Changing Rates of Stroke in the Province of Quebec, Canada: 1981–1988

Nancy E. Mayo, PhD; Mark S. Goldberg, MSc; Adrian R. Levy, BSc; Irena Danys, MD, FRCP(C); and Nicol Korner-Bitensky, MSc

Using more than 37,000 hospital discharges attributed to hemorrhagic or occlusive stroke in the province of Quebec, Canada, we analyzed trends in stroke incidence during the period 1981–1988. There were large and statistically significant (p<0.05) increases in the rates of hemorrhagic stroke over this period. Dramatic increases occurred among men in the rates of both intracerebral (International Classification of Diseases–Ninth Revision [ICD9] code 431) and intracranial (ICD9 code 432) hemorrhagic strokes (40–204% depending on age). In contrast, the rates of occlusion of the precerebral arteries (ICD9 code 433) declined in younger men and women but increased substantially (107%) in older men. Rates of occlusion of the cerebral arteries (ICD9 code 434) declined in men over the age of 50 years and in women aged 50–79 years. Despite the decline in the rate of occlusion of the cerebral arteries, the rate of hemorrhagic stroke appears to have increased. Changes in the hospitalization rates for hemorrhagic stroke were not accompanied by consistent decreases in the case-fatality rate. This finding tends to support the hypothesis of an actual increase in the hospitalization rate for hemorrhagic stroke rather than an artificially elevated rate due to enhanced diagnosis by computed tomography. (Stroke 1991;22:590–595)

From 1945 to 1980, the decline in stroke incidence1–3 in the United States was attributed to modifications in the major risk factors for stroke, particularly to improvements in the control of hypertension.1,4,5 Recently, however, three papers have reported an increase in the rate of stroke.6–8 One report from Rochester, Minnesota, found that the incidence of stroke was 17% higher for the period 1980–1984 than for the period 1975–1979.6 The National Hospital Discharge Survey7 from the United States reported a similar increase in the hospitalization rate for stroke over the period 1979–1983. Neither study could rule out the possibility that the increases were artifactual due to changes in the admission rates for cerebral angiography and endarterectomy or to changes in the use of computed tomography, a procedure that presumably has improved the detection of mild strokes. A study from Sweden found a significant increase in the incidence of stroke among women for the period 1983–1986 compared with the period 1975–1978; however, no specific mechanism contributing to this increase was identified. The rise was probably not due to changes in diagnostic practice favoring the detection of milder strokes because the case-fatality rates were stable over this period.

To investigate the possibility of a similar increase in the incidence of stroke in the province of Quebec, we conducted a survey of hospital discharges attributed to stroke for the period 1981–1988.

Subjects and Methods

We obtained the data for this study from a province-wide data base of hospital discharges, referred to as Med-Echo,9 for the 8 fiscal years (April through March) 1981–1988, inclusive. Since 1981, all acute-care hospitals and, since 1985, all other hospitals within the province of Quebec have reported to the Med-Echo system. Each hospital reporting to this system is responsible for the abstraction, coding, and verification of its own data. Diagnoses at discharge are coded according to the International Classification of Disease, Ninth Revision (ICD9). The data are then entered electronically at a central location and are checked for internal consistency.

In addition to discharge diagnoses and geographic, demographic, and medical information, the Med-Echo data base contains information identifying the discharge hospital and whether it is an acute-care hospital or a long-term care facility. Discharges from
FIGURE 1. Rates of discharge for hemorrhagic stroke (International Classification of Diseases—Ninth Revision code 430, subarachnoid, ○; 431, intracerebral, □; 432, intracranial, △) in province of Quebec from 1981 to 1988 for eight age- and sex-specific groups. Left column, men; right column, women; top row, aged 15–49 years; second row, aged 50–64 years; third row, aged 65–79 years; bottom row, aged ≥80 years.
FIGURE 2. Rates of discharge for occlusive stroke (International Classification of Diseases—Ninth Revision code 433, precerebral, ○; 434, cerebral, □) in province of Quebec from 1981 to 1988 for eight age- and sex-specific groups. Left column, men; right column, women; top row, aged 15—49 years; second row, aged 50—64 years; third row, aged 65—79 years; bottom row, aged ≥80 years.
long-term care hospitals and long-term care units within acute-care hospitals were excluded from these analyses. Rehabilitation hospitals were not distinguished by the Med-Echo system and had to be identified individually and eliminated from the analyses.

We identified all Quebec residents 15 years of age and over who were hospitalized for stroke in a Quebec acute-care hospital and whose primary discharge diagnosis was 430 (subarachnoid hemorrhage), 431 (intracerebral hemorrhage), 432 (other intracranial hemorrhage), 433 (occlusion of the pre-cerebral arteries), 434 (occlusion of the cerebral arteries), 436 (acute ill-defined cerebrovascular disease), or 437 (other and ill-defined cerebrovascular disease) as coded according to ICD9. Records of individuals discharged with a diagnosis of ICD9 code 435 (transient ischemic attack) or 438 (late effects of cerebrovascular disease) were excluded. Information on rates of ill-defined stroke (ICD9 codes 436 and 437) is not presented.

Annual rates of hospitalization were calculated for each ICD9 code for men and for women separately and for each of four age groups (15–49 years, 50–64 years, 65–79 years, and 80 years and over). There was one inconsistency in the reporting over the 8 years of study when one hospital did not report discharges during 1982–1983. For the calculations of hospitalization rates for this year, the number of patients discharged from this hospital was interpolated from the average of the number of patients in each age, sex, and ICD9 code stratum discharged in the year preceding and the year following.

The numerators used to calculate annual rates were the numbers of discharges from the acute-care hospitals (interpolated where necessary). The denominators were the numbers of persons in each age-sex stratum as determined for the province of Quebec from the 1981 and 1986 Canadian censuses. The size of the population for the intercensus and postcensus years was interpolated by determining the percentage change in population between the two census years and apportioning this change evenly over the intervening and ensuing years.

For each discharge diagnosis under consideration (ICD9 codes 430–434), Poisson regression was used to model the natural logarithm of the age- and sex-specific rates of hospital discharge as a function of fiscal year. Plots of the stratum-specific rates of hospital discharge over time indicated that the relation between hospital discharge rate and year was linear and, thus, year was included as a continuous variable. Therefore, the exponent of the regression coefficient for year ($\beta$) from each Poisson model was used as an estimate of the annual change in the rate of hospital discharge; the associated standard errors (SE $\beta$) were used to calculate the 95% confidence intervals according to the formula $e^{\beta \pm 1.96 \times SE \beta}$. The estimates of annual change were used to derive a smoothed estimate of the total percentage change in the stratum-specific rates of hospital discharge for each ICD9 code from 1981 to 1988 according to the formula $100 \times \left( e^{i \times \beta} - 1 \right)$, where $i$ indicates the $ith$ age- and sex-specific stratum.

For each ICD9 code, the annual age- and sex-specific in-hospital case-fatality rates and the proportions of persons discharged home were calculated. Logistic regression was used to determine if there were differences over time in either end point. For these analyses, year was treated as a continuous variable and the goodness-of-fit likelihood ratio test was used to determine if year was associated with these end points.

### Results

From 1981 to 1988, there was a total of 79,482 stroke discharges in the province of Quebec; 4,296 were coded as ICD9 code 430, 4,935 as ICD9 code 431, 1,915 as ICD9 code 432, 10,025 as ICD9 code 433, and 15,862 as ICD9 code 434. The remaining 42,449 strokes were coded as ICD9 codes 436 or 437 and are not dealt with in this paper, but information on these rates may be obtained from the authors. Age- and sex-specific annual rates are presented for hemorrhagic strokes (ICD9 codes 430, 431, and 432) in Figure 1 and occlusive strokes (ICD9 codes 433 and 434) in Figure 2.

The annual rates for ICD9 code 430 did not change significantly over time. Those for ICD9 code 431 increased significantly, by approximately 50% among men aged 50–64 and 65–79 years and by 128% among men aged 80 years and older. Among women the annual rates for ICD9 code 431 increased significantly only in the two oldest age groups: 38% for those aged 65–79 years and 84% for those aged 80 years and older. The annual rates for ICD9 code 432 increased significantly only among men: 40% for those aged 65–79 years and 204% for those aged 80 years and older. The annual rates for ICD9 code 433 declined significantly for men in the two youngest age groups and increased significantly in the two oldest age groups. This increase was slight among men aged 65–79 years (10%) but was substantial among men aged 80 years and older (107%). The annual rates for ICD9 code 434 declined significantly for men of all ages except those aged 15–49 years. The annual rates for occlusion of cerebral arteries (ICD9 code 434) declined significantly among middle-aged women but did not change among the youngest or the oldest women.

A significant threefold increase over the 8-year period in the 30-day case-fatality rate for ICD9 code 430 was observed for women aged 80 years and older; otherwise, the 30-day case-fatality rates did not change significantly. There were marked differences in the 30-day case-fatality rates between ICD9 codes 431 and 432. The case-fatality rates for ICD9 code 431 averaged 49%, more than twice the average for ICD9 code 432. The case-fatality rates for ICD9 code 431 declined significantly for men aged 15–49 years (57%) and for both men and women aged...
65–79 years and 80 years and older (ranging from 51% to 62%). There were no significant changes in the case-fatality rates for ICD9 code 432.

The case-fatality rates for the two types of occlusive stroke differed: persons discharged with ICD9 code 433 had, on average, lower 30-day case fatality rates (7.5%) than did persons discharged with ICD9 code 434 (15%). The case-fatality rates for ICD9 code 434 declined significantly (approximately 37%) over the 8 years of study among men in the two oldest age strata (i.e., those aged 65–79 years or 80 years and older).

The proportion of survivors discharged home ranged from 19% to 80% for persons with intracerebral or intracranial hemorrhagic strokes (ICD9 code 431 or 432) and from 47% to 95% for persons with occlusive strokes. No consistent pattern to the changes in these proportions over time was evident.

Discussion

There were rather large and statistically significant (p<0.05) increases in the annual rates for hemorrhagic stroke observed over the period 1981–1988. Dramatic increases were observed for both intracerebral (ICD9 code 431) and intracranial (ICD9 code 432) hemorrhagic strokes. In contrast, the annual rates for occlusion of the precerebral arteries (ICD9 code 433) declined in younger men and women but increased substantially in older men; rates for occlusion of the cerebral arteries (ICD9 code 434) declined in both men and women.

Are the substantial increases in the annual rates for intracerebral and intracranial hemorrhagic strokes fact or artifact? Statistical variation could be an explanation for the increased rate of hospital discharge, although this is unlikely as we observed a strong linear relation by year.

Changes in the reporting of specific types of strokes over time could also account for the changes, and the increased use of computed tomography could have resulted in enhanced detection of hemorrhagic strokes and cerebral infarcts. The two recent papers that reported a rise in the incidence of stroke attributed the increase, at least in part, to the introduction of computed tomography, a procedure that presumably has improved the detection of mild strokes.

To investigate the possibility that the severity of the strokes decreased over time, 30-day case-fatality rates were examined as a proxy for severity. The increase in the hospitalization rate for intracerebral hemorrhagic strokes was accompanied by a decline in the 30-day case-fatality rate, but the increase in the hospitalization rate for intracranial hemorrhagic strokes was not.

To aid in the interpretation of changes in the severity of stroke, we also examined the proportions of survivors discharged home. If, over time, there was an increase in the number of milder strokes, then we would expect to see an increase in the proportion of individuals who were able to return to their homes. In fact, the declines in case-fatality rates were not accompanied by any consistent increases in the proportion of survivors discharged home. This finding tends to support the hypothesis of a true increase in the hospitalization rate for hemorrhagic stroke rather than an artifactually elevated rate due to enhanced diagnoses of mild hemorrhagic strokes.

Enhanced detection could be a viable explanation for the changes observed in the annual rates for occlusion of the precerebral arteries. In particular, the substantial increase in the rate among men aged 80 years and older could be attributed, in part, to the increased availability and refinement of vascular evaluation through the use of noninvasive Doppler ultrasond. Previously, stroke patients in this age group may not have been assessed fully due to the risk of invasive diagnostic procedures.

Hospital discharge data consistently underestimate incidence, primarily because cases not hospitalized are not ascertained. While some factors could have artifactually changed the rates of particular types of stroke over time, we feel that there is evidence from this study pointing to actual increases in the annual rates of hemorrhagic stroke in the province of Quebec during this last decade perhaps due to previously unexplored etiologic mechanisms.

References


KEY WORDS • cerebrovascular disorders • epidemiology • incidence • Canada
N E Mayo, M S Goldberg, A R Levy, I Danys and N Korner-Bitensky

Stroke. 1991;22:590-595
doi: 10.1161/01.STR.22.5.590

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/22/5/590

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org//subscriptions/