Risk factors for ischaemic stroke recurrence after hospitalisation

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ABSTRACT

Objective: To determine risk factors for ischaemic stroke recurrence among patients admitted to hospital for a first-ever occurrence of ischaemic stroke.

Design, setting and patients: Retrospective study involving linked hospitalisation and death records. The cohort comprised 7816 people who were hospitalised for first-ever ischaemic stroke between July 1995 and December 1999 in Western Australia. Cox's proportional hazards model was used to identify risk factors for stroke recurrence.

Main outcome measures: Time to first recurrence; cumulative recurrence risk; risk factors for recurrence.

Results: The median time to first stroke recurrence was 255 days. The cumulative probability of first recurrence was 5.1% (95% CI, 4.6%–5.7%) at 6 months, 8.4% (95% CI, 7.6%–9.1%) at 1 year and 19.8% (95% CI, 18.1%–21.4%) at 4 years. The risk of first recurrence was increased by advancing age (hazard ratio [HR], 1.03; 95% CI, 1.02–1.04), Aboriginality (HR, 1.50; 95% CI, 1.02–2.22), diabetes (HR, 1.27; 95% CI, 1.07–1.51), a history of cardiac conditions (HR, 1.18; 95% CI, 1.01–1.38), post-stroke urinary incontinence (HR, 1.27; 95% CI, 1.03–1.57) and transfer to another hospital on index admission (HR, 1.26; 95% CI, 1.08–1.46). Admission at first stroke occurrence to a hospital maintaining a stroke unit reduced the risk of recurrence (HR, 0.84; 95% CI, 0.72–0.99).

Conclusion: The risk factors identified in our study have implications for planning secondary prevention strategies. In particular, Aboriginality and transfer to another hospital upon admission for first-ever ischaemic stroke were important risk factors. Research into the level of compliance and access to stroke treatment by Aboriginal patients to prevent further strokes is required.

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Stroke is a major public health problem in Australia,[1] with 90% of all people who suffer strokes requiring hospitalisation.[2] The cost of hospitalisation to the community is high,[3] and ischaemic stroke incurs the greatest cost of any stroke subtype.[4]

People suffering a recurrent stroke have poorer outcomes than those with a first-ever stroke,[5,6] and are likely to have increased disabilities that incur additional hospitalisation costs over the long term.[5] Identifying characteristics of people at high risk of recurrence has important implications for planning secondary prevention strategies to reduce the disease burden.

Previous studies of stroke recurrence based on population samples or treatment-centre-registry records, while ensuring clinically accurate data, have been limited to a small number of recurrent strokes.[6-13] Our study drew on hospital data for the whole of the state of Western Australia. Our aim was to assess the probability of stroke recurrence at varying intervals after first hospitalisation for ischaemic stroke, together with the risk factors affecting recurrence.

METHODS

Our study focused on ischaemic stroke, which accounts for the majority of hospitalisations for stroke. People who suffered a stroke but were not admitted to hospital were excluded from the study.

Data extraction

The WA Data Linkage System[14] (a database linking six core datasets, including the WA Hospital Morbidity Data System and WA mortality records) was used to identify first-ever admissions to hospital for ischaemic stroke between 1 July 1995 and 31 December 1999, in the same manner as our previous stroke survival study.[15] The ICD-10-AM[16] codes I63 (cerebral infarction) and I64 (stroke, not specified as haemorrhage or infarction) were also used to identify admissions for ischaemic stroke. All diagnoses recorded for each admission were searched to ensure the capture of all index admissions. Each record in the final dataset thus represented an ischaemic stroke episode and contained complete information about the patient at the date of admission for that episode.

All hospital readmissions for patients hospitalised with an index ischaemic stroke were reviewed to determine recurrences. Readmissions for reasons other than an acute episode of ischaemic stroke were excluded. Concurrent diagnostic procedures specific to stroke, such as a computed tomography scan, magnetic resonance imaging of the head and neck, a cerebral angiogram, a magnetic resonance angiogram and carotid endarterectomy, were linked with ischaemic stroke diagnoses to confirm a recurrent stroke.

The date of admission for each episode was used as the date of stroke onset. The period between the admission dates of two consecutive stroke episodes determined the recurrence time. If patients died from a recurrent stroke for which they were not admitted to hospital, the recurrence time was defined as the difference between the date of admission for the previous stroke episode and the date of death. For patients surviving to the end of the study period without stroke recurrence, or those dying from other causes, the recurrence time was regarded as "censored".

Medical history was extracted from the linked hospital separation records for each individual up to and including the date of admission for each episode. Selection of variables that could be related to stroke recurrence was based on a comprehensive literature review and on what information was available from the WA Hospital Morbidity Data System.

Data validation

Determining a recurrent stroke event based on hospital discharge summary coding could overestimate stroke events,[17,18] whereas relying on WA death records could underestimate recurrent stroke events.[19] Therefore, death and hospital separation records were verified independently by referring to medical records. The description on the death record for patients dying out-

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1 Demographic and descriptive data for 7816 patients hospitalised in Western Australia for a first occurrence of ischaemic stroke, Jul 1995 to Dec 1999

General data	
Number of patients with recurrence of ischaemic stroke	743 (9.5%)
Proportion of censored observations*	90.5%
Median time to recurrence, in days (interquartile range)	255 (92–529)
Average age at index admission, in years (SD)	73.1 (14.3)
Demographic factors	
Male	51.4%
Aboriginal	3.4%
Rural residence	21.7%
Medical history	
Hypertension	61.6%
Diabetes	21.9%
Atrial fibrillation	23.1%
Hypercholesterolaemia	14.9%
Carotid endarterectomy	1.3%
Urinary incontinence	10.7%
Other cardiac conditions†	49.3%
Hospital care/treatment	
Transferred to another hospital at index admission	25.4%
Treated in stroke unit at index admission‡	41.7%

*Observations on patients who survived to the end of the study period without stroke recurrence or who died from other causes were regarded as "censored". †Includes all heart conditions other than atrial fibrillation. ‡Index admission was to a hospital maintaining a stroke unit.

side WA hospitals was reviewed to verify whether a recurrent stroke event was the underlying cause of death.

A random sample of 16% of events identified as recurrent strokes was submitted to the relevant hospitals for clinical review (resource constraints meant that not all events could be reviewed). The audit, undertaken in 2003, involved clinical coders who were independent of our study. Results of the validation process confirmed that 90% of the readmissions identified as stroke recurrences were genuine and had been recorded correctly on the separation summaries.

Hazard ratios

With the large number of events analysed in our study, there was sufficient power to determine the effect of risk factors using Cox's proportional hazards model.[20]

RESULTS

Incidence of first ischaemic stroke and recurrence

Demographic and descriptive statistics relating to our study sample are summarised in Box 1. Between 1 July 1995 and 31 December 1999, 7816 WA residents were hospitalised for ischaemic stroke for the first time. Our results showed that the incidence of hospitalisation for first-ever ischaemic stroke in 1996 in WA was 80 per 100 000 person-years among men and 53 per 100 000 person-years among women. This was similar to the 1995/1996 incidence determined by the Perth Community Stroke Study[21] for men, but slightly higher for women than in the Perth study, suggesting that ischaemic stroke identification was comprehensive in our study.

Of the 3080 patients in the cohort who died, 1170 (38%) had stroke recorded as the cause of death. Of all patients, 9.5% suffered a recurrent stroke. The average age at the time of the index stroke was 73.1 years (SD, 14.3 years), with a median time to first recurrence of 255 days.

The cumulative risk of having another ischaemic stroke within 6 months of the index event was 5.1% (95% CI, 4.6%–5.7%). The cumulative risk of a first recurrent stroke increased to 8.4% (95% CI, 7.6%–9.1%) after 1 year and 19.8% (95% CI, 18.1%–21.4%) after 4 years.

Risk factors for stroke recurrence

Hazard ratios for factors associated with recurrence of ischaemic stroke are summarised in Box 2. For people who were admitted to a hospital with a stroke unit at the time of their index stroke, the risk of recurrence was reduced by 16%, whereas patients transferred to another hospital at first admission for stroke had a 25% increased risk of stroke recurrence. Aboriginal patients had a 50% greater risk of stroke recurrence than non-Aboriginal patients (however, the numbers were small: 26 recurrent strokes were recorded among the 256 Aboriginal people in the cohort). The risk of recurrence also rose by 3% for each year of increasing age.

Of the comorbid conditions, both diabetes and urinary incontinence were associated with a 27% increased risk of first recurrent stroke, while having "other cardiac conditions" increased the risk of stroke recurrence by 18%.

DISCUSSION

The Perth Community Stroke Study found that the cumulative risk of first recurrent ischaemic stroke (at 8.8%) was highest in the first 6 months after the index stroke event,[7] rising to 22.5% after 5 years — a pattern of cumulative risk similar to that observed in our study.

The risk of stroke recurrence among Aboriginal patients was much higher than among non-Aboriginal patients, despite the relatively low number of recurrent strokes among Aboriginal people and possible underestimation owing to the remoteness of their place of residence. The greater risk of stroke recurrence may be attributable to the high prevalence of risk factors for stroke among the Aboriginal population[22] and to barriers in accessing secondary stroke prevention care. Research is needed into the level of compliance with secondary preventive treatment among Aboriginal people.

The clinical factors found to influence ischaemic stroke recurrence in our study appear to have validity. Previous studies have similarly established that advanced age,[7,12] diabetes[7,9] and a history of heart disease[11] are predictors of recurrence. Urinary incontinence after a stroke, which has been suggested as a marker of stroke severity,[21,23] is itself associated with an increased risk of stroke recurrence.[8] Neither pre-existing hypertension nor atrial fibrillation was associated with ischaemic stroke recurrence.

As details of medication administered were unavailable, it was impossible to determine the effect of anticoagulant or antihypertensive drugs on stroke recurrence.

The transfer status variable was included to account for potential differences in stroke severity between transferred and non-transferred patients. Research has shown that treatment of stroke patients in stroke units can improve outcomes in terms of survival, independence and capacity to live at home.[24] Our study presents additional evidence of a reduction in risk of recurrence for patients initially admitted to a hospital maintaining a stroke unit. The transfer of some patients to another hospital for further diagnostic investigation and access to specialist services may delay the appropriate treatment required, particularly with long travel distances across the vast areas of the state. According to principal diagnosis data, the majority of patients (56%) were transferred to other hospitals for further acute care. Stroke severity,[8] coupled with a delay in diagnosis and treatment, has been shown to increase the risk of stroke recurrence.[25]

2 Adjusted hazard ratios for factors associated with first ischaemic stroke recurrence*

	Adjusted hazard ratio† (95% CI)
Demographic factors	
Age at index admission, in years‡	1.03 (1.02–1.04)
Male§	1.15 (0.99–1.33)
Aboriginal¶	1.50 (1.02–2.22)
Rural residence**	1.00 (0.82–1.20)
Medical history	
Hypertension	1.05 (0.90–1.23)
Diabetes	1.27 (1.07–1.51)
Atrial fibrillation	1.03 (0.86–1.23)
Hypercholesterolaemia	0.85 (0.68–1.06)
Carotid endarterectomy	0.62 (0.30–1.32)
Urinary incontinence	1.27 (1.03–1.57)
Other cardiac conditions	1.18 (1.01–1.38)
Hospital care/treatment	
Transferred to another hospital at index admission	1.26 (1.08–1.46)
Treated in stroke unit at index admission††	0.84 (0.72–0.99)

* Unless otherwise stated, the reference value for each factor was the absence of that factor. † Calculated using Cox's proportional hazards model.[20] ‡ The hazard ratio for age is interpreted as the stroke recurrence risk for each one-year increase in age. § Reference value = female. ¶ Reference value = non-Aboriginal. ** Reference value = metropolitan residence. †† Index admission was to a hospital maintaining a stroke unit.

Although our study design enabled us to measure ischaemic stroke recurrence and identify risk factors in a large and diverse sample, there were some intrinsic limitations. Firstly, the use of hospital separation data implied the exclusion of stroke survivors who were not admitted to hospital. Secondly, the hospital separation records did not contain sufficient information to assess stroke severity or lifestyle risk factors, which are generally available in prospective cohort studies.[26] Thirdly, the accuracy of our results depended on the reliability of case coding for ischaemic stroke and comorbid conditions. Regarding the last point, we believe that coding is reasonably reliable. Coding of all hospitalisations follows the Australian national coding standards,[16] and all coders are routinely individually audited by the WA Department of Health to ensure adherence to these standards. Furthermore, the reliance on accurate coding for casemix funding has increased the scrutiny of the coding process.[27] Validation of recurrent stroke cases derived from case coding indicated that recurrence was only slightly overestimated and that the misclassification rate was relatively low for hospitals admitting recurrent stroke patients. Assuming the misclassification events were independent of the comorbid conditions, results of factors influencing recurrence should still be valid.

Despite the above limitations, the linkage of hospitalisation and death records provided access to a large sample size from diverse sources. It is a complementary method to the more clinically accurate — but more costly and labour-intensive — community-based prospective cohorts, which provide benchmarks upon which to validate our study.

With an ageing population and the rising cost of medical care, strategies are needed to reduce stroke recurrence and hospitalisation. Our findings have important implications for planning effective secondary prevention strategies for ischaemic stroke, particularly in rural and remote areas and for Aboriginal people.

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COMPETING INTERESTS

None identified.

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