A Community-Based Study of the Correlation of Hemorrhagic Stroke Occurrence with Meteorologic Factors

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Background: Meteorologic variations may affect hemorrhagic stroke. Thus, the aim of this study was to explore the correlation of daily meteorologic factors with increased incidence of hypertensive intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH) in a community-based study. *Methods:* In a span of 2 years, 735 patients suffering from hypertensive ICH or SAH were enrolled in the study in Fularji District, Heilongjiang Province, China. Daily meteorologic data were obtained from the Bureau of Meteorology of Qiqihar. Daily meteorologic parameters with and without events were compared with hypertensive ICH and SAH, respectively. Logistic regression was used to assess the correlation of meteorologic factors with hypertensive ICH and SAH. *Results:* Daily mean ambient temperature (AT) was statistically associated with the onset of primary hypertensive ICH (odds ratio [OR], .983; $P < .001$) and SAH (OR, .984; $P = .046$). After adjustment with AT variations, the occurrence of primary hypertensive ICH was not only influenced by daily mean AT ($P = .0004$) but also by the interaction between the mean temperature and its variation ($P = .0082$). Interestingly, there was no statistical association between meteorologic factors and recurrent hypertensive ICH. *Conclusions:* The higher incidence of primary hypertensive ICH in the late spring and early autumn was because of the influence of daily mean AT and its variation. When temperature changed, suddenly dropping in the hot weather or rising in the cold weather, the incidence of primary hypertensive ICH was also increased. Conversely, the incidence of SAH increased during days with lower temperature. **Key Words:** Hypertensive intracerebral hemorrhage—subarachnoid hemorrhage—meteorologic factors—epidemiology.

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It has been well documented that seasonal and climatic variations may influence the onset of stroke.[1-27] However, most results are inconsistent, if not controversial.[11,16,18] There are various factors simultaneously affecting the onset of stroke. Many of the studies have been focused on meteorologic factors, such as seasonal, monthly,[2,3,5,8-10,20,21,24-26] or weekly climate changes.[7,23] Unfortunately, it is extremely difficult to correlate the daily meteorologic factors with the onset of hemorrhagic stroke.[4,13,15,17,19,22] Meanwhile, the easy confusion between stroke subtypes also obscured the results.[6,27] Some of the studies have focused on the onset of intracerebral hemorrhage (ICH) or subarachnoid hemorrhage (SAH) and demonstrated that low temperature influenced the stroke onset of ICH[14,28] but not SAH.[3,26,28]

In China, stroke incidence and subsequent mortality increase dramatically and vary widely among regions. Interestingly, there is but a noticeable north–south gradient, as the incidence of cerebrovascular disease was highest in the north of China, although the exact reasons remain unknown.[29]

In the present study, we aim to conduct a community-based study and to elucidate the correlation between meteorologic variations and the incidence of hypertensive ICH and SAH in the northeast region of China.

Materials and Methods

The Geographic Characters of the Study

The Fularji District is 37 km southwest to Qiqihar City in Heilongjiang Province, China. It is situated on the Nenjiang Plain, and located at 123°45′east, 47°15′north, with a total area of 375 square kilometers. The district is under continental monsoon climate. And the weather conditions of 4 seasons are starkly distinguishable: dry and windy in spring, hot and rainy in summer, early frost in short autumn, and cold in long winter. Annual average temperature is 4.55°C, ranging from –16.94°C in January to 22.92°C in July. The social and demographic composition of the population is relatively stable.

The Fularji district has 3 large hospitals serving a population of 264,000 persons. The 3 hospitals have both neurosurgical and neurologic departments, and they also offer computed tomography (CT) and magnetic resonance imaging scanning, whereas other hospitals in this region do not. According to the report of Fularji District Health and Epidemic Prevention Station, about 95% of the total number of patients with stroke were treated in the 3 hospitals in the same period.

Meteorologic Data

Meteorologic records from January 1, 2004, to December 31, 2005, were obtained from the Bureau of Meteorology of Qiqihar. They are ambient temperature (AT, C), atmospheric pressure (AP, hPa), and relative humidity (RH, %). We also collected variables of the previously mentioned factors, daily mean AT (C), daily maximum AT (C), daily minimum AT (C), AT difference between daily maximum and minimum AT (C), variation in AT (with respect to the previous day, C), daily mean AP (hPa), daily maximum AP (hPa), daily minimum AP (hPa), AP difference between daily maximum and minimum AP (hPa), daily mean RH (%), and daily minimum RH (%). According to the total incidences of seasonal strokes, we categorized seasons as spring (March 1st-May 31st), summer (June 1st-August 31st), autumn (September 1st-November 30th), and winter (1 December 1st-29 February 29th in 2004 or February 28th in 2005).

Patient Population

The patients with ICH or SAH, who were admitted to the 3 hospitals from January 2004 to December 2005, were included in this study. All the information of patients was from the Disease Register of the 3 hospitals. Neurosurgeons and neurologists evaluated all patients with neurologic symptoms and CT scanning. We also checked the medical records of all patients. And some clinical information was obtained from the records, including sex, age, nationality, date and time of onset, activity at the time of onset, systolic and diastolic blood pressure at admission, history of hypertension, ICH or SAH, and location and volume of hematoma determined on the CT images and the diagnosis of discharge. We also designated this study to the Han Chinese population.

The onset of stroke was determined by the initial observation of symptoms. Hypertensive ICH was diagnosed clinically in subjects with a history of hypertension (with clear and accurate diagnosis of hypertension or antihypertensive medications to control blood pressure before admission) or with the discharge diagnosis including hypertension and their high blood pressure at admission. SAH was defined by clinical signs and CT scanning. Lumbar puncture was conducted o ascertain the diagnosis. Traumatic cerebral hemorrhage was excluded. Interhospital transport, coded as stroke and readmission, was considered as 1 event. However, the patients who were transported to a nonlocal hospital were excluded from the study.

Statistical Analysis

The statistical analyses were performed with SPSS (version 13.0J, SPSS Inc., Chicago, IL). Relations between daily occurrence of hypertensive ICH or SAH and daily meteorologic factors and variables were evaluated by Spearman rank correlation. To avoid sampling bias caused by hemorrhagic stroke, we chose days instead of occurrences of stroke so that multiple events on 1 day were counted as one. Because some of the parameters do not show normal distribution, we used the Wilcoxon rank-sum test. Logistic regression was used for the initial analysis to test the correlation of meteorologic variables and the onset of hypertensive ICH and SAH, respectively. By backward stepwise selection, we chose relative meteorologic factors for the multivariate analysis by a logistical model. The chi-square, Fisher exact, and Kruskal–Wallis tests were also used to evaluate the differences between clinical information and meteorologic factors among disease groups.

Ethics

In this study, we did not collect personal information, such as patients' names, addresses, telephone numbers, and other private information. The investigation confirmed with the principles according to the