

Trends in Stroke Survival Incidence Rates in Older Australians in the New Millennium and Forecasts into the Future

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Aims: The objective of this study is (i) to evaluate trends in the incidence rates of stroke survivors aged 60 years and older over a 11-year period in the Australian Capital Territory (ACT) and (ii) to forecast future trends in Australia until 2051.

Methods: Analysis of age- and sex-specific standardized incidence rates of older first-ever stroke survivors in ACT from 1999-2000 to 2009-2010 and projections of number of stroke survivors (NSS) in 2021 and 2051 using 2 models based only on (i) demographic changes and (ii) assuming changing of both incidence rates and demography. *Results:* In the ACT in the first decade of the 21st century, the absolute numbers and age-adjusted standardized incidence rates of stroke survivors (measured as a function of age and period) increased among both men and women aged 60 years or older. The trend toward increased survival rates in both sexes was driven mainly by population aging, whereas the effect of stroke year was more pronounced in men compared with women. The absolute NSS (and the financial burden to the society) in Australia is predicted to increase by 35.5%-59.3% in 2021 compared with 2011 and by 1.6- to 4.6-fold in 2051 if current only demographic (first number) or both demographic and incidence trends (second number) continue.

Conclusions: Our study demonstrates favorable trends in stroke survivor rates in Australia in the first decade of the new millennium and projects in the foreseeable future significant increases in the absolute numbers of older stroke survivors, especially among those aged 70 years or older and men. **Key Words:** Stroke survivors—incidence rates—trends—projections—Australia.

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Introduction

Rising life expectancy and declining birth rates have resulted in unprecedented aging of the population worldwide. The continuing demographic transformation, with the oldest age group comprising the fastest growing segment of the population, will further increase the

proportion of seniors in coming years. Increasing age is the strongest risk factor for chronic diseases, including stroke, and dependency. Globally, stroke is projected to be at least until 2030 the second leading cause of mortality¹ and ranks between the third and the seventh cause of disease burden.²⁻⁴ Among an estimated 62 million stroke survivors worldwide,⁴ more than half are dependent on others for every day activities⁵⁻¹⁰ and about a third have severe disability or need institutionalization.¹¹

In Australia, between 1996-1997 and 2005-2006, the number of hospitalizations for stroke remained stable, and there was an annual reduction of 4.0% in mortality rate and of 2.2% in hospitalization rate.¹² On the other hand, the nonfatal proportion of stroke burden was significantly higher (45% in men and 37% in women) than previously estimated.¹³

Because the population is aging and stroke mortality is declining faster than stroke incidence,¹⁴⁻¹⁸ long-term survival after stroke may continue to improve.¹⁹ In the

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rapidly growing number of very old stroke patients, newer therapies (eg, thrombolysis) may be underused,^{20,21} and the nonfatal burden of stroke-related disability in coming years is likely to rise despite advances in treatment of stroke. However, most epidemiological studies focus mainly on the incidence and mortality rates, whereas age- and sex-specific information regarding stroke survivors is limited and controversial. Little information exists on sex differences and future directions in age-specific incidence rates of stroke survivors, particularly among persons aged 60 years or older, the group in which most stroke events occur and which does not always receive adequate care.^{22,23} Moreover, divergent trends in stroke incidence for men and women were reported.^{14,24} Some researchers found a higher risk of serious cardiovascular events in older male stroke survivors,²⁵ whereas others concluded that over coming decades the societal impact of stroke in women will increase as the population ages.²⁶

Data on temporal trends and long-term projections of stroke survivors are essential for understanding, planning, and decision making in health-care policies, resource allocation, research, prevention, and treatment of this debilitating disease. Surprisingly, such information is still scarce and controversial.

The objectives of this study were to present (i) age- and sex-specific trends in the incidence rates of stroke survivors 60 years of age and over in an 11-year period from 1999-2000 to 2009-2010 in the Australian Capital Territory (ACT) and (ii) projections of future trends in Australia until 2051.

Methods

Study Sample

All strokes occurring in the ACT are treated (hospitalized) only in the Canberra and Calvary public hospitals that make this region an ideal place for population-based epidemiologic research. We used administrative databases to identify patients discharged with a diagnosis of stroke. We performed a retrospective screening of medical records of all suspected stroke cases in these 2 hospitals. Separations with a principal diagnosis of *International Classification of Diseases, 10th Revision (ICD-10-AM)* codes 160 through 164 were included in the data set. To prevent double counting, inter- and intrahospital transfers for the same event and readmission were identified by matching date of birth, patient ID number, and admission and separation dates and were excluded from this analysis. Thus, each stroke was counted only once and only if the patient was alive at the time of discharge. Although both patients with first-ever and recurrent strokes were included in the primary database, only the first event was included in the final analysis. Patients younger than 60 years were excluded in the present study. A "stroke survivor" was defined as a person discharged after a nonfatal stroke.

Stroke Classification

We used the World Health Organization standard definition of stroke. All stroke cases were identified with the first-listed ICD code. Cases were further categorized into subarachnoid hemorrhage (*ICD-10-AM* 160), intracerebral hemorrhage (ICH, *ICD-10-AM* 161-162), cerebral infarction (*ICD-10-AM* 163), and ill-defined (unspecified) stroke (*ICD-10-AM* 164).

Population Data

Population estimates were obtained from the Australian Bureau of Statistics (ABS).²⁷ The ACT in 2006 (the time of census) had a total population of 334,119 people (1.75% of 19.9 million Australians), of whom 96.3% were white, 1.2% indigenous, and 2.6% Asians, with 13.8% aged 60 years and older. Our study covered the period from July 1, 1999, until June 30, 2010. Over this 11-year period, there was a 13.5% increase in the total ACT population (women +13.8% and men +13.3%) with a shift toward higher age: a 50.4% increase in people aged 60 years or older (women +48.3% and men +53.0%) and a 86.8% increase in people aged 80 years or older (women +73.5% and men +113.1%). For Australia, the corresponding proportion figures were 15.5% (15.5%, 15.5%), 31.7% (28.3%, 35.7%), and 52.3% (42.9%, 70.0%). Population estimates from 2011 onward were obtained from the ABS population projection Series B that is based on the 2011 census and trends in fertility rates, life expectancy at birth, and migration and most closely reflects recent trends.

Statistical Analysis

Annual sex- and age-specific incidence rates (per 100,000 population) were determined using the population data obtained from population census of the ABS. Age- and sex-adjusted stroke survivor rates were estimated using the number of hospital discharges as the numerator and the ACT age and gender population data at mid-year as the denominator. In noncensus years, population estimates from ABS were used. The annual age- and sex-specific incidence rates of stroke survivors were based on the numbers in 5 age groups. Then we calculated incidence rates for 3 age groups: 60-69, 70-79, and 85 years or older. The rates were also determined for stroke subtypes (hemorrhagic, ischemic, and ill defined).

Furthermore, to look into the overall trend in incidence rates of stroke survivors, sex-specific age-standardized incidence rates were calculated by the direct method using the Australian 2006 population aged 60 years or older as the standard. To get age- and sex-adjusted rates, age- and sex-specific rates for each year were multiplied by the corresponding Australian population, which was then divided by the total Australian population of men and women. After standardization, any differences between

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