Validation Study of the Siriraj Stroke Score in African Nigerians and Evaluation of the Discriminant Values of Its Parameters

A Preliminary Prospective CT Scan Study

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Background and Purpose—CT scanning is important to identify stroke pathology and exclude mimics. Its poor availability in our environment makes the search for simple, reliable clinical-score imperative. This study aims to validate the Siriraj Stroke score (SSS) and determine the discriminant values of its parameters in the black population of African-Nigerians.

Methods—A prospective multicenter study was carried out on patients that presented with stroke and had brain CT scan done within 14 days of onset. An interviewer structured questionnaire was administered and SSS computed. The stroke-type was classified and compared with CT diagnosis. Data were analyzed using Epi-info-2002.

Results—1122 patients presented with clinical features of stroke, of which only 101 (9%) could afford the cost of CT scan. Of these, 90 had CT-scan features consistent with acute stroke, 5 had cortical atrophy and 1 was normal. Thus, 96 patients were analyzed, of which 68 (71%) had cerebral ischemia and 28 (29%) had intracerebral hemorrhage. The 6 patients with no visible infarct on CT were regarded as cerebral infarction. The correlation between SSS, headache, vomiting, loss-of-consciousness and CT diagnosis achieved statistical significance, whereas atheroma markers and diastolic blood pressure did not. The SSS has an overall predictive accuracy of 80%.

Conclusions—This preliminary study has shown that only 9% of our hospital stroke population had benefit of CT scan. The limited number of patients studied and their potential lack of representativeness, represent a funding issue to properly establish the performance of clinical scoring systems and assist in descriptive epidemiology of hospital and community-based stroke studies in resource-poor settings. However, in this study, the SSS diagnosis correlates significantly with CT diagnosis. (Stroke. 2006;37:1997-2000.)

Key Words: clinical studies ■ CT ■ stroke

Therapeutic decisions regarding management of stroke require accurate diagnosis of stroke types and exclusion of mimics. Distinction between intracerebral hemorrhage (ICH) and cerebral infarction on the basis of clinical features alone has been shown to be unreliable. Appropriately timed CT is a safe, noninvasive gold standard, and most accurate in distinguishing ICH from cerebral infarction.

In the absence of CT scan, as is prevalent in this part of the world, weighted clinical scoring systems such as the Allen Stroke score (Guy Hospital score), Siriraj Stroke score (SSS) and the Besson score, may be used for improved diagnostic gain. The SSS has similar accuracy to the Allen score, but it is easier to use at the bedside with fewer variables. The scores were each developed on 1 group of patients in a single location and therefore need to be validated in as many other patients groups as possible. The Guy Hospital score has been validated with data from the Oxfordshire Community Stroke project (OCSP) and at the National Hospital for Nervous Disease, London, whereas the clinical score by Besson was validated in the University Hospital Grenoble, France. The SSS has been evaluated in Siriraj hospital Bangkok, Thailand, Western infirmary, Glasgow and recently, in a retrospective study in Nigeria that reported a predictive accuracy of 54% with a conclusion that the SSS was not sufficiently sensitive to distinguish cerebral infarction from ICH. However, a prospective study with a view to modifying its parameters and plausibly developing a more accurate scoring system for our environment was suggested.

It is with this background that we aimed at evaluating the diagnostic accuracy of the SSS prospectively and determining...
the discriminant values of its parameters with a view to modifying them for a simpler, more accurate and reliable scoring system for use in Nigeria.

Materials and Methods

This was a multicenter prospective study.

Selection of Patients

Patients that presented at the study centers from January 2002 to December 2004 with clinical diagnosis of stroke, and had brain CT scan done within 14 days of onset were included in the study. An interviewer structured questionnaires were administered by K.O. and recorded the patients’ age, dates of admission and discharge, presence of headache and vomiting. Other parameters recorded include: level of consciousness, blood pressure, history of hypertension, transient ischemic attack, diabetes mellitus, obesity, presence of or history suggestive of angina pectoris, intermittent claudication, hemoglobinopathy, electrocardiographic findings and serum cholesterol.

The SSS was calculated as \((2.5 \times \text{level of consciousness}) + (2 \times \text{vomiting}) + (2 \times \text{headache}) + (0.1 \times \text{diastolic blood pressure}) - (3 \times \text{atheroma markers}) - 12\). This was computed for each patient and based on the individual score, the patient was classified as ICH or cerebral infarction using the criteria \(> +1\) for ICH and \(< -1\) for cerebral infarction. Values between \(-1\) and \(+1\) were regarded as ill-defined or indeterminate stroke.

The exclusion criteria were: (1) patients below the age of 16 years; (2) patients with stroke duration of >14 days because of the possibility of missing an ICH; (3) causes of focal neurological deficit other than stroke or stroke-like syndromes; (4) repeat or recurrent stroke.

Study Setting

Four centers were involved in the study: The Olabisi Onabanjo University Teaching Hospital (OOUTH), Lagos University Teaching Hospital (LUTH), Eko Hospital (EH), and Radmed Diagnostic Center (RDC). These facilities serve an estimated urban population of about 7 million in 2 states in southwest Nigeria. The patients were sourced consecutively, all variables entered simultaneously and, if affordable, CT scan (plain and contrast-enhanced) were done between 12 hours and 14 days of ictus using the same criteria for diagnosis in all the centers; viz, cerebral infarction: hypodense area in the brain with no mass effect on cerebral tissue or a normal CT scan in the face of a clinical picture of acute stroke. The shape and distribution of the lesion usually should be within the territory of a particular arterial blood vessel, and there should be no change after contrast enhancement except in cases with “luxury perfusion”. Cerebral hemorrhage: hypodense area in the brain and CT values between 50 to 80 Hounsfield (HU). The radiologists were blinded to the SSS classification.

Statistics

Epi-info 2002 was used to analyze parametric variables with \(t\) test, whereas \(\chi^2\) analysis with 95% CI was used for the nonparametric variables. Correlation and logistic regression analysis as well as odds ratio with 95% CI were done to determine significant parameters for the stroke types. \(P<0.05\) was accepted as statistically significant. The presence or absence of clinical variables in the SSS was matched against the stroke types as confirmed by CT scan. Sensitivity, specificity, and positive predictive values were calculated using standard methods. The ethical committee of OOUTH granted approval for the study.

Results

A total of 1122 patients with clinical features of stroke were seen at the 4 centers, of which 499 were seen at LUTH, 340 at OOUTH, 180 at EH and 103 at RDC. CT scan was requested for all the patients, but only 101 (9%) could afford the cost of CT. Of these, 90 had CT-scan features consistent with acute stroke, 5 had cortical atrophy, 3 had subdural hematoma, 2 had brain tumor and 1 was normal. Thus, 96 patients formed the basis of this study, of which 68 (71%) had cerebral ischemia (CT cerebral infarction) and 28 (29%) had intracerebral hemorrhage (CT ICH). The 6 patients with no visible infarct (5 with cortical atrophy and 1 with normal CT) were regarded as cerebral infarction.

There were 64 males and 32 females giving a male:female ratio of 2:1, and the age range was between 19 to 84 years with a mean age of 54±9 years.

Analysis of the clinical variables using \(\chi^2\) and logistic regression revealed that headache, vomiting, loss-of-consciousness as well as their relationship to brain CT scan achieved statistical significance, whereas diabetes mellitus and diastolic blood pressure did not (Table 1). The \(t\) test and linear regression analysis of the correlation between diastolic blood pressure and stroke type by CT also did not achieve statistical significance (Table 1).

The SSS has a positive predictive accuracy of 91% for cerebral infarction, and 63% for hemorrhagic stroke with an overall predictive accuracy of 80% and the relationship between SSS diagnosis and brain CT diagnosis achieved statistical significance (Table 2).

Discussion

This preliminary study has shown that over a 3-year period, only 9% of our hospital stroke population from 4 specialist centers had benefit of CT scan. This was a reflection of the poor availability and high cost of CT scan in resource-poor settings, such as Nigeria. CT-scan costs about $400 to $500, and the minimum wage in employed individuals is about $1200 per annum, while many more remain unemployed. Therefore, in our environment, request for CT scan depends partly on cost, affordability and availability. The limited number of patients studied and their potential lack of representativeness, represent a funding issue and underscore the need for research funders to justify the funding of brain CT scan to properly establish the performance of clinical scoring systems in resource poor settings.

In this study, headache, vomiting and loss of consciousness directly correlated with brain CT diagnosis and have high discriminant values, whereas atheroma markers and diastolic blood pressure have poor discriminant values. Intermittent claudication and angina pectoris were uncommon findings in the study subjects. There is need to assess the discriminant values of other atheroma markers such as hyperlipidemia, arcus presenilis/senilis, thickened arterial wall, locomotor brachialis and transient ischemic attack in our environment.

The overall predictive accuracy of 80% in this study is comparable to the study of Glenc et al.,20 lower than the accuracy of 90% in Bangkok,13 and higher than the 54% reported in an earlier retrospective study in our environment.17 Moreover, it is substantially superior to that obtained if one assumes that all strokes are attributable to infarction (69%). It is therefore possible that the SSS could be sufficiently sensitive to distinguish cerebral infarction from ICH in the black population of African-Nigerians. Although we contend that CT scan remains the gold standard and cornerstone in the diagnosis of stroke types, the use of SSS in our environment could be encouraged in rural settings without benefit of CT scan.
About 71% of the subjects studied had cerebral infarction as confirmed by brain CT, whereas 29% had hemorrhagic stroke. Although this study was hospital-based and in a highly selected stroke population with a small sample size, it supports the suspicion that the proportion of hemorrhagic stroke may be on the increase in our environment when compared with earlier reports. However, the suspected increase in ICH may well be on account of introduction and increasing use of neuroimaging facilities in our environment as well as hospital-based bias, as more severe cases of stroke which are largely ICH presented, or are referred to the tertiary institutions. The confounding effects of age, gender, misclassification and possible lack of generalization to rural populations should also be considered. A larger sample size and population-based study in a CT-funded project

### TABLE 1. Discriminant Values of SSS Classification and Variables in the CT Scan Confirmed Cerebral Infarction/ICH: Brain CT Scan

<table>
<thead>
<tr>
<th>SSS classification/Variable</th>
<th>CT Cerebral Infarction (n=68)</th>
<th>CT ICH (n=28)</th>
<th>Total (n=96)</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache present SSS cerebral infarction</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS ICH</td>
<td>4</td>
<td>13</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>5</td>
<td>13</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headache absent</td>
<td>63</td>
<td>15</td>
<td>78</td>
<td>0.09 (0.02–0.33)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Vomiting present SSS cerebral infarction</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS ICH</td>
<td>1</td>
<td>8</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>2</td>
<td>8</td>
<td>10</td>
<td>0.08 (0.05–1.74)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Vomiting absent</td>
<td>66</td>
<td>20</td>
<td>86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOC present SSS cerebral infarction</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS ICH</td>
<td>5</td>
<td>21</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS indeterminate</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>9</td>
<td>22</td>
<td>31</td>
<td>0.04 (0.01–0.15)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>LOC absent</td>
<td>59</td>
<td>6</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM present SSS cerebral infarction</td>
<td>18</td>
<td>2</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS ICH</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS indeterminate</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>21</td>
<td>4</td>
<td>25</td>
<td>2.68 (0.75–10.4)</td>
<td>0.09</td>
</tr>
<tr>
<td>DM absent</td>
<td>47</td>
<td>24</td>
<td>71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DBP &lt;100 mm Hg SSS cerebral infarction</td>
<td>12</td>
<td>0</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS ICH</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS indeterminate</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>9</td>
<td>22</td>
<td>31</td>
<td>0.04 (0.01–0.15)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>DBP &gt;100 mm Hg</td>
<td>36</td>
<td>4</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS cerebral infarction</td>
<td>12</td>
<td>20</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS ICH</td>
<td>7</td>
<td>1</td>
<td>8</td>
<td>1.97 (0.46–9.61)</td>
<td>0.31</td>
</tr>
</tbody>
</table>

LOC indicates loss-of-consciousness; DBP, diastolic blood pressure; DM, diabetes mellitus; SSS cerebral infarction, cerebral infarction based on SSS; SSS ICH, ICH based on SSS; CT cerebral infarction, cerebral infarction based on CT scan; CT ICH, ICH based on CT scan.

### TABLE 2. SSS Classification Into Stroke Types in Patients With CT Confirmed Diagnosis of Stroke: CT Scan Diagnosis

<table>
<thead>
<tr>
<th>SSS Diagnosis</th>
<th>CT Cerebral Infarction (%)</th>
<th>CT ICH (%)</th>
<th>Total (%)</th>
<th>( \chi^2 )</th>
<th>Sensitivity %</th>
<th>Specificity %</th>
<th>Positive Predictive Accuracy, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSS cerebral infarction</td>
<td>48</td>
<td>5</td>
<td>53 (55.2)</td>
<td>28.3 &lt;0.01</td>
<td>(48/68) 71</td>
<td>(22/35) 63</td>
<td>(48/53) 91</td>
</tr>
<tr>
<td>SSS ICH</td>
<td>13</td>
<td>22</td>
<td>35 (36.5)</td>
<td></td>
<td>(22/28) 79</td>
<td>(48/53) 91</td>
<td>(22/35) 63</td>
</tr>
<tr>
<td>SSS indeterminate</td>
<td>7</td>
<td>1</td>
<td>8 (8.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>68 (71)</td>
<td>28 (29)</td>
<td>96 (100)</td>
<td></td>
<td></td>
<td></td>
<td>80</td>
</tr>
</tbody>
</table>

See Table 1 for abbreviations.
would be needed to assist in descriptive epidemiology of stroke in our environment.

In conclusion, this preliminary study has demonstrated the need for funded CT-scan studies to establish the performance of clinical scoring system in our environment as well as assist in descriptive epidemiology of stroke in hospital- and community-based studies. The SSS is sufficiently sensitive to distinguish cerebral infarction from ICH in the black African population when CT scan facilities are lacking or unaffordable. Addition of other atheroma markers to improve the predictive accuracy of the score is suggested.

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Disclosures
None.

References
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