

Gender Difference in Stroke Case Fatality: An Integrated Study of Hospitalization and Mortality

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Background: Providing regional and state-specific prognosis factors for stroke patients has both clinical and public health importance. Results from previous studies of sex difference in stroke case fatality have been mixed. The current study links stroke hospitalizations to community-based mortality records to examine sex difference in stroke case fatality and associated prognosis factors. *Methods:* Hospital discharge data and death certificate data from January 2005 to December 2009 in Nebraska were linked. Multivariable logistic regression was used to estimate sex differences in 30-day mortality, and the Cox proportional hazard model was used to predict overall survival. *Results:* A total of 15,806 patients were included. Females were more likely to die during the 30 days after stroke hospitalization. However, there was no significant difference in overall survival in the multivariate analysis that controlled for age, comorbidity, and rehabilitation factors. Females were more likely to have comorbidities, such as atrial fibrillation, anemia, and heart failure, while males were more likely to have chronic kidney disease. In addition, males were more likely to receive rehabilitation services after stroke. *Conclusions:* Among persons hospitalized with a stroke in Nebraska between 2005 and 2009, the crude case fatality rate was 50% higher in women. However, after accounting for age and other variables, adjusted mortality rates were essentially the same for men and women. **Key Words:** Case fatality—data linkage—hospital discharge data—sex. © 2013 by National Stroke Association

In the United States, stroke contributes significantly to cardiovascular disease (CVD) death and was the third highest cause of mortality in 2007, with more than 130,000 deaths. Approximately 3% of Americans have had a stroke, for a direct and indirect cost of \$73.7 billion.¹ Since 1990, cardiovascular mortality, including stroke mortality, has declined, but the decline is greater for

men than for women.¹ Because women live longer and have considerably lower mortality from CVD than men, the slow decline in stroke mortality for women coupled with disproportionately more women aged 60 years and older will likely create a greater need for stroke care among women than among men.

Research has shown little consistency in sex differential in stroke case fatality. Some early studies suggest a female survival advantage shortly after a hospital stay,²⁻⁴ while others suggest the opposite advantage for ischemic stroke patients.⁵ An overwhelming majority of studies both in the United States and other countries show higher female short-term (28-day) case fatality.^{6,7} A notable exception is from a study among the Get With the Guidelines-Stroke population in the United States,⁸ which shows no sex difference in case fatality after controlling for other factors.

The apparent sex difference inconsistency in hospital-based case fatality may be related to the interplay between hospital- and community-based findings. It is

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known that women, in general, have lower stroke mortality than men. This fact, coupled with no sex difference in case fatality within the hospital-based stroke care system, suggests that men are more likely to die in the community, without having been hospitalized for stroke care. On the other hand, if women do not have a survival advantage in the short term (4-6 weeks after hospitalization) but are disadvantaged in stroke case fatality, then they would be more likely to die from stroke in the community while men would be more likely to die from other causes. In addition, there are more women than men aged 60 years and older, and an age-specific adjustment may not fully account for the overall sex difference. In any case, evidence from hospital-based data cannot be straightforwardly summed with cause-specific mortality that includes both community- and hospital-based data.

Sex differences in stroke mortality can also be examined from community-based studies. First, difference in treatment in hospitals affects both in- and out-of-hospital survival prognoses. Treatment for stroke is dependent on time, and a late response can be deadly.^{1,9} Gorgano et al¹⁰ suggests that women receive treatment later than men because older women tend to live alone and cannot call for help at the onset of stroke. Second, informal care provided by a spouse may differ, and the difference usually favors men because of the traditional role of women.¹¹ Third, community resources, follow-up care, and public health interventions may affect people differently. Women are more likely to live alone and have less social support than men.¹¹ Those who receive hospital-based rehabilitation services are more likely to survive than those who receive no rehabilitation services or other types of rehabilitation services.¹² In addition, both treatment effectiveness and after-hospital survival depend on follow-up care at the community level. Because rural areas tend to have fewer community-based resources and are less likely to provide timely access to emergency stroke care,⁹ rural residents tend to have poorer survival outcomes than urban residents.¹³ Fourth, survivors of stroke who are functionally dependent have a higher risk of dying than functionally independent survivors,¹⁴ and women are more likely to be functionally dependent, with a greater number of comorbidities. Finally, women are also more likely to be depressed after their stroke, which can impact recovery.¹¹ Because most of these factors favor male stroke patients, female stroke patients may have more survival disadvantages both in and out of the hospital.

In this paper, we take an integrated approach to sex differences in stroke case fatality, connecting hospital and community settings. We include patients who received hospital-based stroke care and patients who died of stroke outside of a hospital. We linked 5-year Nebraska hospital discharge data from 2005 to 2009 to the Nebraska vital statistical record system in 2010 to obtain both 30-day case fatality and survival information. The results also provide

stroke prognosis factors for Nebraska, which is important for stroke care providers and public health practitioners.

Methods

Data

Two data sources were used. Hospital discharge data for all Nebraska residents who were hospitalized for stroke and discharged between January 2005 and December 2009 were retrieved from the Nebraska Hospital Association. Nebraska death records from January 2005 to September 2010 were obtained from the Nebraska Department of Health and Human Services' Office of Vital Records. The hospital discharge data records have inpatient and outpatient (including emergency department and rehabilitation) discharge information from all hospitals in Nebraska. The system is based on the standard UB-04 form, which includes patient demographic information, diagnostic codes, procedure codes, and disposition. The UB-04 also includes *International Classification of Diseases, 9th revision* (ICD-9) codes for primary, secondary, etc., diagnoses. CVD is the leading cause of hospitalization in Nebraska, and it accounted for about 8,000 emergency department visits and more than 30,000 hospitalizations each year. The current study is restricted to Nebraska residents only. Out-of-state patients who sought care in Nebraska hospitals were excluded, and records for Nebraska patients who sought care in other states were not available.

To obtain survival information, we linked hospitalization data to death certificate data. A probabilistic linkage strategy was used, with major linkage variables being patient name, date of birth, sex, and residence ZIP code. The linkage was processed using Link-plus at the Nebraska Hospital Association building, which hosts the hospital discharge data. After linkage, the data were deidentified by removing name and address information. Our check of linkage quality showed that 97.4% of hospital discharge records with an indication of "expired" (24,368 records) among all CVD patients (ICD-9-CM 390-459) matched death certificate data. The remaining 2.6% of unmatched records might be related to the transportation of patients who died to adjacent states for a funeral or for other unknown reasons. Because the linkage is patient-based, readmissions or other hospital encounters are also available, and we had to decide which admission to use as the baseline. If a patient had multiple hospitalizations, we selected the first hospitalization, which should be similar to the "first-ever" stroke used by Roquer et al.¹⁵ Stroke is defined by the primary diagnosis (ICD-9 430-434, 436-438), where transient ischemic attacks were excluded.

Control variables included age group and metropolitan and nonmetropolitan residence status. In addition, we included a number of comorbidities identified in the literature.^{5,15} Diabetes mellitus is a potential factor in stroke survival and has been shown to be more prevalent in men. Atrial fibrillation is a known risk factor for stroke

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