Abnormal Glucose Regulation in Patients With Acute Stroke Across China
Prevalence and Baseline Patient Characteristics

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Background and Purpose—The prevalence of diabetes is high among patients with ischemic stroke. However, the prevalence of abnormal glucose regulation and clinical characteristics among patients with stroke in the Chinese population is uncertain. We investigated the prevalence of prediabetes and diabetes in Chinese patients after stroke onset in a nationwide cohort study and investigated abnormal glucose regulation in patients with acute stroke across China (ACROSS-China).

Methods—The ACROSS-China study consecutively recruited patients hospitalized for acute stroke in 2008 to 2009 and investigated the prevalence of impaired glucose tolerance and diabetes among the patients on day 14 after stroke onset. Oral glucose tolerance test was performed in the diagnosis of abnormal glucose regulation.

Results—The prevalence of abnormal glucose regulation was 68.7% among all the patients with stroke. Diabetes was identified in 42.3% of all the patients (45.8% for patients with ischemic stroke, 31.2% for patients with intracerebral hemorrhage, and 26.4% for patients with subarachnoid hemorrhage, respectively). Prediabetes (impaired fasting glucose and impaired glucose tolerance) was identified in 26.4% of all the patients with stroke. The prevalence of diabetes and impaired glucose tolerance was the highest in the patients with atherothrombotic infarction (73.4%).

Conclusions—The prevalence of abnormal glucose regulation was high in Chinese patients with acute stroke, especially in patients with atherothrombotic infarction. Oral glucose tolerance test identified a large percentage of patients with newly diagnosed diabetes or impaired glucose tolerance after stroke onset. (Stroke. 2012;43:00-00.)

Key Words: abnormal glucose regulation ■ acute stroke ■ diabetes mellitus ■ prevalence

Diabetes is a major public health problem in China, with an age-standardized prevalence of 9.7%.1 Diabetes is an independent risk factor for ischemic stroke, with an increased relative risk in patients with diabetes ranging from 1.8 to nearly 6.0.2 Several studies suggested that diabetes was associated with higher mortality of ischemic stroke,3,4 dependency,5-6 or recurrent stroke.7,8 Data from Asia indicated that diabetes was a predictor of mortality associated with intracerebral hemorrhage.3,9 The previous studies showed that the prevalence of diabetes ranged from 21% to 44.4% among patients with acute ischemic stroke,3,10,11 and ranged from 25% to 37.5% among intracerebral hemorrhage.3,9 In these studies, fasting glucose or random glucose concentration was performed in the diagnosis of diabetes. In Chinese patients with stroke, data for the prevalence of diabetes remain limited, especially in patients with intracerebral hemorrhage and subarachnoid hemorrhage (SAH).

Impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) were regarded as the preliminary stage before the onset of diabetes. Oral glucose tolerance test (OGTT) was frequently used in the diagnosis of IFG and IGT. Matz et al12 reported that the use of OGTT had significantly improved the identification of diabetes and impaired glucose tolerance among patients with stroke, and the prevalence of abnormal glucose regulation reached 60.5%. A study from Japan with a small sample of 113 patients undergoing OGTT indicated that the prevalence of diabetes, only IGT, and only IFG among patients with ischemic stroke were 24.8%, 33.6%, and 3.5%, respectively, with the highest prevalence of IGT in the atherothrombotic infarction group.13 In China, data on the prevalence of IFG or IGT among patients with stroke were scarce.

In this study, the prevalence of diabetes, IFG, and IGT were investigated in the hospitalized patients with ischemic...
stroke, intracerebral hemorrhage, and SAH with the use of OGTT in a large-sample cohort study of abnormal glucose regulation in patients with acute stroke across China (ACROSS-China).

Materials and Methods
The study of abnormal glucose regulation in patients with acute stroke across China (ACROSS-China) was a well-designed, nationwide online-only supplemental data. A prospective cohort study aimed at investigating the prevalence and distribution of abnormal glucose regulation among hospitalized patients with ischemic and hemorrhagic stroke, observing the current condition of treatment on the abnormal glucose regulation among those patients with stroke, and investigating the impact of abnormal glucose regulation on the outcome of those patients.

Patients were recruited consecutively if the following conditions were met: acute occurrence within 14 days of neurological deficit with focal or overall involvement of nervous system, excluding nonvascular causes (primary and metastatic neoplasms, postseizure paralysis, head trauma, and others) that lead to brain function deficit, including ischemic stroke, intracerebral hemorrhage, and SAH, without medical history of stroke. Acute stroke was diagnosed according to World Health Organization criteria14 combined with brain CT or MRRI confirmation. The inclusion criteria were consistent across all participating hospitals.

Patients were classified as having previous diabetes if either of the following was met: self-reported physician diagnosis of diabetes mellitus or hypoglycemic medications (eg, insulin or sulfonylureas) before hospitalization. Diabetes mellitus in this study included type 1 and type 2 diabetes.

A standard OGTT was performed in all the patients without previous diabetes at the day 14±3 after stroke onset or before discharge according to the World Health Organization criteria;15 after overnight fasting, patients drank 250 mL of a solution including 75 g of glucose within 3 minutes. Immediately before administering the drink and after 120 minutes, venous blood samples were taken in sodium fluoride tubes for testing plasma glucose, insulin, and C-peptide concentration. The diagnosis of abnormal glucose regulation was performed according to the World Health Organization criteria and the concept of IFG included in the American Diabetes Association criteria.17

Diabetes mellitus (DM) was defined as having fasting hyperglycemia (IFH) (fasting plasma glucose [FPG] ≥7.0 mmol/L, and 2 h post-challenge glucose [PG] <11.1 mmol/L), or post-challenge hyperglycemia (IPH) (FPG <7.0 mmol/L and 2 h PG ≥11.1 mmol/L), or complex hyperglycemia (CH) (FPG ≥7.0 mmol/L and 2 h PG ≥11.1 mmol/L).

Impaired Glucose Regulation (IGR, pre-diabetes) was defined as having impaired fasting glucose (IFG) (FPG ≥6.1 mmol/L and <7.0 mmol/L, meanwhile, 2 h PG <7.8 mmol/L), or impaired glucose tolerance (IGT) (IFG ≥6.1 mmol/L, meanwhile, 2 h PG ≥7.8 mmol/L and <11.1 mmol/L), or complex impaired glucose tolerance (IGT-IGF) (IFG ≥6.1 mmol/L and <7.0 mmol/L, meanwhile, 2 h PG ≥7.8 mmol/L and <11.1 mmol/L).

Normal glucose tolerance was indicated by fasting glucose (FPG) <6.1 mmol/L and 2-hour PG <7.8 mmol/L. Patient baseline information was recorded within 24 hours after admission, including sex, age, height, weight, waist circumference, hip circumference, blood pressure (mm Hg), fasting glucose concentration (mmol/L), cholesterol (mmol/L), triglyceride concentration (mmol/L), body mass index (calculated as measured weight [kg] divided by the square of measured height [m²]), and others. The assessment of medical history included history of hypertension, dyslipidemia, atrial fibrillation (history of atrial fibrillation confirmed by at least one ECG), coronary heart disease, diabetes, current or previous smoking, alcohol consumption, and family history of stroke.

On day 14 after stroke onset, the fasting and 2-hour postchallenge glucose and insulin concentration according to OGTT, the homeostatic model assessment-insulin resistance (HOMA-IR) an indirect index of insulin resistance calculated as fasting plasma insulin [μU/mL]×FPG [mg/dL]/405, the HOMA2β (an indirect index estimating β-cell function by using C-peptide and insulin concentration), the HOMA2S (an indirect index estimating insulin sensitivity by using fasting glucose, C-peptide, and insulin concentration), the occurrence of pneumonia or urinary system infection complication during hospitalization, and the medicine use during hospitalization were also recorded.

The severity of neurological impairment was evaluated by the National Institutes of Health Stroke Scale and Glasgow Coma Scale within 24 hours after admission and on day 14 after onset, respectively. The etiologic subtypes of ischemic stroke were classified according to the Trial of ORG 10172 in Acute Stroke Treatment (TOAST) as atherothrombotic infarction, cardiogenic embolism, lacunar infarction, undetermined type, and other type.21 The clinical subtypes of ischemic stroke were classified according to the Oxfordshire community stroke project criteria into partial anterior circulation infarct, total anterior circulation infarct, lacunar infarction, and posterior circulation infarct (POCI).22 The Ethics Committees at all participating hospitals approved the procedures and all patients or their designated relatives gave informed consent.

Statistical Analysis
In this article, proportions were used for categorical variables, means with standard deviations were used for continuous variables, and medians together with the interquartile ranges (or 5th–95th percentile) were used for ordinal variables. Percentages were used for the prevalence of abnormal glucose regulation among patients with stroke. Demographic and clinical characteristics of ischemic stroke patients with available OGTT results were compared with all the patients with ischemic stroke using the χ² and t test for categorical and continuous variables, respectively. Data were analyzed with SAS version 9.1.3 statistical software.

Results
This survey consecutively recruited 3450 hospitalized patients with acute stroke within 14 days after onset from 35 participating hospitals across China from 2008 to 2009. Of 3450 patients, 2639 patients had acute ischemic stroke diagnosed, 649 had intracerebral hemorrhage, and 162 had SAH (Figure 1). Of the 3450 stroke patients, 585 had history of diabetes, and OGTT results were available for 2432 patients who had no history of diabetes. The causes of the other 433 patients who had neither previously diagnosed diabetes nor available OGTT results included coma, alimentary tract hemorrhage, and dysphagia.

The baseline characteristics of patients with stroke are shown in Table 1. Comparing all the patients with ischemic stroke, patients with available OGTT results appeared similar regarding sex, age, severity of neurological impairment, blood pressure level, and cholesterol concentrations at admission, as well as regarding history of hypertension, hyperlipidemia, coronary heart disease, and smoking. On day 14 after stroke onset, patients with available OGTT results had similar blood pressure levels, National Institutes of Health Stroke Scale scores, and Glasgow Coma Scale scores as all the ischemic stroke patients. Of all the patients with ischemic stroke, more than one-quarter had used oral hypoglycemic drugs. Less than 50% of patients with previously known diabetes had been administered insulin during hospitalization. Less frequent use of antidiabetic drugs was found in the group undergoing OGTT compared with all the patients with ischemic stroke (P<0.0001). Approximately 45% of patients with available OGTT results had used antihyper-
tensive drugs, whereas the use of diuretics or beta-blockers was not frequent.

Table 2 indicates the clinical characteristics of patients with different ischemic stroke subtypes. Of all the patients with ischemic stroke, the diagnoses of TOAST subtypes were available for 2542 patients. The majority of patients with ischemic stroke were identified as having atherothrombotic infarction (1650 cases), which had higher fasting glucose concentration not only at admission (6.62 mmol/L) but also on day 14 after onset (5.59 mmol/L). In the patients with cardioembolic embolism (161 cases), the majority of patients were females with older average ages and more severe neurological deficit at admission than patients with other subtypes. The history of atrial fibrillation was significantly more frequent in the cardioembolic embolism group. According to Oxfordshire community stroke project subtypes, the majority of ischemic stroke patients were classified having partial anterior circulation infarct (1505 cases). POCI accounted for 22.9% (577 cases) of all the patients with ischemic stroke. Patients with POCI showed higher levels of HbA1C (6.83%) at admission and higher fasting or 2-hour postchallenge glucose concentrations on day 14 after onset.

Overall, the prevalence of abnormal glucose regulation was 68.7% among all the stroke patients in ACROSS-China survey (Figure 2). Diabetes was identified in 42.3% of all the patients, including newly diagnosed DM (22.9%) and previously diagnosed DM (19.4%). Impaired glucose regulation, including IFG and IGT, accounted for 26.4% of all the patients. In the patients with ischemic stroke, the prevalence of DM and impaired glucose regulation were 45.8% and 23.9%, respectively. Patients with newly diagnosed DM (22.8%) accounted for almost half of all the ischemic stroke patients with DM. The prevalence of isolated IGT, isolated IFG, and complex impaired glucose tolerance (IFG+IGT) were 20.5%, 1%, and 2.4%, respectively. In the patients with intracerebral hemorrhage, the prevalence of DM was 31.2%, of which newly diagnosed DM during hospitalization accounted for the majority (24.4%). Of all the patients with SAH, 26.4% had DM diagnosed and another 33.1% were identified as having isolated IGT.

Figure 3 shows the prevalence of abnormal glucose regulation in different TOAST subtypes of patients with ischemic stroke. In the atherothrombotic infarction group, the prevalence of DM and isolated IGT were 43.2% and 25.9%, respectively. In the patients with cardiogenic embolism, the occurrence of DM was more frequent, with the proportion being 47.5%. High prevalence of DM was also presented in the lacunar infarction group (44.3%).

The prevalence of DM and IGT in the ischemic stroke patients with different Oxfordshire community stroke project subtypes are shown in Figure 4. The prevalence of isolated IGT in the partial anterior circulation infarct, total anterior circulation infarct, lacunar infarction, and POCI groups were 21.6%, 16.7%, 21.8%, and 19.1%, respectively. The highest frequency of DM appeared in the patients with POCI, with a prevalence of 51.8%, including newly diagnosed DM (23.6%) and previously diagnosed DM (28.2%).

Discussion

To our knowledge, the present study enrolled the largest number of samples of Chinese stroke patients who had OGTT performed to identify abnormal glucose regulation. Compared with the recent survey, the China National Stroke Registry,23 the average age of patients, sex, proportion of stroke subtypes, and severity of neurological deficit (evaluated by National Institutes of Health Stroke Scale) at admission in this study were almost comparable, which suggests that the baseline characteristics of patients in the present study were similar to those of the Chinese stroke patients as a whole.

We analyzed the baseline and day 14 characteristics of the group who underwent OGTT and found that the majority of variables, including gender, age, severity of neurological impairment at admission, history of vascular risk factors,
Table 1. Clinical Characteristics of Patients With Stroke at Admission and on Day 14 After Onset

<table>
<thead>
<tr>
<th></th>
<th>All Patients</th>
<th>IS</th>
<th>IS Patients With Previously Known Diabetes</th>
<th>IS Patients Without Known Diabetes</th>
<th>IS Patients With OGGT</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers</td>
<td>3450</td>
<td>2639</td>
<td>534</td>
<td>2105</td>
<td>1793</td>
<td></td>
</tr>
<tr>
<td>Gender (male, %)</td>
<td>63.13</td>
<td>64</td>
<td>60.86</td>
<td>64.8</td>
<td>64.27</td>
<td>0.8541</td>
</tr>
<tr>
<td>Age, y (mean±SD)</td>
<td>61.54±12.78</td>
<td>62.71±12.53</td>
<td>64.17±11.07</td>
<td>62.35±12.85</td>
<td>62.3±12.82</td>
<td>0.28</td>
</tr>
<tr>
<td>NIHSS at admission</td>
<td>4 (2, 9)</td>
<td>4 (2, 8)</td>
<td>4 (2, 8)</td>
<td>4 (2, 8)</td>
<td>4 (2, 8)</td>
<td>0.7889</td>
</tr>
<tr>
<td>GCS at admission</td>
<td>14.08±2.01</td>
<td>14.28±1.71</td>
<td>14.4±1.63</td>
<td>14.25±1.73</td>
<td>14.25±1.7</td>
<td>0.5086</td>
</tr>
<tr>
<td>Fasting glucose at admission (mmol/L)</td>
<td>6.47±2.65</td>
<td>6.55±2.76</td>
<td>9.29±3.61</td>
<td>5.86±1.98</td>
<td>5.85±1.96</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>HbA1C (%)</td>
<td>6.41±1.76</td>
<td>6.59±1.84</td>
<td>8.37±2.06</td>
<td>6.14±1.48</td>
<td>6.13±1.45</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>SBP at admission (mm Hg)</td>
<td>147.77±21.78</td>
<td>146.45±20.86</td>
<td>148.25±19.37</td>
<td>146.0±21.2</td>
<td>146.35±21.24</td>
<td>0.8799</td>
</tr>
<tr>
<td>DBP at admission (mm Hg)</td>
<td>86.65±12.56</td>
<td>85.79±11.91</td>
<td>85.36±10.62</td>
<td>85.89±12.22</td>
<td>86.01±12.3</td>
<td>0.5601</td>
</tr>
<tr>
<td>Triglyceride at admission (mmol/L)</td>
<td>1.77±1.22</td>
<td>1.78±1.19</td>
<td>2.07±1.48</td>
<td>1.7±1.09</td>
<td>1.72±1.1</td>
<td>0.0925</td>
</tr>
<tr>
<td>HDL at admission (mmol/L)</td>
<td>2.99±1.17</td>
<td>3.01±1.23</td>
<td>3.07±1.05</td>
<td>3.0±1.27</td>
<td>3.02±1.32</td>
<td>0.9057</td>
</tr>
<tr>
<td>LDL at admission (mmol/L)</td>
<td>1.22±0.42</td>
<td>1.18±0.36</td>
<td>1.14±0.3</td>
<td>1.19±0.37</td>
<td>1.2±0.34</td>
<td>0.205</td>
</tr>
<tr>
<td>sCRP (mg/L)</td>
<td>2.53 (1.71)</td>
<td>2.22 (1.59)</td>
<td>2.8 (1.62)</td>
<td>2.14 (1.58)</td>
<td>2.14 (1.57)</td>
<td>0.4662</td>
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<tr>
<td>BMI at admission</td>
<td>24.77±3.78</td>
<td>24.80±3.71</td>
<td>25.27±3.74</td>
<td>24.68±3.69</td>
<td>24.74±3.76</td>
<td>0.6458</td>
</tr>
<tr>
<td>Waist circumference at admission</td>
<td>86.11±10.13</td>
<td>86.49±10.14</td>
<td>89.24±10.34</td>
<td>85.8±9.97</td>
<td>85.87±9.84</td>
<td>0.0467</td>
</tr>
<tr>
<td>HOMA-IR at admission</td>
<td>1.46</td>
<td>1.48</td>
<td>1.98</td>
<td>1.46</td>
<td>1.84</td>
<td>0.0001</td>
</tr>
<tr>
<td>HOMA-β at admission</td>
<td>1.84</td>
<td>1.84</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
<tr>
<td>HOMA-S at admission</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

(Continued)
Table 1. Continued

<table>
<thead>
<tr>
<th>Medicine use during hospitalization</th>
<th>All Patients</th>
<th>IS</th>
<th>IS Patients With Previously Known Diabetes</th>
<th>IS Patients Without Known Diabetes</th>
<th>IS Patients With OGGT</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary infection</td>
<td>9.8</td>
<td>7.94</td>
<td>8.45</td>
<td>7.81</td>
<td>7.56</td>
<td>0.6474</td>
</tr>
<tr>
<td>Urinary infection</td>
<td>4.34</td>
<td>3.37</td>
<td>4.23</td>
<td>3.6</td>
<td>3.88</td>
<td>0.8052</td>
</tr>
<tr>
<td>Oral hypoglycemic drugs (%)</td>
<td>21.82</td>
<td>25.96</td>
<td>64.57</td>
<td>15.3</td>
<td>14.84</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Insulin (%)</td>
<td>13.63</td>
<td>15.41</td>
<td>49.04</td>
<td>6.15</td>
<td>5.7</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Antihypertensive drugs (%)</td>
<td>50.39</td>
<td>45.13</td>
<td>50.87</td>
<td>43.69</td>
<td>45.19</td>
<td>0.9666</td>
</tr>
<tr>
<td>Diuretics (%)</td>
<td>3.36</td>
<td>1.91</td>
<td>3.37</td>
<td>2.28</td>
<td>2.4</td>
<td>0.8284</td>
</tr>
<tr>
<td>β-blockers (%)</td>
<td>4.49</td>
<td>4.28</td>
<td>5.99</td>
<td>3.85</td>
<td>4.18</td>
<td>0.8725</td>
</tr>
<tr>
<td>Lipid-lowering drugs (%)</td>
<td>57.65</td>
<td>72.34</td>
<td>71.59</td>
<td>72.53</td>
<td>72.4</td>
<td>0.9637</td>
</tr>
</tbody>
</table>

BMI indicates body mass index; DBP, diastolic blood pressure; GCS, Glasgow Coma Scale; HDL, high-density lipoprotein; IS, ischemic stroke; HOMA-IR, homeostatic model assessment-insulin resistance; LDL, low-density lipoprotein; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; OGGT, oral glucose tolerance test; SBP, systolic blood pressure; sCRP, soluble C-reactive protein; SD, standard deviation.

*P indicates IS patients with OGGT results compared with all the patients with IS.

The presence of complications, use of antihypertensive drugs, and lipid-lowering drugs during hospitalization, were comparable to that of total cohort of ischemic stroke patients, which suggested that the patients who underwent OGGT could represent well all the enrolled patients with ischemic stroke.

We noticed that the use of antidiabetic drugs during hospitalization could influence the data of OGGT. In this study, however, OGGT was performed in the patients without previously diagnosed DM; accordingly, the use of antidiabetic drugs in these patients was less frequent (14.84% for

Table 2. Clinical Characteristics of Different Subtypes in Patients With Ischemic Stroke

<table>
<thead>
<tr>
<th>TOAST Subtypes</th>
<th>IS Patients</th>
<th>IS Patients With OGGT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atherothrombotic Infarction</td>
<td>57.65</td>
<td>72.34</td>
</tr>
<tr>
<td>Cardiogenic Embolism</td>
<td>4.49</td>
<td>4.28</td>
</tr>
<tr>
<td>Lacunar Infarction</td>
<td>50.39</td>
<td>45.13</td>
</tr>
<tr>
<td>Other</td>
<td>3.36</td>
<td>1.91</td>
</tr>
<tr>
<td>Undetermined</td>
<td>4.49</td>
<td>4.28</td>
</tr>
<tr>
<td>Partial Anterior Circulation Infarct</td>
<td>15.3</td>
<td>14.84</td>
</tr>
<tr>
<td>Total Anterior Circulation Infarct</td>
<td>14.84</td>
<td>13.12</td>
</tr>
<tr>
<td>Lacunar Circulation Infarct</td>
<td>0.88</td>
<td>0.87</td>
</tr>
<tr>
<td>Posterior Circulation Infarct</td>
<td>12.45</td>
<td>12.82</td>
</tr>
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</table>

BMI indicates body mass index; GCS, Glasgow Coma Scale; HOMA-IR, homeostatic model assessment-insulin resistance; LDL, low-density lipoprotein; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; SD, standard deviation; TOAST, Trial of ORG 10172 in Acute Stroke Treatment.
oral hypoglycemic drugs and 5.7% for insulin), which lessened the effect of postadmission use of antidiabetic drugs on OGTT. Some factors such as the use of diuretics or β-blockers, which could have influenced blood glucose concentration in OGTT, were also considered. Our results indicated that the use of diuretics or β-blockers was not frequent in the patients who underwent OGTT; accordingly, the effect of these factors on the results of OGTT might be neglected.

We noticed that patients with cardioembolic embolism had older average ages and more severe neurological deficit at admission; moreover, history of atrial fibrillation was significantly more frequent in this group, which coincided with the clinical and etiopathogenic characteristics of the cardioembolic embolism group. According to our data, patients with POCI showed higher levels of HbA1C and higher fasting or 2-hour postchallenge glucose concentration on day 14. More frequent occurrences of neuroendocrine disorders in patients with POCI might be the possible reason for higher glucose concentrations in these patients.

In this study, the prevalence of abnormal glucose regulation was 68.7% among all the stroke patients, which was significantly higher than the prevalence of 21% to 37.4% reported before. It was known that the majority of previous

![Figure 2](image-url) Prevalence (95% confidence interval [CI]) of abnormal glucose regulation in hospitalized patients with stroke.

![Figure 3](image-url) Prevalence (95% confidence interval [CI]) of abnormal glucose regulation in TOAST subtypes in patients with ischemic stroke.
studies used fasting or random glucose instead of OGTT in the diagnosis of abnormal glucose regulation. We performed OGTT in this study and significantly improved the identification of abnormal glucose regulation among the stroke patients, especially those with newly diagnosed DM and impaired glucose tolerance. OGTT was performed in this study on day 14±3 after stroke onset or before discharge, and those with acute stage of stroke had passed the test; therefore, the diagnosis of abnormal glucose regulation did not include stress hyperglycemia. In the patients with ischemic stroke, the prevalence of DM and impaired glucose regulation were 45.8% and 23.9%, respectively. The prevalence of isolated IGT, isolated IFG, and complex impaired glucose tolerance (IFG+IGT) were 20.5%, 1.0%, and 2.4%, respectively. Several studies from Europe and Japan in which OGTT was performed supplied either no diagnosis of IFG or small sample sizes.13,24 Data on the prevalence of IFG and IGT among patients with intracerebral hemorrhage or SAH remained scarce. Our results indicate high prevalence of IGT and newly diagnosed DM in patients with intracerebral hemorrhage and SAH, which suggested that the identification of abnormal glucose regulation should be emphasized in the patients not only with ischemic stroke but also with intracerebral hemorrhage and SAH, and OGTT should be performed in all the stroke patients without history of diabetes after acute stage of stroke.

According to TOAST subtypes, the atherothrombotic infarction group showed higher prevalence of abnormal glucose regulation, including DM (43.2%), isolated IGT (25.9%), isolated IFG (0.7%), and IFG with IGT (3.6%). In the Japanese study,13 atherothrombotic infarction with previous diabetes accounted for 60.9% of patients, newly diagnosed DM accounted for 11.2% of patients, IGT accounted for 14.4% of patients, and IFG accounted for 1.2% of patients. The prevalence of DM was also frequent in the patients with cardiogenic embolism and lacunar infarction (48.75% and 45.61%, respectively). Our results supply an overview of the distribution of abnormal glucose regulation in the ischemic stroke patients with different etiopathogenesis. According to Oxfordshire community stroke project subtypes, the highest frequency of DM appeared in the patients with POCI (51.8%). More frequent occurrences of neuroendocrine disorders in patients with POCI might be the possible reason.

Our study had several limitations. The selection of participating hospitals was by convenience. All the hospitals participating in the survey were from urban regions of China. These study sites may represent the institutes with more resources and expertise than county-level hospitals. OGTT results were not available for 433 of our enrolled patients because of severe neurological deficits or complications such as necoma, dysphagia, and alimentary tract hemorrhage, which might influence the evaluation of prevalence of abnormal glucose regulation among the stroke patients.

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Disclosures
None.

References


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On Behalf of the Investigators for the Survey on Abnormal Glucose Regulation in Patients With Acute Stroke Across China (ACROSS-China)

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