika*