

Stroke events and case fatalities in Switzerland based on hospital statistics and cause of death statistics

Katharina Meyer^{a,b}, Anja Simmet^a, Marcel Arnold^c, Heinrich Mattle^c, Krassen Nedeltchev^d

^a Swiss Health Observatory & Medical Faculty, University of Bern, Bern, Switzerland

^b Swiss Health Observatory, Neuchâtel, Switzerland

^c Department of Neurology, University Clinic, Inselspital, Bern, Switzerland

^d Department of Neurology, Triemli Hospital, Zürich, Switzerland

Summary

Objective: In Switzerland there is a shortage of population-based information on stroke incidence and case fatalities (CF). The aim of this study was to estimate stroke event rates and both in- and out-of-hospital CF rates.

Methods: Data on stroke diagnoses, coded according to I60-I64 (ICD 10), were taken from the Federal Hospital Discharge Statistics database (HOST) and the Cause of Death database (CoD) for the year 2004. The number of total stroke events and of age- and gender-specific and age-standardised event rates were estimated; overall CF, in-hospital and out-of-hospital, were determined.

Results: Among the overall number of 13 996 hospital discharges from stroke (HOST) the number was lower in women (n = 6736) than in men (n = 7260). A total of 3568 deaths (2137 women and 1431 men) due to stroke were recorded in the CoD database. The number of estimated stroke events

was 15 733, and higher in women (n = 7933) than in men (n = 7800). Men presented significantly higher age-specific stroke event rates and a higher age-standardised event rate (178.7/100 000 versus 119.7/100 000). Overall CF rates were significantly higher for women (26.9%) than for men (18.4%). The same was true of out-of-hospital CF but not of in-hospital CF rates.

Conclusion: The data on estimated stroke events obtained indicate that stroke discharge rate underestimates the stroke event rate. Out-of-hospital deaths from stroke accounted for the largest proportion of total stroke deaths. Sex differences in both number of total stroke events and deaths could be explained by the higher proportion of women than men aged 55+ in the Swiss population.

Key words: stroke epidemiology; estimated stroke event rate; stroke case fatality

Introduction

Cerebrovascular disease is the most frequent cause of disability in adults, the second most common cause of dementia, and the third most common cause of death in Switzerland [1–3]. Currently, data on stroke events in Switzerland are provided by the Hospital Statistics database (HOST) of the Federal Statistical Office (FSO) [4]. Data on death due to stroke are available from the FSO's Cause of Death statistics (CoD) [5]. Although the HOST database keeps a record of all hospital discharges of stroke patients in Switzerland, it does not contain a complete set of data on stroke events, since an undetermined number of patients are treated for or die from stroke out of hospital. For its part, the CoD database does not provide information on case fatality (CF) nor

does it differentiate between in- and out-of-hospital deaths.

The aim of this study was to estimate the stroke event rate, in order to determine overall CF and in-hospital and out-of-hospital CF in Switzerland, by using the combined data from 2004 HOST and CoD databases. Additionally, the number of deaths due to stroke occurring out-of-hospital was determined. The findings will be entered in cardiovascular monitoring of acute myocardial infarction, heart failure [6] and stroke which has been established by the Swiss Health Observatory (www.obsan.ch). Stroke monitoring provides important information for economic studies and for planning of the stroke care and supply system [7].

Materials and methods

Data sources

Data were drawn from HOST and CoD databases from the FSO of Switzerland for the time period 1 January–31 December 2004 [4, 5]. They were coded according to the International Classification of Disease, Version 10 (ICD 10) [8]. For HOST, data were coded in the hospitals patients were discharged from. The codes were then transferred to the HOST database. The hospital response rate was 100%. Cause of death was recorded in the CoD according to WHO rules [8]. Mortality-related data are transferred to the civil registry offices, recorded and coded centrally in the FSO's CoD database. Due to Switzerland's current data protection laws, linking of both databases for determining stroke events is not possible at the moment.

Preparation of the HOST and CoD datasets for calculation

1. From the HOST database, cases with the following discharge diagnoses (principal diagnosis and/or one of the 2nd to 5th diagnosis position) were selected: subarachnoid haemorrhage (I60), intracerebral haemorrhage (I61), other non-traumatic intracranial haemorrhage (I62), cerebral infarct (I63), and stroke not specified as haemorrhage or infarct (I64) (for analysis called "cases A"). If a patient was admitted to a small (e.g. district) hospital following an acute event and – irrespective of the time delay – later transferred to a larger hospital (e.g. university or cantonal hospital), a connection code was used to identify the patient as being the same person and to count him or her only once.

2. Patients surviving until discharge from hospital were called in-hospital survivors ("cases As"). Data on all stroke cases having a discharge code of 5 (i.e. patients

dying whilst in hospital) were extracted from the HOST database and labelled "cases Ad".

3. Based on the CoD database, all cases in which stroke was the underlying cause of death (I60 – I64) were identified and called "cases D".

4. Since only two cases of death from stroke were recorded amongst the population aged under 25, only the target population aged over 25 was included.

Calculations

With respect to the data preparation procedure described above, the following variables were calculated (Rate = Number of cases per 100 000 population):

- 1) Age- and sex-specific discharge rates ([cases A / age- and sex-specific population] × 100 000).
- 2) Age- and sex-specific event rate of stroke ([cases As + cases D] / age- and sex-specific population × 100 000).
- 3) Mortality rate ([cases D / population] × 100 000).
- 4) Overall CF (cases D / [cases As + cases D] × 100).
- 5) In-hospital CF (cases Ad / [cases As + cases D] × 100).
- 6) Out-of-hospital CF ([cases D – cases Ad] / [cases As + cases D] × 100).
- 7) Percentage of out-of-hospital deaths among total deaths ([cases D – cases Ad] / cases D × 100).

For data analysis, the age groups recommended by EUROCISS [9] were used. The Swiss Census population data were used as denominator to calculate the rates for the year 2004 [10]. Age standardisation was calculated according to the European standard population [11]. The 95% confidence intervals for event rates and case fatalities were calculated using Schoenberg's methods [12]. These were used to determine significant differences by age and sex.

Results

In 2004, a total of 13 996 cases with hospital discharge from stroke (6736 women and 7260 men) were identified in the HOST database. A total of 3568 deaths (2137 women and 1431 men) due to stroke were recorded in the CoD database.

Hospital discharge rate from stroke

The hospital discharge rates per 100 000 population increased exponentially with age in both women and men (fig. 1, table 1a). From age group 45–54 to age group ≥85, the age-specific discharge rates for men were significantly higher than for women. The age-standardised discharge rate was 133.7/100 000 overall, 107.3/100 000 for women and 167.2/100 000 for men (table 1a).

Table 1a

Age-specific and age-standardised stroke discharges (absolute number of cases, and rate per 100 000 population) (Switzerland 2004).

Age groups (yr)	Women				Men			
	No. of cases	Population	Rate	95% CI	No. of cases	Population	Rate	95% CI
25–34	86	504 589	17.0	13.8–21.1	77	498 009	15.5	18.4–19.3
35–44	194	615 414	31.5	27.4–36.3	221	621 005	35.6	31.2–40.6
45–54	393	513 015	76.6	69.4–84.6	575	519 978	110.6	101.9–120.0
55–64	661	441 071	149.9	138.9–161.7	1241	432 561	286.9	271.4–303.3
65–74	1308	328 811	397.8	376.8–420.0	1962	27 075	708.1	677.5–740.1
75–84	2617	251 407	1040.9	1001.8–1081.5	2303	160 299	1436.7	1379.2–1496.6
≥85	1477	103 737	1423.8	1353.0–1498.3	881	43 376	2031.1	1901.3–2169.7
All	6736	2 758 044	244.2	238.5–250.1	7260	2 552 303	284.4	278.0–291.1
ASR			107.3	104.8–110.9			167.2	163.4–171.1

CI: confidence interval; ASR: Age-standardised rates adjusted to the European standard population

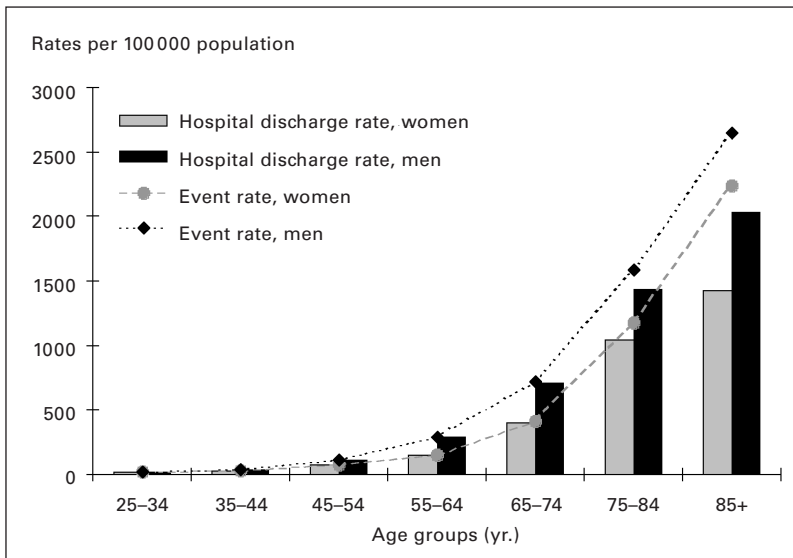


Figure 1
Age-specific hospital discharge rates and estimated event rates for stroke per 100 000 population, women and men (Switzerland 2004).

Estimated stroke events

The overall number of patients who suffered a stroke was 15 733 (7933 women and 7800 men). The overall stroke event rate was 296.3 per 100 000 population (287.7/100 000 in women and 305.6/100 000 in men) (table 1b), and exceeded the discharge rate from stroke by 12.4%.

The stroke event rate increased with age. From the 45–54 age group to the ≥85 age group event rates of stroke were significantly higher for men than for women (fig. 1). The age-standard-

ised event rate was 146.0/100 000 overall and significantly different by sex (table 1b).

Death from stroke

In Switzerland, the mortality rates for both sexes increased significantly with age. Men exhibited significantly higher mortality rates for age groups 55–64, 65–74, and 75–84 than women. Although the absolute number of stroke deaths was 50% higher for women (n = 2137) than for men (n = 1431), the age-standardised mortality rate was significantly higher for men 31.4/100 000 than for women 25.6/100 000 (table 2).

Case fatalities

In women, the overall CF rate increased with age from 3.6% in the 25–34 age group to 51.0% among women aged ≥85. In men, except for the age group 45–54, the overall CF rate increased from 1.3% to 40.3%. A significant sex difference was found only for the age group ≥85, with 51.0% for women and 40.3% for men. Overall, CF rate was significantly higher for women (26.9%) than for men (18.4%) (table 3). No significant difference was found for the age-standardised overall CF rate for women (5.1%) and men (5.0%).

The in-hospital CF rate also increased with age, without significant sex differences (11.8% for women and 11.4% for men in total).

The out-of hospital CF rates in women and men aged 65–74 and over increased exponentially with age. Only in the age group ≥85 was the CF rate significantly higher for women (36.4%) than

Table 1b
Estimated age-specific and total stroke events (absolute number of cases, and rate per 100 000 population) (Switzerland 2004).

Age groups (yr)	Women				Men			
	No. of cases	Population	Rate	95% CI	No. of cases	Population	Rate	95% CI
25–34	83	504 589	16.4	13.5–20.0	75	498 009	15.1	12.1–18.7
35–44	194	615 414	31.5	27.6–35.9	219	621 005	35.3	31.3–39.8
45–54	387	513 015	75.4	68.8–82.7	579	519 978	111.4	103.1–120.3
55–64	653	441 071	148.0	137.7–159.1	1244	432 561	287.6	273.1–302.8
65–74	1339	328 811	407.2	387.8–427.6	1992	277 075	718.9	690.4–748.6
75–84	2956	251 407	1175.8	1139.4–1213.3	2542	160 299	1585.8	1533.4–1640.0
≥85	2321	103 737	2237.4	2167.8–2309.2	1149	43 376	2648.9	2530.9–2772.9
All	7933	2 758 044	287.7	282.3–293.1	7800	2 552 303	305.6	299.7–311.7
ASR			119.7	153.7–159.6			178.7	223.5–232.4

CI: Confidence interval; ASR: Age-standardised rates adjusted to the European standard population

Table 2
Age-specific number of deaths due to stroke, and stroke mortality rates per 100 000 population (Switzerland 2004).

Age groups (yr)	Women			Men		
	No. of deaths	Rate	95% CI	No. of deaths	Rate	95% CI
25–34	3	0.6	0.2–1.8	1	0.2	0–1.4
35–44	9	1.5	0.8–2.8	17	2.7	1.7–4.4
45–54	27	5.3	3.6–7.7	35	6.7	4.8–9.4
55–64	49	11.1	8.4–14.7	110	25.4	21.1–30.7
65–74	168	51.1	43.9–59.4	228	82.3	72.3–93.7
75–84	697	277.2	257.4–298.6	577	360.0	331.7–390.6
≥85	1184	1141.3	1078.2–1,208.2	463	1067.4	974.5–1169.2
All	2137	77.5	74.3–80.9	1,431	56.1	53.3–59.1
ASR		25.6	24.5–26.7		31.4	29.8–33.1

CI: Confidence interval; ASR: Age-standardised rates adjusted to the European standard population

Table 3
Overall case fatality (CF), in-hospital CF and out-of-hospital CF; women, men (Switzerland 2004).

	n	Women (95% CI)	n	Men (95% CI)	n	Total 95% CI
Overall CF (%)	2137	26.9 (25.8–28.1)	1431	18.3 (17.3–19.3)*	3568	22.7 (21.9–23.4)
In-hospital CF (%)	940	11.8 (11.1–12.7)	891	11.4 (10.7–12.2)	1831	11.6 (11.1–12.2)
Out-of-hospital CF (%)	1197	15.1 (14.3–16.0)	540	6.9 (6.5–7.5)*	1737	11.0 (10.5–11.6)

CI: Confidence interval; *Significant sex difference

for men (23.3%). On average the total out-of-hospital CF rate was also significantly higher in women than in men (15.1% versus 6.9%) (table 3).

For both women and men the proportion of deaths from stroke occurring outside a hospital increased with age. In the 75–84 and over age

groups, deaths due to stroke occurred predominantly outside a hospital: 48.6% for women and 41.4% for men in the 75–84 age group, and 71.3% for women and 57.9% for men in the ≥85 age group. Overall, 48.7% of all deaths from stroke occurred outside hospital (56.0% for women and 37.8% for men).

Discussion

The major findings of this study are three.

1. Overall stroke event rate estimated from the HOST and CoD data was 12.4% higher than the overall discharge rate obtained from the HOST data only.
2. Women had more stroke events than men, but from an age-specific point of view women exhibited lower event rates than men between the 4th and 8th decade.
3. Out-of-hospital deaths due to stroke accounted for 48.7% of total stroke deaths.

Methodological aspects

The present study included both all hospitalisations for stroke in Switzerland as registered in the 2004 HOST database, and all deaths caused by stroke as reported in the 2004 CoD database. Population-based registries are considered to be the best and most reliable sources of morbidity data [9], but they are not available in Switzerland. Due to Switzerland's restrictive data protection law, it is not possible at the moment to link data from the HOST and CoD databases for determination of stroke events.

Event rates of stroke

HOST and CoD databases do not distinguish between first-ever and recurrent events. Hence the incidence of first-ever stroke could not be derived from this analysis. However, it is feasible to compare the estimated stroke event rates of Switzerland with published stroke attack rates (first-ever and recurrent events) of other populations. The differences by age and sex for stroke risk, as observed in this study, seem to be in line with contemporary trends. Stroke is more prevalent in men than in women, and men also have higher age-specific stroke event rates than women [13–15]. In the USA, stroke event rates (first-ever and recurrent; all age groups) in men were higher than in women at a younger age, but not in old age. The sex quotient of men to women was 1.25

(ages 55–65); 1.50 (ages 65–74); 1.07 (ages 75–84) and 0.76 at age 85+ [16]. In Switzerland the 2004 stroke event rates in men are higher than in women for all age groups, except the youngest (table 1b). Among 25–34-year-olds the male/female event rate was 0.92 but 1.94 for the 55–64 age group; 1.77 for the 65–74 age group; 1.35 for the 75–84 age group and 1.18 at age 85 and over (table 1b). In young women factors such as oral contraceptive use and pregnancy may contribute to the increased risk of stroke [17, 18]. In the 75–84 and over age groups the lower stroke event rate in women, despite their higher absolute number of stroke events, can be explained by the higher proportion of women in the Swiss population.

Case fatalities and mortality rates

The absolute number of deaths from stroke in 2004 was 50% higher for women than men. This is in line with US figures for the same year [19]. The larger number of stroke deaths in Swiss women aged 75 and over (table 2) can be explained by two facts: firstly, in the older population there are more women still living than men, which results in a larger absolute number of stroke cases in women. Secondly, the onset of various cardiovascular diseases in women occurs at a later age than in men [20], and these may contribute to later development of strokes in women. The former also explains why the age-standardised deaths presented as rate per 100 000 population were higher for men (table 2).

In Switzerland almost five out of ten deaths due to stroke occurred out of hospital, with the highest rate for women aged 85 and over (71.3%). Similarly, in the USA some 50% of stroke deaths in 2003 reportedly occurred out of hospital [16]. The relatively larger proportion of deaths occurring out of hospital and the out-of-hospital CF rate (table 3) may indicate that elderly men and women with an acute stroke who are living at home or in a nursing home are less likely to be ad-

mitted to a hospital than younger individuals. The noticeably higher out-of-hospital CF rate, but no higher in-hospital CF rate, in older women compared to men (table 3), may suggest that older women (at higher risk for stroke) were more likely to be living alone.

Limitations

This study is based on routine statistics, which means that the stroke event rates do not allow comparison with incidence rates which refer to first-ever stroke events and are obtained, for example, from population-based registry data.

The methods applied in this study do not take into account patients with a stroke diagnosis who

are treated out of hospital and survive the stroke, suggesting that the stroke event rate is underestimated.

In 2004 in Switzerland, stroke as the underlying cause of death was validated by autopsy in only 5.1% of patients [21]. Hence the number of stroke events and deaths may be an underestimate of the actual stroke numbers and deaths. On the other hand, death certificates may also overestimate the number of deaths from stroke, since stroke may be stated as the cause of death when there are numerous co-morbidities and the actual cause of death is uncertain. This limitation might particularly be the case in the older age groups.

Conclusions

The data on estimated stroke events indicate that stroke discharge rate underestimates the stroke event rate. Sex differences in both the number of total stroke events and deaths from stroke may be accounted for by the higher proportion of women aged 55+ in the Swiss population. The noticeably higher out-of-hospital than in-hospital CF rate may reflect the fact that many patients may die before reaching hospital or survive in-hospital stroke care and die later at home or in a nursing home. Due to methodological limitations an unknown number of stroke cases, and deaths due to stroke, may remain unrecorded. To be able to estimate the actual overall stroke event rate more accurately, personal identification numbers

would be needed to link the data in the HOST database with data in the CoD database.

We gratefully acknowledge the expert support of Dr Andros Tofield, medical writer, for proof reading and English language recommendations.

Correspondence:

Katharina Meyer, PhD, MPH
Swiss Health Observatory & Medical Faculty,
University of Bern
Espace de l'Europe 10
CH-2010 Neuchâtel
E-Mail: meyer.katharina@bluewin.ch

References

- Junker C. Todesursachenstatistik. Ursachen der Sterblichkeit 2003 und 2004. Bundesamt für Statistik. Neuchâtel 2007
- Bonita R. Epidemiological studies and prevention of stroke. *Cerebrovasc Dis.* 1994;(Suppl 1):2-10.
- Bermejo-Pareja F, Benito-Léon J, Vaga S, Medrano MJ, Roman GC. Neurological disorders in central Spain (NEDICES) Study group. Incidence and subtypes of dementia in three elderly populations of central Spain. *J Neurol Sci.* 2008;15:264:63-72.
- Swiss Federal Office of Statistics: [http://www.bfs.admin.ch/bfs/portal/de/index/themen/gesundheitsversorgung/einrichtungen/publikationen.html](http://www.bfs.admin.ch/bfs/portal/de/index/themen/gesundheit/gesundheitsversorgung/einrichtungen/publikationen.html)
- Swiss Federal Office of Statistics: http://www.bfs.admin.ch/bfs/portal/de/index/themen/gesundheitszustand/sterblichkeit/todesursachen/kennzahlen0/todesursachen0/wichtigste_todesursachen.html
- Meyer K, Mürner N, Laederach-Hofmann K, Simmet, A, Hess OM. Heart failure events, and case fatalities in Switzerland based on hospital statistics and cause of death statistics. *Swiss Med Wkly.* 2008;138:506-11.
- Mahler MP, Züger K, Kaspar K, Haefeli A, Jenni W, Leniger T, Beer JH. A cost analysis of the first year after stroke – early triage and inpatient rehabilitation may reduce long term costs. *Swiss Med Wkly.* 2008;138:459-65.
- WHO: International Statistical Classification of Disease and Related Health Problems, 10th Revision. ICD 10. Geneva: 1994.
- EUROCISS. Cardiovascular Indicator Surveillance Set. Final Report. (www.cuore.iss.it). 2006.
- Swiss Federal Office of Statistics: Statistics on the annual population. Neuchâtel. 2004.
- Waterhouse J. Cancer incidence in five continents. IARC, Lyon. 1976.
- Schoenberg BS. Calculating confidence intervals for rates and ratios. *Neuroepidemiol.* 1983;2:257-65.
- Anderson CS, Carter KN, Hackett ML, Feigin V, Barber PA, Broad JB, Bonita R. Trends in stroke incidence in Auckland, New Zealand, During 1981 to 2003. *Stroke.* 2005;36:2087-93.
- Mackay J, Mensah G. Atlas of Heart Disease and Stroke. World Health Organization, Geneva. 1994.
- Thorvaldsen P, Davidsen M, Bronnum-Hansen H, Schroll M. Stable stroke occurrence despite incidence reduction in an aging population: Stroke trends in the Danish Monitoring Trends and Determinants in Cardiovascular Disease (MONICA) Population. *Stroke.* 1999;30:2529-34.
- The American Heart Association Statistics Committee and Stroke Statistics Subcommittee: Rosamond W, Flegal K, Friday G, Furie K, Go A, Greenlund K. American Heart Association. Heart disease and stroke statistics – 2007 update. *Circulation* 2007;115:e69-e171.
- Kittner SJ, Stern BJ, Feeser BR, Hebel JR, Nagey DA, Buchholz DW, et al. Pregnancy and the risk of stroke. *N Engl J Med.* 1996;335:768-74.
- Mosca L, Manson JE, Sutherland SE, Langer RD, Manolio T, Barrett-Connor E. Cardiovascular Disease in Women. A Statement for healthcare professionals from the American Heart Association. *Circulation.* 2000;96:2468-82.
- Vital Statistics of the U.S., Data Warehouse, NCHS. <http://www.cdc.gov/nchs/datawh.htm>.
- Roquer J, Campello AR, Gomis M. Sex differences in first-ever acute stroke. *Stroke.* 2003;34:15811-5.
- Bundesamt für Statistik. Erhebungen, Projekte, Quellen – Todesursachenstatistik. www.bfs.admin.ch/bfs/portal/de/index/infothek/erhebungen_quellen/bkank/blank/blank/cod/02.html