Hospital-Based Study of the Frequency and Risk Factors of Stroke Recurrence in Two Years in China

Qian He, PhD,*,[1] Cheng Wu, PhD,*,[1] Wei Guo, PhD,*,[1] Zhi-Yong Wang, Master,† Yan-Fang Zhao, PhD,* Jian Lu, PhD,* Ying-Yi Qin, PhD,* Yi-Bin Guo, PhD,* Yu-Chen Qin, PhD,* Chuan-Di Pan, Master,‡ and Jia He, PhD*

Background: Stroke causes death and disability throughout the world and recurrent stroke events are more likely to be disabling or fatal. We conducted a hospital-based study to investigate the frequency and influence factors of stroke recurrence in China. *Methods:* Data from patients hospitalized with stroke between January 2007 and December 2010 of 109 tertiary hospitals in China were used. Stroke recurrence and associated factors were ascertained. The zero-inflated model was used to evaluate the factors of recurrence. *Results:* Of 101,926 discharged patients, the cumulative 2-year stroke recurrence rate was 3.80% for subarachnoid hemorrhage (SAH), 5.31% for intracerebral hemorrhage (ICH), and 8.71% for ischemic stroke (IS), respectively. Among patients with stroke recurrence, 54.11% with SAH, 60.42% with ICH, and 92.92% with IS relapsed for the same type of the first-onset stroke. For discharged patients with SAH with middle cerebral artery aneurysm clipping or artery aneurysm embolization, it was less likely to stroke relapse, but the times of recurrence would increase if 1 recurrence appeared. Cerebral artery aneurysms and hypertension were risk factors for recurrence frequency. For ICH, protective factors for recurrence were trepanation and drainage of intracranial hematoma, cerebral angiography, puncture and drainage of intracranial hematoma, and length of stay (LOS). But rheumatic heart disease and atrial fibrillation would further the relapse frequency. For IS, age and LOS were protective factors, but

From the *Department of Health Statistics, Second Military Medical University, Shanghai, China; †Department of Information, Changhai Hospital, Second Military Medical University, Shanghai, China; and ‡Zhejiang Engineering Research Center of Intelligent Medicine, The First Affiliated Hospital of Wenzhou Medical University, Wenzhou, China.

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Declarations: Ethics approval and consent to participate: The study was approved by the Ethics Committee of the Second Military Medical University, Shanghai, China. The ethics committee waived the need of informed consent for the study because of its retrospective nature, and data were analyzed anonymously. Availability of data and material: The datasets generated and analyzed during the current study are not publicly available because the study is not concluded, but are available from the corresponding author on reasonable request.

Address correspondence to Jia He, PhD, Department of Health Statistics, Second Military Medical University, Shanghai 200433, China. E-mail: hejia63@yeah.net.

[1] These authors contributed equally.

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recurrence frequency would increase if the first recurrence happened. Cervical spondylopathy, male gender, and diabetes were risk factors for frequency of relapse. *Conclusions:* Associated factors were different for recurrence frequency among different stroke types. **Key Words:** Stroke recurrence—intracerebral hemorrhage—ischemic stroke—subarachnoid hemorrhage—zero-inflated model.
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Introduction

Stroke is one of the leading causes of death and disability throughout the world,[1] responsible for 4.4 million (9%) of the total 50.5 million deaths each year.[2] China has 2.5 million new stroke cases each year and 7.5 million stroke survivors, and the recurrence rate of stroke remains high in the Chinese population (11.2%).[3] As more people survive their first stroke, the study of recurrent events has become increasingly important, particularly as recurrent stroke events are more likely to be disabling or fatal than first strokes.[4] Stroke recurrence rates have varied substantially across previous studies among different types of stroke in different regions. Among patients with minor stroke, 9.8% experienced recurrent stroke during the 3-month follow-up.[5] The recurrence rates of acute ischemic stroke (IS) patients with diabetes were from 10% to 54% approximately at 3 months, 12 months, and 36 months in Tianjin, China.[6,7] And recent information about recurrence frequency and risk factors after stroke hospitalization is lacking in China, although there were some studies to assess the risk of recurrent ischemic events during hospitalization for transient ischemic attack or stroke beyond the acute phase.[8,9] We therefore aimed to investigate the rates and influence factors of stroke recurrence in China.

Methods

Study Population and Data Acquisition

We performed a retrospective analysis of data from all patients treated between January 2007 and December 2010 for stroke from 109 tertiary hospitals, which were from northern (10 cities), eastern (4 cities), southern (7 cities), and western (10 cities) China.[10] All the tertiary hospitals involved in our study were large-scale general hospitals that integrate medical service, education, and research with more than 500 beds. To identify stroke hospitalizations according to the primary diagnosis in the electronic medical records of these hospitals, we used all discharges for which International Classification of Diseases, 9th Revision (ICD-9) codes 430-438 were included in the primary diagnosis for conservative estimation.[11,12] In the hospital information system (HIS), each record was kept as cases, not patients. A person treated several times at the hospital will be counted as multiple cases. So we transformed the records as patients by matching the identified number. The inpatients were included from January 2007 to December 2008, and their records were collected in the latter 2 years. Data were captured including demographics, discharge-level information on diagnoses, comorbid conditions, operative treatment, and recurrence.

Stroke type was categorized as follows[11,13,14]: (1) subarachnoid hemorrhage (SAH, ICD-9 430); (2) intracerebral hemorrhage (ICH, ICD-9 431); and (3) IS (ICD-9 433, 434, and 436).

Data Analysis

Descriptive statistics of baseline characteristics included the median, the first and third quartiles for non-normal distribution of quantitative variables, and the frequency for qualitative variables. Baseline characteristics among different stroke types were compared. Numerical variables that followed a non-normal distribution were analyzed by the Kruskal–Wallis test, such as age and length of stay (LOS). Unordered categorical variables were analyzed by chi-square test, including gender and hospital region.

Correlation factors of readmission frequency among stroke inpatients were analyzed by a zero-inflated Poisson (ZIP) or zero-inflated negative binomial (ZINB) regression model according to different stroke types. In the present study, count outcomes recording the frequencies of the recurrence among patients with stroke contained a preponderance of zeros because of the presence of "structural zeros." Structural zeros occur in a study when some subjects were not at risk of the behavior of interest, unlike random zeros in which responses can be greater than zero but are zero due to sampling variability. Structural zeros are usually very different, both statistically and clinically. False interpretations of results and study findings may result if differences in the 2 types of zeros are ignored.[15] So in this article, we used the zero-inflated regression model that is commonly used to address zero-inflated data. Variables such as baseline characteristics and complications were included in the zero-inflated regression model if the univariate comparisons suggested an association with a P value of .05 or lower.

All tests were 2-tailed, and a P value of .05 or lower was considered statistically significant, given that the significance level of selection and elimination in the zero-inflated regression model were set at .05 and .10, respectively. Statistical analysis was performed using a commercially available software package (SAS statistical software version 9.4; SAS Institute, Inc., Cary, NC).

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