Admission blood pressure indexes and risk of in-hospital death and dependency among acute hemorrhagic stroke patients, Inner Mongolia, China

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Abstract

Purpose: To study the association between blood pressure (BP) SBP, DBP, mean arterial pressure (MAP) and pulse pressure (PP) and clinical outcome in acute hemorrhagic stroke patients in the Chinese population.

Methods: 1,760 hemorrhagic stroke patients admitted to six hospitals from January 1, 2003 to December 31, 2005 were included in the study. BP and other variables were collected within the first 24-hr of admission. Clinical outcomes at discharge were evaluated by neurologists. Multivariate-adjusted odds ratios associated with increment of 1 standard deviation (SD) mmHg in four BP were determined by multiple logistic regression analysis.

Results: The four BP indexes at admission were positively associated with death and SBP, DBP, MAP were associated with dependency. Adjusted odds ratios (95% confident interval) of death associated with increment of 1 SD mmHg were 1.74 (1.44,2.12), 1.39 (1.15,1.69),1.61 (1.32,1.96) and 1.66 (1.39,1.99) for SBP, DBP, MAP and PP, respectively (all P<0.01), and adjusted odds ratio of dependency associated with increment of 1 SD mmHg was 1.15 (1.03,1.27), 1.21 (1.09,1.34) and 1.19 (1.07,1.32) for SBP, DBP and MAP, respectively (all P<0.05).

Conclusion: Increased SBP, DBP, MAP and PP at admission were all associated with in-hospital mortality, and increased SBP, DBP and MAP were associated with dependency at discharge among hemorrhagic stroke patients.

Stroke is the leading cause of death and long-term disability worldwide.1 In China, stroke is the third leading cause of death for men and the second for women.2 The incidence and proportion of hemorrhagic stroke, especially, is much higher in the Chinese population than in western populations.3 Systolic blood pressure (SBP) and diastolic BP (DBP), two important indexes of BP, were strongly and independently associated with the incidence and mortality of stroke.4,5 Pulse pressure(PP), an estimation of the pulsatile component of BP, has been established as a risk factor of stroke by some cohort studies6-9: mean arterial pressure (MAP), reflecting the steady component of BP, was also considered to be
positively related to the risk of stroke. However, the
relationship between BP and clinical outcome (i.e.,
death or disability) among acute stroke patients is less
certain. Some observational studies have suggested that elevated BP was associated with poor outcome for acute stroke patients. Several other studies did not find an association between BP and poor outcome.

Despite the fact that stroke is a leading cause of
death and that the incidence and proportion of hemor-
rhagic stroke are higher in China, there are no data on
the relationship between BP, SBP, DBP, MAP and PP,
and clinical outcome in acute hemorrhagic stroke
patients in the Chinese population. In this study, we
examined the association between admission SBP,
DBP, MAP and PP and clinical outcome, including
death and dependency among acute hemorrhagic
stroke patients in Inner Mongolia, China.

Subjects and Methods

Participants
The study was approved by Soochow University
School of Radiation Medicine and Public Health Eth-
ics Committee. Acute hemorrhagic stroke patients
were recruited from 6 hospitals (Tongliao Municipal
Hospital, Teaching Hospital of Inner Mongolia
University For Nationality, Kezuohou Banner
Hospital, Kezuozhong Banner Hospital, Zalute Ban-
ner Hospital, and First Hospital of Kerqin District) in
Tongliao, a prefecture-level city in eastern Inner
Mongolia, China. These are the only hospitals with
western medicine facilities in this region and serve a
population of 2.04 million, most of whom are of Han
or Mongolian ethnicity. All patients with a clinical
diagnosis of acute hemorrhagic stroke admitted to the
hospitals from January 1, 2003 to December 31, 2005
were potentially eligible for the study. However, only
those cases confirmed by computed tomography (CT)
scan or magnetic resonance imaging (MRI) were in-
cluded. All hemorrhagic stroke (intracerebral hemor-
rhage or subarachnoid hemorrhage) were included in
this study. A team of investigators including neurolo-
gists reviewed the eligibility of study participants.
1760 patients had a CT scan or MRI being confirmed
as hemorrhagic stroke and were included in this
analysis.

Data Collection
Baseline data were collected within the first 24-hr of
admission by in-person interview with patients or
their family members (if patients were not able to
communicate). Data on demographic characteristics,
lifestyle risk factors, medical history, clinical labora-
tory tests, and imaging data (CT and MRI) were ob-
tained using a standard questionnaire administered by
trained staffs. Cigarette smoking was defined as hav-
ing smoked at least 1 cigarette per day for 1 year or
more. The amount and type of alcohol consumption
during the past year was collected. Alcohol consump-
tion was defined as consuming one or more alcoholic
drinks per day during the last year. Three BP meas-
urements were taken within 30 min of admission and
the participants were in the supine position using a
standard mercury sphygmomanometer according to a
standard protocol. The first and fifth Korotkoff
sounds were recorded as SBP and DBP, respectively.
The mean of 3 BP measurements were used in all
analyses.

Fasting plasma glucose (FPG) was measured using
a modified hexokinase enzymatic method. Total cho-
lesterol, HDL-cholesterol, and triglycerides were ana-
lyzed enzymatically on a Beckman Synchron CX5
Delta Clinical System (Beckman Coulter, Inc., Fuller-
ton, CA, USA) using commercial reagents. LDL-
cholesterol levels were calculated by use of the Frie-
dewald equation for the participants who had triglyc-
eride levels <400 mg/dL: LDL cholesterol = total cho-
lesterol - HDL-cholesterol - triglycerides/5.

The study outcome included death during hospi-
talization and dependency at discharge. If a patient
died in the hospital, a study staff member recorded the
death on the event form and obtained the death certificate. If a patient survived the acute stroke, the study neurologists conducted a comprehensive clinical evaluation at discharge. Dependency was defined as moderate or severe disability using a Modified Rankin’s scale (MRs) ≥ 3.22,23

Statistical Analysis

MAP was calculated as 1/3 SBP + 2/3 DBP, and PP was calculated as SBP - DBP. The mean and standard deviation (SD) of continuous variables and proportion of categorical variables at hospital admission were calculated for the patients with MRs < 3, dependency and death, respectively. Multiple logistic regression analysis was used to examine the association between four BP indexes and clinical outcome (death and dependency) adjusted for age, gender, ethnicity (Mongol vs. Han), alcohol consumption, cigarette smoking, and history of hypertension, history of diabetes, hyperglycaemia, and dyslipidemia. Patients were also divided into male and female groups, association between four BP indexes and clinical outcome was examined in male and female groups, respectively, by using multiple logistic regression analysis. Odds ratio (OR) and 95% confidence interval (95% CI) associated with increment of 1 SD mmHg in four BP indexes were calculated in the analysis. Statistical analysis was conducted using SAS 9.13 statistical software.

Results

Table 1 presents the demographic and clinical characteristics at admission among hemorrhagic stroke patients. Among all subjects, there were 103 patients who died during hospitalization, 576 patients with dependency and 1081 patients with MRs < 3 at discharge. The median durations of hospitalization were 4, 13 and 12 mos for the patients with death, dependency and MRs < 3, respectively. Patients with dependency were more likely to be older, and have a higher rate of hypertension compared with those MRs < 3, and patients who died were more likely to have lower rates of Mongolian ethnicity, cigarette smoking, alcohol drinking and a higher rate of hyperglycemia than those with MRs < 3. The patients who died had lower rates of cigarette smoking, alcohol drinking and hypertension, and a higher rate of hyperglycaemia than those with dependency. Patients who died had higher mean values of SBP, DBP, MAP and

| TABLE 1. Baseline characteristics of patients with acute hemorrhagic stroke |
|-------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Age, mean (SD)          | MRs<3 (n=1081)       | Dependency (n=576)   | Death (n=103)         | P         | P       | P         |
| Male, No. (%)           | 55.41(11.85)         | 57.07(11.23)         | 55.42(12.17)          | 0.006    | 0.993   | 0.175    |
| Mongolian ethnicity, No. (%) | 297(27.7)         | 157(27.3)            | 17(16.5)              | 0.491    | 0.034   | 0.068    |
| Cigarette smoking, No. (%) | 214(19.8)          | 132(22.9)            | 10(11.7)              | 0.137    | 0.044   | 0.010    |
| Alcohol drinking No. (%) | 230(21.3)          | 139(24.1)            | 13(12.6)              | 0.183    | 0.038   | 0.010    |
| History of hypertension, No. (%) | 602(55.7)       | 370(64.2)            | 48(46.6)              | 0.001    | 0.077   | 0.001    |
| History of diabetes, No. (%) | 24(2.2)           | 12(2.1)              | 2(1.9)                | 0.856    | 1.000   | 1.000    |
| Dyslipidemia *, No. (%) | 235(63.9)          | 145(68.7)            | 6(75.0)               | 0.236    | 0.781   | 1.000    |
| Hyperglycaemia †, No. (%) | 420(53.7)          | 231(54.2)            | 41(80.4)              | 0.863    | <0.001  | <0.001   |
| Systolic BP, mean (SD)  | 169.40(34.92)       | 174.28(31.42)        | 192.13(40.86)         | 0.004    | <0.001  | <0.001   |
| Diastolic BP, mean (SD) | 102.35(19.18)       | 105.68(18.82)        | 110.61(23.42)         | 0.001    | 0.001   | 0.045    |
| MAP, mean (SD)          | 124.70(22.96)       | 128.55(21.57)        | 137.78(26.61)         | 0.001    | <0.001  | 0.001    |
| PP, mean (SD)           | 67.05(23.70)        | 68.60(21.21)         | 81.51(31.05)          | 0.175    | <0.001  | <0.001   |

* Total cholesterol ≥ 200mg/dl or LDL-cholesterol ≥ 130mg/dl or HDL-cholesterol < 40mg/dl or triglyceride ≥ 150mg/dl; † Fasting plasma glucose ≥ 6.1
TABLE 2. OR and 95% CI of clinical outcomes associated with increment of 1 SD mmHg for four BP indexes among patients with acute hemorrhagic stroke

<table>
<thead>
<tr>
<th></th>
<th>Death</th>
<th>Dependency</th>
<th>OR (95%CI)</th>
<th>P value</th>
<th>OR (95%CI)</th>
<th>P value</th>
<th>OR (95%CI)</th>
<th>P value</th>
<th>OR (95%CI)</th>
<th>P value</th>
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<tbody>
<tr>
<td></td>
<td>unadjusted</td>
<td>adjusted †</td>
<td></td>
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<tr>
<td></td>
<td>SBP</td>
<td></td>
<td>1.77(1.47,2.15)</td>
<td>&lt;0.001</td>
<td>1.74(1.44,2.11)</td>
<td>&lt;0.001</td>
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<td></td>
<td>DBP</td>
<td></td>
<td>1.42(1.17,1.72)</td>
<td>&lt;0.001</td>
<td>1.39(1.15,1.69)</td>
<td>0.001</td>
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<tr>
<td></td>
<td>MAP</td>
<td></td>
<td>1.64(1.35,1.99)</td>
<td>&lt;0.001</td>
<td>1.61(1.32,1.96)</td>
<td>&lt;0.001</td>
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<td></td>
<td>PP</td>
<td></td>
<td>1.67(1.40,1.98)</td>
<td>&lt;0.001</td>
<td>1.66(1.39,1.99)</td>
<td>&lt;0.001</td>
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<tr>
<td></td>
<td>SBP</td>
<td></td>
<td>1.16(1.05,1.29)</td>
<td>0.005</td>
<td>1.15(1.03,1.27)</td>
<td>0.012</td>
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<td></td>
<td>DBP</td>
<td></td>
<td>1.19(1.08,1.32)</td>
<td>0.001</td>
<td>1.21(1.09,1.34)</td>
<td>&lt;0.001</td>
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<tr>
<td></td>
<td>MAP</td>
<td></td>
<td>1.19(1.07,1.32)</td>
<td>0.001</td>
<td>1.19(1.07,1.32)</td>
<td>0.001</td>
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<tr>
<td></td>
<td>PP</td>
<td></td>
<td>1.07(0.97,1.19)</td>
<td>0.107</td>
<td>1.05(0.94,1.16)</td>
<td>0.421</td>
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† Adjusted for age, sex, ethnicity (Mongol vs. Han), alcohol consumption, cigarette smoking, and history of hypertension, history of diabetes, hyperglycemia, and dyslipidemia.

PP (all P<0.05) than patients with dependency and MRs<3. Patients with dependency had higher means of SBP, DBP and MAP (all P<0.05) than patients with MRs<3. There were no differences in sex, diabetes, or dyslipidemia between patients with dependency and MRs<3, death and dependency, respectively.

Table 2 presents the ORs and 95% CIs of death and dependency associated with increments of 1 SD mmHg in four BP indices. All four indexes were associated with the risk of death, corresponding ORs for SBP, DBP, MAP after adjustment for covariates (all P<0.01). SBP, DBP and MAP were also associated with the risk of dependency (all P<0.05), but PP was not after adjusted for covariates.

The ORs (95% CIs) of death and dependency associated with increments of 1 SD mmHg for four BP indices by sex are presented in table 3. In both male and female groups, death was associated with the SBP, DBP, MAP and PP after adjustment for covariates (all P<0.05). Dependency was only associated with DBP after adjustment for covariates in males, but associated with all four BP indices adjusted for covariates in females (all P<0.05).

**Discussion**

We found that both deceased and dependent patients had higher admission SBP, DBP, MAP and PP levels than those with MRs<3, and that patients who died...
also had higher levels of four BP indices at admission than those with dependency. Our study also showed associations between elevated SBP, DBP, MAP and PP and death or elevated SBP, DBP, MAP and dependency among hemorrhagic stroke patients. These findings indicated that all four BP indices were related to poor outcome during hospitalization among acute hemorrhagic stroke patients.

Some, but not all, previous studies found that elevated BP was associated with increased case-fatality rate among acute hemorrhagic stroke patients. A systematic review including 32 observational studies on BP and outcome suggested that the combined outcome of death and dependency was associated with increased SBP (OR, 2.69) and DBP (OR, 4.68) in patients with intracerebral hemorrhage. A J-shaped association between BP and case-fatality rate was reported among 1097 patients with hemorrhagic stroke. Our study supported the observation that elevated BP was associated with increased case-fatality rate among acute hemorrhagic stroke patients.

It is well known that BP is usually characterized by its pulsatile and steady components. In addition to SBP and DBP, the two main components, our study also included PP and MAP in analyzing the relationship between BP and clinical outcome among hemorrhagic stroke patients. Like SBP and DBP, MAP and PP were also associated with death during hospitalization and MAP was associated with dependency at discharge among hemorrhagic stroke patients. There are some studies about the relationship between MAP or PP and mortality of stroke among the general population, but the findings are not consistent. There are also some reports about an association between MAP and PP and mortality of stroke among the general population, but the findings are not consistent. There are also some reports about an association between MAP and PP and clinical outcome of acute hemorrhagic stroke. For example, Fogelholm reported an increased 28-day case-fatality rate associated with higher admission MAP in 282 patients with acute intracerebral hemorrhage: the increased mortality was especially striking in the highest quartile of MAP levels (145mmHg). Dandapani showed that the case-fatality rate was higher among 34 acute hemorrhagic stroke patients with an admission MAP >145mmHg than in 53 patients with an admission MAP <145mmHg. Tuhrim and colleagues found that elevated PP was related to a poor outcome in 30 days after onset of hemorrhagic stroke. In Vemmos’ study, increased PP values during the first hours after stroke (including ischemic and hemorrhagic stroke) were independently associated with higher 1-year mortality: no effect was observed between MAP and late outcome. However, these studies could not conclude that BP index was more powerful for predicting death and dependency after onset of hemorrhagic stroke.

In summary, our study found that increased SBP, DBP, MAP and PP were associated with death during hospitalization and that increased SBP, DBP, MAP were associated with dependency at discharge among patients with acute hemorrhagic stroke. However, this study could not determine which BP index was more powerful for predicting death and dependency after onset of hemorrhagic stroke. This suggests that lowering BP may be necessary for acute hemorrhagic stroke patients with hypertension.

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References


mean blood pressure and pulse pressure on stroke and coronary artery disease in essential hypertension. Circulation 2001;103:2579-84.


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