The design, rationale, and baseline characteristics of a nationwide cohort registry in China: blood pressure and clinical outcome in TIA or ischemic stroke

Jie Xu¹,²,*
Yi Liu³,⁴*
Yongli Tao⁴
Xuewei Xie¹,²
Hongqiu Gu¹,²
Yuesong Pan¹,²
Xingquan Zhao¹,²
Yongjun Wang¹,²
Aoshuang Yan³
Yilong Wang¹,²

¹Department of Neurology, Beijing Tiantan Hospital, Capital Medical University, ²China National Clinical Research Center for Neurological Diseases, ³Department of Epidemiology and Health Statistics, School of Public Health, Capital Medical University, Beijing, ⁴Department of Neurology, First Affiliated Hospital of Zhengzhou University, Zhengzhou, China

*These authors contributed equally to this work

Background: The relationship between poststroke blood pressure (BP) and clinical outcomes in ischemic stroke (IS) is still controversial. However, there is no large BP database for IS or transient ischemic attack (TIA) in China. This study aims to describe the rationale, study design, and baseline characteristics of a nationwide BP database in IS or TIA patients in China.

Materials and methods: The BOSS (blood pressure and clinical outcome in TIA or ischemic stroke) study was a hospital-based, prospective cohort study aiming to assess BP parameters and clinical outcome in IS/TIA patients. BP parameters were based on office BP, ambulatory BP, and home BP. Clinical outcomes included stroke recurrence, combined vascular events, and disability. Electronic case-report forms were used to record baseline and follow-up data. The patients were followed up for clinical outcomes at 3 months through face-to-face interview and at 12 months by telephone.

Results: Between October 2012 and February 2014, the BOSS registry recruited 2,608 patients from 61 hospitals, with a mean age of 62.5 years, 32.4% of whom were female, 88.9% with an entry diagnosis of IS, and 86% diagnosed with hypertension. The rates of patients lost-to-follow-up were 3.1% at 3 months and 5.1% at 1 year; 93% of patients completed ambulatory BP monitoring during hospitalization and 94.7% finished a 3-month BP diary.

Conclusion: The BOSS registry will provide important evidence about BP management in the acute phase and secondary prevention for IS/TIA patients.

Keywords: blood pressure, ischemic stroke, transient ischemic attack

Introduction

Stroke is the second-leading cause of death in the world and the leading cause of death in China.¹⁻⁴ In 2013, more than 1.9 million Chinese adults died from stroke, which represented an increase of 47.7% from 1.3 million in 1990.⁴ Hypertension is the most important risk factor for stroke.⁵ About 54% of strokes worldwide were attributable to high blood pressure (BP), and about 80% of the attributable burden occurred in low- or middle-income countries.⁶ To date, an estimated 0.2 billion people had hypertension in China, accounting for a fifth of the total hypertensive population in the world. The rising incidence of stroke and hypertension has created a heavy burden to the Chinese health care system.

American,⁷ European,⁸ and Japanese⁹ hypertension guidelines have confirmed the importance of ambulatory BP monitoring (ABPM) and home BP (HBPM). Most studies¹⁰⁻¹³ on stroke still use BP values based on traditional office measurements,
rather than ABPM or HBPM. Moreover, BP lowering in the acute phase of ischemic stroke (IS) and secondary prevention has been a longstanding controversy.\textsuperscript{14,15} It is not clear when the optimal time is to initiate early BP lowering or what the target-BP level is in IS and transient ischemic attack (TIA) patients. There are few BP databases\textsuperscript{16,17} for IS patients worldwide to date. As far as we know, China, which has a fifth of the world’s population, still lacks a BP database for IS and TIA patients. Given this, we performed a nationwide prospective investigation on BP parameters and clinical outcomes in our cohort of patients with acute IS or TIA from 2012 in 61 hospitals, and 1-year follow-up data of all 2,068 patients was completed in 2015. In this report, we introduce the rationale, study design, and the baseline characteristics of BOSS (blood pressure and clinical outcome in TIA or ischemic stroke).

Materials and methods
Study design
BOSS was a nationwide, hospital-based, longitudinal cohort study aiming to assess BP parameters and clinical outcome in IS/TIA patients, conducted at 61 hospitals in China. The participating hospitals were mainly tertiary urban hospitals, selected from 16 provinces and four municipalities across mainland China, including Northeast China (Heilongjiang, Jilin, Liaoning), Northwest China (Shaanxi), North China (Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia), East China (Shanghai, Shandong, Jiangsu, Fujian, Zhejiang), South-central China (Henan, Hubei, Guangdong), and Southwest China (Chongqing, Sichuan). The details of centers are shown in Table S1. A total of 2,720 IS/TIA patients were consecutively enrolled from October 2012 to February 2014. An average of 42.5 participants were enrolled in each center. The study was approved by the central Institutional Review Board at Beijing Tiantan Hospital, and all patients or their designated relatives provided written informed consent. Electronic case-report forms were used to record baseline and follow-up data. The patients were followed up at 3 months through face-to-face interview and at 12 months by telephone.

BP measurement
Office BP (OBP) was measured by doctors or trained nurses according to a standard measurement method recommended by the American Heart Association\textsuperscript{18} at admission, discharge, and 3-month visit. After enrollment, each patient was assigned a semiautomatic upper-arm BP monitor (HEM-4030; Omron, Kyoto, Japan), and patients or their accompanying relatives were trained by nurses to use it. During hospitalization, BP would be measured twice daily by patients themselves or their relatives, and BP data were recorded in an assigned hospitalization BP diary. Moreover, ABPM was also completed during hospitalization. BP measurements were taken every 15 minutes during the day and every 30 minutes at night. Daytime episodes were defined from 6 am to 9:59 pm and nighttime episodes from 10 pm to 5:59 am. If the recorded BP readings are less than 80% of expected measurements, the ABPM should be repeated. Sleep diaries were compiled by patient self-report, including sleep time and awake time. At discharge, the assigned Omron BP monitor was taken home by patients. Patients would persist on measuring BP twice daily at home from the first day after discharge to 3 months after onset, and once a day from 3 months to 12 months after onset, and all BP data were recorded on the assigned home BP diaries (Figure S1). For patients with atrial fibrillation, they did not need to complete ABPM, and all of them were assigned a mercury sphygmomanometer to monitor home BP, rather than a semiautomatic monitor, because oscillometric devices may not record BP accurately in patients with arrhythmias.\textsuperscript{19,20}

Inclusion criteria and baseline and follow-up data collection
Patients were recruited consecutively if the following conditions were met: age of 18 years or older, diagnosis of an acute IS or TIA, and within 7 days of the index event. TIA was defined as new symptomatic neurologic deterioration lasting less than 24 hours with no new infarction on neuroimaging. Acute IS was diagnosed according to World Health Organization criteria combined with brain computed tomography or magnetic resonance imaging confirmation.\textsuperscript{21}

A standard electronic data-collection system was developed by Goodwill Information Technology Co Ltd, and the electronic case-report forms were used for baseline and follow-up data collection. All research coordinators and investigators were trained how to use this electronic data-collection system before the trial-kickoff meeting.

Baseline information included demographics, risk factors, medication use, diagnosis, disease management, and discharge status. Risk factors were defined as follows: history of hypertension (a reported history of hypertension or antihypertensive medication use), history of stroke (defined as a medical chart-confirmed history of stroke, including IS, intracerebral hemorrhage, or subarachnoid hemorrhage), coronary heart disease (a reported history of myocardial infarction or cardiac surgery, or with a final diagnosis of myocardial infarction at discharge), atrial fibrillation...
From October 2012 to February 2014, 2,720 IS/TIA patients from 64 hospitals were registered. Three hospitals were eliminated because most of their enrolled patients did not complete ABPM or HBPM, so all 109 patients enrolled in these three hospitals were excluded. Moreover, three patients were removed, because their baseline information were absent. We included a total of 2,608 consecutive patients as our cohort.

We followed up the cohort patients for 1 year; 82 (3.1%) patients were lost to follow-up at 3 months, and 132 (5.1%) patients were lost to follow-up at 1 year. A detailed patient-recruitment flowchart is illustrated in Figure 1. Of 2,608 patients, the mean age was 62.5 years, 32.4% were females, 88.9% had an entry diagnosis of IS, and 86% was diagnosed with hypertension. Other characteristics are summarized in Table 1.

Table 2 shows the BP parameters based on OBP, ABP, and HBPM. Mean OBP was 150.53±20.67/86.44±12.58 mmHg at admission, 136.94±13.89/80.29±9.71 mmHg at discharge, 134.51±11.94/80.52±8.60 mmHg at the 3-month visit. Visit-to-visit systolic BP (SBP) variability based on OBP was 13.11±9.05 mmHg, 24-hour SBP variability based on ABPM was 15.35±4.42 mmHg, and day-to-day SBP variability based on HBPM was 8.62±4.1 mmHg. ABP data showed that 70% of patients had morning hypertension, 51.1% had nocturnal hypertension, and 27.7% were reverse dippers.

Medication information is described in Table 3. Proportions of antihypertensive medication during hospitalization, at discharge, and at 3 months were 65.9%, 68.5%, and 67.6%; 93% of patients completed ABP monitoring, 94.7% of patients completed their 3-month BP diary. Detailed information about ABPM- and BP-diary completion is reported in Table 4. As to clinical outcomes, rates of stroke recurrence, combined vascular events, and mortality are listed in Table 5.

Discussion
To our knowledge, BOSS is the first nationwide BP database including the most comprehensive BP information for IS/TIA patients in China, and will provide important BP parameters for further investigation in the management of acute IS and secondary prevention of IS. There were three types of BP monitoring in this study: OBP, ABP, and HBPM. Because ABPM offers specific advantages over OBP, such as providing a much larger number of readings, identifying white-coat and masked hypertension phenomena, and supplying nocturnal hypertension and dipping patterns, European Society of Hypertension practice guidelines for ABPM33 point out that ABPM improves prognostic accuracy in target-organ damage and cardiovascular morbidity and mortality compared with OBP. However, to date most
stroke studies\textsuperscript{24–27} still use OBPM, and we found that the conclusion of these studies about the relationship between BP level and stroke outcomes remains controversial, especially for IS/TIA patients. It is urgent to establish a large ABPM database in relation to stroke outcome, like IDACO (international database of ambulatory blood pressure in relation to cardiovascular outcome).\textsuperscript{16} BOSS has an independent and complete ABPM database, in which there are 93\% of total patients and more than 85\% of patients with at least 80\% of expected measurements during 24-hour recording.

HBPM is also recommended by guidelines.\textsuperscript{7–9} HBPM seems to be more closely associated with hypertensive end-organ damage than clinic BP, even for a low number of measurements. In BOSS, uniform devices were used to measure home BP to avoid measurement error. In addition, BP data were recorded on each day, so BP variation could be calculated as day-to-day variability, rather than visit-to-visit variability, which was used in most previous studies.\textsuperscript{28–30} It is worth noting that the completion rate of the 3-month BP diary was as high as 94.7\%, which could supply high-quality data to calculate BP parameters.

In addition, adherence to secondary prevention medication in IS and TIA patients was another focus in BOSS. Adherence was defined in consistence with the AVAIL study.\textsuperscript{31}

### Table 1 Baseline characteristics of the study population

| Variable                                      | All (n=2,608) | Missing n (%)/mean ± SD |
|-----------------------------------------------|---------------|-------------------------|
| Stroke subtype                                |               |                         |
| IS                                            | 2,318 (88.9)  | 0                       |
| TIA                                           | 290 (11.1)    | 0                       |
| Female                                        | 845 (32.4)    | 0                       |
| Age (years)                                   | 62.5 ±11.1    | 0                       |
| Current or previous smoker                    | 1,124 (43.2)  | 4 (0.2)                 |
| Moderate or heavy drinking                    | 451 (17.3)    | 4 (0.2)                 |
| Body mass index, median (Q1–Q3)              | 24.6 (22.9–26.6) | 92 (3.5)               |
| History of hypertension                       | 1,837 (70.6)  | 4 (0.2)                 |
| History of stroke                             | 618 (23.8)    | 6 (0.2)                 |
| History of TIA                                | 102 (3.9)     | 6 (0.2)                 |
| Hypertension with discharge diagnosis         | 2,238 (86)    | 7 (0.3)                 |
| Diabetes mellitus with discharge diagnosis    | 739 (28.4)    | 7 (0.3)                 |
| Dyslipidemia with discharge diagnosis         | 1,083 (41.7)  | 8 (0.3)                 |
| Coronary heart disease with discharge diagnosis | 328 (12.6) | 8 (0.3)                 |
| Atrial fibrillation with discharge diagnosis  | 104 (4)       | 7 (0.3)                 |
| NIHSS score on admission                      | 3.1 ±3.4      | 49 (1.9)                |
| Ischemic stroke subtype                       |               |                         |
| Large-artery atherosclerosis                  | 1,358 (59.1)  | 19 (0.7)                |
| Cardioembolism                                | 89 (3.9)      |                         |
| Small-artery occlusion                        | 776 (33.8)    |                         |
| Other                                         | 76 (3.3)      |                         |

**Abbreviations:** IS, ischemic stroke; NIHSS, National Institute of Health Stroke Scale; SD, standard deviation; TIA, transient ischemic attack.
Table 2 BP parameters based on OBP, ABP, and HBP

| Variable            | All (n=2,608) | Missing n (%) |
|---------------------|---------------|---------------|
|                     | Mean ± SD     |               |
| OBP                 |               |               |
| SBP on admission    | 150.5±20.7    | 50 (1.9)      |
| SBP at discharge    | 136.9±13.9    | 39 (1.5)      |
| SBP at 3 months     | 134.5±11.9    | 225 (8.6)     |
| DBP on admission    | 86.4±12.6     | 50 (1.9)      |
| DBP at discharge    | 80.3±9.7      | 41 (1.6)      |
| DBP at 3 months     | 80.5±18.6     | 225 (8.6)     |
| Visit-to-visit BP variability |          |               |
| Systolic, mmHg      | 13.1±9.1      | 17 (0.7)      |
| Diastolic, mmHg     | 7.8±5.5       | 17 (0.7)      |
| ABP                 |               |               |
| Average 24-hour BP  |               |               |
| Systolic, mmHg      | 141.7±18.2    | 182 (7)       |
| Diastolic, mmHg     | 84±13         | 182 (7)       |
| Average 24-h HR, bpm| 69.9±9.6      | 185 (7.1)     |
| Average daytime BP  |               |               |
| Systolic, mmHg      | 143±18.3      | 182 (7)       |
| Diastolic, mmHg     | 85.1±13.3     | 182 (7)       |
| Average daytime HR, bpm | 71.4±9.8      | 185 (7.1)     |
| Average nighttime BP|               |               |
| Systolic, mmHg      | 137.4±20.4    | 213 (8.2)     |
| Diastolic, mmHg     | 80.4±13.4     | 213 (8.2)     |
| Average nighttime HR, bpm | 64.9±9.9      | 216 (8.3)     |
| Morning hypertension, n (%) | 1.684 (70) | 204 (7.8)   |
| Nocturnal hypertension, n (%) | 1.223 (51.1) | 213 (8.2) |
| Circadian rhythm    |               |               |
| Extreme dippers, n (%) | 38 (1.6)    |               |
| Dippers, n (%)      | 434 (18.1)    |               |
| Nondippers, n (%)   | 1,260 (52.6)  |               |
| Reverse dippers, n (%) | 663 (27.7)   |               |
| 24-hour BP variability |             |               |
| Systolic, mmHg      | 15.4±4.4      | 183 (7)       |
| Diastolic, mmHg     | 11.6±4.1      | 183 (7)       |
| HBP                 |               |               |
| Average BP          |               |               |
| Systolic, mmHg      | 134.1±12.3    | 139 (5.3)     |
| Diastolic, mmHg     | 79.4±9.4      | 139 (5.3)     |
| Average morning BP  |               |               |
| Systolic, mmHg      | 134.5±12.7    | 142 (5.4)     |
| Diastolic, mmHg     | 79.8±9.6      | 142 (5.4)     |
| Average evening BP  |               |               |
| Systolic, mmHg      | 134.5±12.7    | 142 (5.4)     |
| Diastolic, mmHg     | 79.8±9.6      | 142 (5.4)     |
| Day-to-day BP variability |         |               |
| Systolic, mmHg      | 8.6±4.1       | 139 (5.3)     |
| Diastolic, mmHg     | 7±7.2         | 139 (5.3)     |

Table 3 Medication information

| Variable          | All (n=2,608) | Missing n (%) |
|-------------------|---------------|---------------|
| History of medication |               |               |
| Antiplatelet      | 544 (20.9)    | 4 (0.2)       |
| Anticoagulant     | 14 (0.5)      | 4 (0.2)       |
| Statin            | 258 (9.9)     | 4 (0.2)       |
| Antidiabetic      | 465 (17.9)    | 4 (0.2)       |
| Antihypertensive  | 1,146 (44.4)  | 4 (0.2)       |
| Medication during hospitalization |         |               |
| Antiplatelet      | 2,523 (97)    | 7 (0.3)       |
| Anticoagulant     | 200 (7.7)     | 8 (0.3)       |
| Statin            | 2,332 (89.7)  | 7 (0.3)       |
| Antidiabetic      | 650 (25)      | 7 (0.3)       |
| Antihypertensive  | 1,714 (65.9)  | 8 (0.3)       |
| Other             | 1,340 (78.2)  |               |
| ACE              | 286 (16.7)    |               |
| ARB              | 396 (23.1)    |               |
| Diuretic         | 113 (6.6)     |               |
| β-Blocker        | 135 (7.9)     |               |
| Others           | 28 (1.7)      |               |
| Medication with discharge |       |               |
| Antiplatelet      | 2,434 (96.3)  | 80 (3.1)      |
| Anticoagulant     | 29 (1)        | 80 (3.1)      |
| Statin            | 2,167 (85.7)  | 80 (3.1)      |
| Antidiabetic      | 547 (21.6)    | 80 (3.1)      |
| Antihypertensive  | 1,731 (68.5)  | 80 (3.1)      |
| CCB              | 1,337 (77.2)  |               |
| ACEI             | 227 (13.1)    |               |
| ARB              | 461 (26.6)    |               |
| Diuretic         | 108 (6.2)     |               |
| β-Blocker        | 182 (10.5)    |               |
| Others           | 9 (0.5)       |               |
| Medication at 3 months |         |               |
| Antiplatelet      | 2,244 (94.7)  | 238 (9.1)     |
| Anticoagulant     | 28 (1.2)      | 240 (9.2)     |
| Statin            | 1,846 (77.9)  | 239 (9.2)     |
| Antidiabetic      | 485 (20.5)    | 239 (9.2)     |
| Antihypertensive  | 1,600 (67.6)  | 240 (9.2)     |
| CCB              | 1,223 (76.4)  |               |
| ACEI             | 205 (12.8)    |               |
| ARB              | 426 (26.6)    |               |
| Diuretic         | 76 (4.8)      |               |
| β-Blocker        | 165 (10.3)    |               |
| Others           | 8 (0.5)       |               |

Abbreviations: OBP, office BP; ABP, ambulatory BP; HBP, home BP; SD, standard deviation; HR, heart rate; SBP, systolic BP; DBP, diastolic BP.

Abbreviations: BP, blood pressure; OBP, office BP; ABP, ambulatory BP; HBP, home BP; SD, standard deviation; HR, heart rate; SBP, systolic BP; DBP, diastolic BP.

which provided the possibility of comparison of medication adherence of secondary prevention between Chinese and American patients.

Fortunately, the rate of loss to follow-up of BOSS was only 3.1% at 3 months and 5.1% at 1 year, which can offer credible event outcomes. However, we found the event rate of BOSS to be much lower than historical cohorts, eg, the 1-year risk of stroke in historical cohorts was 17.7% in CNSR,32 12.3% in CHANCE,33 and 12.2% in SAMMPRIS34 compared with 6.1% in our cohort. It is worth noting that recently the TIAREgistry.org project35 also reported a very low risk of stroke after a TIA or minor stroke: 3.7% at 90 days and 5.1% at 1 year after symptom onset, which is close to our cohort. The lower event rates in our cohort may be explained...
Table 4 ABPM- and BP diary-completion information

| Variable                                      | All (n=2,608) | Missing |
|-----------------------------------------------|---------------|---------|
| Completion of ABPM                           |               |         |
| Monitoring length (hours)                     |               |         |
| ≥24                                          | 1,929 (94.2)  | 183 (7) |
| ≥20, <24                                      | 1,411 (74.1)  |         |
| ≥14, <20                                      | 54 (2.2)      |         |
| <14                                          | 38 (1.6)      |         |
| Successful readings                          |               |         |
| ≥80%                                         | 2,144 (88.4)  | 183 (7) |
| ≥60%, <80%                                    | 203 (8.4)     |         |
| <60%                                         | 78 (3.2)      |         |
| Including 5–7 am duration                    | 2,329 (96.1)  | 184 (7.1) |
| Completion of 3-month BP diary               |               |         |
| Total monitoring length (days)               |               |         |
| ≥60, <90                                     | 2,363 (95.7)  |         |
| ≥30, ≤60                                     | 39 (1.6)      |         |
| ≥7, <30                                      | 59 (2.4)      |         |
| <7                                           | 9 (0.3)       |         |

Abbreviations: ABPM, ambulatory blood pressure monitoring; BP, blood pressure.

HBPM improving not only BP-medications adherence but also overall compliance with secondary prevention treatment. Our study showed that adherence rates of antiplatelet, statin, and antihypertensive medication use at 3 months were similar to the rates at discharge (see Table 3).

This registry has potential limitations. The first limitation is the different type of device and analysis software for ABPM used in each site. Given this, the original BP data of all of the patients were re-entered in EpiData and all of the BP-composite parameters were recalculated using SAS software. Second, although 94.7% of patients completed 3-month BP diary in this study, only 40% of the patients returned their diaries for recording HBP from 3 months to 1 year after symptom onset. Third, telephone but not face-to-face follow-up was adopted at 1 year. For patients with clinical events at 1-year telephone follow-up, we would further confirm this event. Each case fatality was either confirmed on a death certificate from the local citizen registry or from the attended hospital. In cases of lack of local citizen-registry information or death without hospitalization, case fatality was deemed to be reliable if death was reported on two consecutive follow-up periods from different proxies. We would call back patients with nonfatal events for a face-to-face follow-up or carry out a home visit. Fourth, according to the protocol of this registry, all patients were required to be consecutively enrolled. However, in consideration of HBP monitoring, more mild patients were recruited, which would lead to a selection bias. Fifth, this was a mainly ethnically Chinese cohort, which did not include white and black people.

Conclusion

This study introduced the design, rationale, and baseline characteristics of BOSS, which was a nationwide, hospital-based, longitudinal cohort study aiming to assess BP parameters (based on OBPM, ABPM, and HBPM) and clinical outcome in IS/TIA patients. The BOSS registry will provide important evidence about BP management in the acute phase and secondary prevention for IS/TIA patients.

Acknowledgments

Thanks to the top three hospitals that enrolled the most cases for the BOSS study: Xi’an 141 Hospital (Qiuru Liu), Changzhi People’s Hospital (Lili Zhao), and the First Affiliated Hospital of Zhengzhou University (Yuming Xu). The study was supported by grants from the Ministry of Science and Technology of the People’s Republic of China (2011BAI08B01 and 2013BAI09B03) and a grant from Beijing Municipal Administration of Hospitals’ Youth Program (QML2015 0504). This study was also funded by AstraZeneca, which did not participate in the proposal design, implementation, or statistical analysis.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Global Burden of Disease Study 2013 Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2015;386(9995):743–800.
2. Feigin VL, Krishnamurthi RV, Parmar P, et al. Update on the Global Burden of Ischemic and Hemorrhagic Stroke in 1990–2013: the GBD 2013 study. *Neuroepidemiology*. 2015;45(3):161–176.
3. Yang G, Wang Y, Zeng Y, et al. Rapid health transition in China, 1990–2010: findings from the Global Burden of Disease Study 2010. *Lancet*. 2013;381(9882):1987–2015.
4. Zhou M, Wang H, Zhu J, et al. Cause-specific mortality for 240 causes in China during 1990–2013: a systematic subnational analysis for the Global Burden of Disease Study 2013. *Lancet*. 2016;387(10015):251–272.
5. O’Donnell MJ, Xavier D, Liu L, et al. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study. *Lancet*. 2010;376(9735):112–123.

6. Lawes CM, Vander Hoorn S, Rodgers A. Global burden of blood-pressure-related disease, 2001. *Lancet*. 2008;371(9623):1513–1518.

7. James PA, Oparil S, Carter BL, et al. 2014 Evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). *JAMA*. 2014;311(5):507–520.

8. ESH/ESC Task Force for the Management of Arterial Hypertension. 2013 Practice guidelines for the management of arterial hypertension of the European Society of Hypertension (ESH) and the European Society of Cardiology (ESC). *J Hypertens*. 2013;31(10):1925–1938.

9. Shimamoto K, Ando K, Fujita T, et al. The Japanese Society of Hypertension guidelines for the management of hypertension (JSH 2014). *Hypertens Res*. 2014;37(4):253–390.

10. He J, Zhang Y, Xu T, et al. Effects of immediate blood pressure reduction on death and major disability in patients with acute ischemic stroke: the CATIS randomized clinical trial. *JAMA*. 2014;311(5):479–489.

11. Robinson TG, Potter JF, Ford GA, et al. Effects of antihypertensive treatment after acute stroke in the Continue or Stop Post-Stroke Antihypertensives Collaborative Study (COSACS): a prospective, randomised, open, blinded-endpoint trial. *Lancet Neurol*. 2010;9(8):767–775.

12. Benavente OR, Coffey CS, Conwit R, et al. Blood-pressure targets in patients with recent lacunar stroke: the SPS3 randomised trial. *Lancet*. 2013;382(9891):507–515.

13. Bath PM, Woodhouse L, Scutt P, et al. Efficacy of nitric oxide, with or without continuing antihypertensive treatment, for management of high blood pressure in acute stroke. *Lancet*. 2015;385(9968):617–628.

14. Sacco RL, Rundek T. The value of urgent specialized care for TIA and ischemic stroke. *JAMA*. 2014;311(5):469–479.

15. Rothwell PM. Blood pressure in acute stroke: which questions remain? *Lancet*. 2013;382(9891):112–123.

16. Thijs L, Hansen TW, Kikuya M, et al. The international database of ambulatory blood pressure in relation to cardiovascular outcome (IDACO): protocol and research perspectives. *Am Heart J*. 2012;163(2):339–346.

17. Nissen SE, Tuzcu EM, Nicholls SC, et al. Prognostic significance of visit-to-visit variability, maximum systolic blood pressure, and episodic hypertension. *Lancet*. 2010;375(9718):895–905.

18. Wilson PW, D’Agostino RB, Levy D, et al. Prognostic equation for cardiovascular disease risk calculation. *JAMA*. 2005;293(15):1823–1834.
Supplementary materials

Table S1 Participating hospital information

| Location           | Name                                                   | Grade | PI                |
|--------------------|--------------------------------------------------------|-------|-------------------|
| **North China**    |                                                        |       |                   |
| Beijing            | Beijing Tiantan Hospital, Capital Medical University   | III   | Xingquan Zhao     |
| Beijing            | Beijing An Zhen Hospital, Capital Medical University   | III   | Qi Bi             |
| Beijing            | Beijing Friendship Hospital                            | III   | Jimei Li          |
| Beijing            | Third Hospital of Peking University                    | III   | Dongsheng Fan     |
| Beijing            | Beijing Hospital                                      | III   | Tao Gong          |
| Beijing            | People's Hospital of Peking University                 | III   | Xuguang Gao       |
| Hebei              | Second Hospital of Hebei Medical University            | III   | Guohua Zhang      |
| Hebei              | First Hospital of Handan                               | III   | Yiping WuJie Lin  |
| Hebei              | Cangzhou Central Hospital                              | III   | Junling Zhang     |
| Hebei              | Shijiazhuang Central Hospital                          | III   | Wanying Shi       |
| Hebei              | Third Hospital of Hebei Medical University             | III   | Junyan Liu        |
| Hebei              | People's Hospital of Hebei                             | III   | Peiyuan Lv        |
| Inner Mongolia     | Baogang Hospital                                       | III   | Dong Wang         |
| Shanxi             | Second Hospital of Shanxi Medical University           | III   | Guangli Li        |
| Shanxi             | Changzhi People's Hospital                             | III   | Lili Zhao         |
| Tianjin            | Fourth Central Hospital of Tianjin                     | III   | Chunling Ji       |
| Tianjin            | Tianjin Huanhu Hospital                                | III   | Yong Ji           |
| Tianjin            | Tianjin Binhai People's Hospital                      | II    | Bin Li            |
| **Northeast China**|                                                        |       |                   |
| Heilongjiang       | First Machine Factory Workers Hospital of Qiqihar      | II    | Chunling Yang     |
| Jilin              | Jilin Central Hospital                                 | III   | Hanyi Zhang       |
| Jilin              | First Hospital of Jilin University                     | III   | Jiachun Li        |
| Liaoning           | First Hospital of Liaoning Medical University          | III   | Rubo Sui          |
| Liaoning           | Hospital of Dalian Economic and Technological Development Zone | II   | Ying Lian         |
| **Northwest China**|                                                        |       |                   |
| Shaanxi            | Xi'an 141 Hospital                                     | II    | Qiuwu Liu         |
| **East China**     |                                                        |       |                   |
| Fujian             | Xiamen Second Hospital                                 | III   | Jianping Niu      |
| Jiangsu            | First Hospital of Suzhou University                    | III   | Zhan Xu           |
| Jiangsu            | Second Hospital of Suzhou University                   | III   | Heqing Zhao       |
| Jiangsu            | Nanjing First Hospital                                 | III   | Junshan Zhou      |
| Jiangsu            | Liangyungang Traditional Chinese Medicine Hospital    | III   | Lejun Li          |
| Jiangsu            | Gulou Hospital of Nanjing University Medical College   | III   | Zhongyuan Wang    |
| Shandong           | People's Hospital of Zibo Linzi                        | III   | Yongliang Cao     |
| Shandong           | Affiliated Hospital of Qingdao University              | III   | Xudong Pan        |
| Shandong           | Hospital of Shandong Province                          | III   | Yifeng Du         |
| Shanghai           | East Hospital of Yangpu District                       | II    | Fei Li            |
| Shanghai           | Shanghai Tongji Hospital                               | III   | Zhiyu Nie         |
| Shanghai           | Central Hospital of Shanghai Yangpu                   | III   | Xin Li            |
| Shanghai           | Sixth People's Hospital of Shanghai Jiaotong University | III   | Xiaojiang Sun     |
| Shanghai           | Branch of Shanghai First People's Hospital            | II    | Shaoshi Wang      |
| Shanghai           | Public Hospital of Shanghai Pudong New Area           | II    | Xuelian Yang      |
| Shanghai           | Xinhuas Hospital of Shanghai Jiaotong University Medical Department | III   | Zhenguo Liu       |
| Shanghai           | Ruijin Hospital of Shanghai Jiaotong University Medical Department | III   | Shengdi Chen      |
| Zhejiang           | First People's Hospital of Taizhou                    | III   | Zhimin Wang       |
| Zhejiang           | First Hospital of Wenzhou Medical University           | III   | Chengye Zhou      |
| Zhejiang           | First Hospital of Zhejiang University Medical College  | III   | Benyan Luo        |
| Zhejiang           | Hangzhou First Hospital                               | III   | Guozhong Niu      |
| Zhejiang           | Shaoyifu Hospital of Zhejiang University Medical College | III   | Xingyue Hu        |
| Zhejiang           | No 2 Hospital of Zhejiang University Medical College   | III   | Baorong Zhang     |

(Continued)
Blood pressure in TIA or ischemic stroke

Table S1 (Continued)

| Location       | Name                                      | Grade | PI              |
|----------------|-------------------------------------------|-------|-----------------|
| South-central China |                                            |       |                 |
| Guangdong       | Jiangmen Central Hospital                  | III   | Jianxin Zhong   |
| Guangdong       | First Hospital of Jinan University         | III   | Anding Xu       |
| Guangdong       | First People’s Hospital of Foshan          | III   | Yukai Wang      |
| Guangdong       | First People’s Hospital of Guangzhou       | III   | Xiaoping Pan    |
| Guangdong       | Third Hospital of Zhongshan University     | III   | Zhengqi Lu      |
| Guangdong       | Zhuijiang Hospital                         | III   | Zhenhua Liu     |
| Guangdong       | People’s Hospital of Shenzhen              | III   | Xiaofan Chu     |
| Henan           | First Hospital of Zhengzhou University     | III   | Yuming Xu       |
| Hubei           | Wuhan Union Hospital, Tongji Medical College of HUST | III | Yuanjin Guo |
| Hubei           | Wuhan Neurosurgical Hospital               | III   | Yuhua Chen      |
| Hubei           | Wuhan First Hospital                       | III   | Guohua Chen     |
| Hubei           | Wuhan Zhongshan Hospital                   | III   | Xiaorong Deng   |
| Hubei           | Xinhua Hospital of Hubei                   | III   | Kang Xu         |
| Southwest China |                                            |       |                 |
| Sichuan         | Third People’s Hospital of Chengdu         | III   | Li Gao          |
| Sichuan         | People’s Hospital of Sichuan               | III   | Wenbin Wu       |
| Chongqing       | Daping Hospital of Third Military Medical University | III | Huadong Zhou |
| Chongqing       | First Hospital of Third Military Medical University | III | Kangning Chen |

Abbreviations: PI, principal investigator; HUST, Huazhong University of Science and Technology.

The design of the BOSS study

Figure S1 Design of the BOSS study.
Abbreviations: BOSS, blood pressure and clinical outcome in TIA or ischemic stroke; BP, blood pressure; OBP, office BP; ABPM, ambulatory BP monitoring; HBPM, home BPM; TIA, transient ischemic attack.