e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(6); 77-86

Original Research Article

Comparative Evaluation of Greek Stroke Score, Siriraj Stroke Score, and Allen Stroke Score for Differential Diagnosis of Intracerebral Hemorrhage and Infarct: Correlation with CT Scan Findings

Bajrang Kumawat[1], Bhavsinh Parmar[2], Aakash Sureshchandra Rajpal[3]

[1]DNB Medicine Residents, GMERS Medical College, Gandhinagar, Gujarat

[2]Assistant professor, Department of Medicine, GMERS Medical College, Gandhinagar, Gujarat

[3] Resident Doctor, Department of General Medicine, GMERS Medical College, Gandhinagar, Gujarat

Received: 25-03-2023 / Revised: 27-04-2023 / Accepted: 30-05-2023

Corresponding author: Dr. Bhavsinh Parmar

Conflict of interest: Nil

Abstract

Introduction: The introduction highlights the global burden of stroke and the challenges in stroke management, particularly in resource-constrained settings. It introduces three stroke scoring systems - the Siriraj stroke score, Allen stroke score, and Greek stroke score - and acknowledges the limited evidence regarding their comparison. The objective of the study is to validate and compare these scoring systems against CT scan findings to improve early and accurate diagnosis for optimal treatment and patient outcomes.

Material and methods: This section outlines the study design, which is a cross-sectional observational study conducted at GMERS Medical College, Gandhinagar in India. The study population consists of patients with acute stroke admitted to the emergency department. The sample size calculation is described, along with the inclusion and exclusion criteria. Data collection involves the use of a pre-validated questionnaire, encompassing various patient details and stroke scoring systems. Ethical approval and informed consent are obtained prior to the study.

Results: The comparison of three stroke scoring systems, namely the Allen score, Siriraj score, and Greek score, with CT scan results revealed their diagnostic performance in differentiating between cerebral hemorrhage and cerebral infarct. The sensitivity for identifying hemorrhage was 90.0% for the Allen score, 86.6% for the Siriraj score, and 90.0% for the Greek score. In terms of infarct diagnosis, the sensitivity was 83.3% for the Allen score, 90.0% for the Siriraj score, and 86.6% for the Greek score. All three scoring systems showed similar values for specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy.

Conclusion: In conclusion, the Allen score, Siriraj score, and Greek score showed high diagnostic accuracy in differentiating between cerebral hemorrhage and cerebral infarct. These scoring systems can be valuable tools for guiding treatment decisions in stroke patients.

Keywords: Greek Stroke Score, Siriraj Stroke Score, Allen Stroke Score, Intracerebral Hemorrhage and Infarct.

Introduction

Stroke is a major global health challenge, contributing significantly to disability and mortality rates on a worldwide scale.[1] The Global Burden of Disease (GBD) study reports that stroke-related mortality rates are as high as 142 per 100,000 person-years, resulting in 6.5 million stroke-related deaths annually. Moreover, stroke accounts for approximately 113 million disability-adjusted life years (DALYs) each year.[2] In nations like India, stroke represents a considerable burden, with prevalence rates ranging from 84 to 424 per 100,000 individuals in rural and urban areas.[3] The estimated incidence of stroke in India varies from 119 to 145 per 100,000 person-years, underscoring the urgent requirement for effective diagnostic tools and management strategies.[3]

Prompt diagnosis and expeditious treatment play a pivotal role in stroke cases due to the brain's limited tolerance to ischemia compared to other organs. Studies have consistently demonstrated a correlation between delayed diagnosis and treatment and heightened mortality and disability rates among stroke patients. In resource-constrained settings, the challenges in stroke management are compounded by limited resources and delayed access to diagnostic imaging modalities like computed tomography (CT) scans.[4] As ischemic and hemorrhagic strokes necessitate different treatment approaches, the development of dependable clinical evaluation criteria assumes critical importance. Such criteria can assist physicians in making preliminary diagnoses and initiating appropriate treatment promptly, thereby optimizing patient outcomes.[5,6]

In response to this requirement, several stroke scoring systems have been developed, including the Siriraj stroke score, Allen stroke score (also known as Guy's score), and Greek stroke score. These scoring systems employ clinical findings and limited laboratory investigations to provide preliminary diagnoses until CT scans can be conducted. While some studies have compared the Siriraj and Allen stroke scores with CT scans, indicating the superiority of the Siriraj score over the Allen score[7,8], concerns regarding the accuracy and validity of these scoring systems persist. Moreover, there is limited evidence available regarding the comparison of the Greek stroke score with the Allen and Siriraj scores.[9]

Considering the existing controversies and gaps in knowledge, the objective of this study is to validate and compare the Allen stroke score, Siriraj stroke score, and Greek stroke score against the gold standard diagnosis derived from CT scans. Through this comparative analysis, we aim to enhance our understanding of the usefulness and effectiveness of these stroke scoring systems in differentiating between intracerebral hemorrhage and infarction. The ultimate goal is to facilitate early and precise diagnosis, thereby optimizing the initiation of appropriate treatment and ultimately improving patient outcomes.

Material And Method

This study was a cross-sectional hospital-based observational study conducted at GMERS Medical College in Gandhinagar, Gujarat, India. The study population consisted of patients who were hospitalized in the emergency department of GMERS Medical College with the etiology of acute stroke. The study duration spanned from November 2020 to March 2022.

The sample size calculation was performed to determine the number of subjects required for the study. For each category, 30 subjects with cerebral hemorrhage and 30 subjects with cerebral infarction were included. The calculation considered a prevalence of stroke in India of 0.15%, an allowable error of 1.5%, and a confidence interval of 95%. A design effect of 1 (one) was assumed, and a 10% non-response rate was added. Therefore, the minimum sample size for each category of cases was determined to be 30 subjects. Efforts were made to include almost all consented subjects who met the enrollment criteria and were admitted during the study period to maximize the power of the study.

Inclusion criteria for the study were as follows: patients who fit the definition of stroke as mentioned by the World Health Organization (WHO), patients presenting within 48 hours of the onset of illness, and age group above 20 years. On the other hand, exclusion criteria included patients with subarachnoid hemorrhage, neurological deficits associated with space-occupying lesions in the brain, head injury, infra-tentorial hemorrhage, and those who had not given consent for the study.

Stroke diagnosis was based on specific criteria. Patients were registered as stroke cases if they fulfilled the modified WHO criteria, which included a focal or global disturbance of cerebral functions persisting for more than 24 hours with no apparent cause other than vascular. Additionally, evidence of stroke on a CT scan of the head was required for diagnosis. Cerebral infarction was determined by the presence of an area of decreased attenuation within the cerebral substance in a plain CT scan. In contrast, cerebral hemorrhage was identified by an area of increased attenuation within the cerebral substance in the CT scan.

Data collection was done using a semi-closed, pre-validated questionnaire. The questionnaire gathered information such as basic sociodemographic details, medical history, clinical examination findings, laboratory investigation reports, CT scan findings, and more. It also incorporated details and tables of the Siriraj score, Greek score, and Allen score based on standard guidelines and protocols.

Before commencing the study, ethical approval was obtained from the Institutional Ethical Committee (IEC) to ensure adherence to ethical guidelines. Informed written consent was obtained from all study participants prior to their enrollment, indicating their voluntary participation and understanding of the study's objectives, procedures, potential risks, and benefits.

The Siriraj stroke score, following the original method by Poungvarin et al.[10], was calculated immediately upon patient admission. Interpretation of the score was as follows: scores greater than 1 indicated intracerebral hemorrhage, scores less than -1 indicated infarction, and scores between -1 and +1 were considered equivocal. The Guy's hospital score, as described by Allen[11], was calculated 24 hours after symptom onset. Scores below +4 were classified as infarction, scores above +24 were classified as hemorrhage, and scores between +4 and +24 were considered equivocal. Similarly Greek stroke score was calculated based upon classification system given by Efstathiou et al.[12]

Overall, this methodology allowed for the collection and analysis of data from stroke patients to validate and compare the Siriraj stroke score, Allen stroke score, and Greek stroke score against the gold standard diagnosis obtained from CT scans. The aim was to enhance the understanding of these stroke scoring systems in differentiating between intracerebral hemorrhage and infarction, enabling early and accurate diagnosis for improved treatment and patient outcomes.

Statistical Analysis

The collected data from study participants was entered into MS Excel software after undergoing a data cleaning procedure. Statistical analyses were performed using Epi Info 7.0 software to interpret the findings. Descriptive tests, such as frequency and averages, were used to summarize the data. Analytical tests, including significance tests and paired t-tests, were conducted to assess associations and differences in the data. The p value of

<0.05 was considered significant and p value <0.001 was considered highly significant. Sensitivity, specificity, positive predictive value, negative predictive value and measures of central tendency were applied to the data collected.

Results

The analysis of age and gender distributions revealed no significant differences between the groups with cerebral hemorrhage and cerebral infarct. In terms of age distribution, the majority of participants in both groups fell within the age range of 31-60 years, with 60.0% in the cerebral hemorrhage group and 53.3% in the cerebral infarct group. The gender distribution showed that 60.0% of participants with cerebral hemorrhage were male, while 40.0% were female. In the cerebral infarct group, 63.3% were male and 36.7% were female. Statistical analysis yielded p-values of 0.66 for age and 0.47 for gender, indicating no significant differences between the two groups based on age or gender.

The most common presenting complaint among the study participants was weakness, reported by 90% of patients. Headache was reported by 26% of patients, followed by nausea/vomiting in 18% of cases, and altered consciousness in 34% of cases. In our study, past medical history analysis of the total study participants (n=60) showed that 56% had hypertension, 38% had diabetes mellitus (DM), 16% had previous myocardial infarction (MI), and 26% had rheumatic heart disease (RHD).

The findings from the comparison of the three scoring systems (Allen score, Siriraj score, and Greek score) with CT scan results provide valuable insights into their diagnostic performance. (Table 1)

For the Allen score, among the total of 29 cases classified as hemorrhage, 90.0% were confirmed as cerebral hemorrhage by CT scan, while only 6.7% were identified as cerebral infarct. In the equivocal category, 3.3% were determined as hemorrhage and 10.0% as infarct. Among the 27 cases classified as infarct by the Allen score, an impressive 83.3% were confirmed as cerebral infarct by CT scan. Regarding the Siriraj score, out of the total 28 cases classified as hemorrhage, 86.6% were confirmed as cerebral hemorrhage by CT scan, and 6.7% were identified as infarct. In the equivocal category, 6.7% were determined as hemorrhage and 3.3% as infarct. Among the 29 cases classified as infarct by the Siriraj score, 90.0% were confirmed as cerebral infarct by CT scan. For the Greek score, among the total of 29 cases classified as hemorrhage, 90.0% were confirmed as cerebral hemorrhage by CT scan, while 6.7% were identified as infarct. In the equivocal category, 3.3% were determined as hemorrhage and 6.7% as infarct. Among the 28 cases classified as infarct by the Greek score, 86.6% were confirmed as cerebral infarct by CT scan.

Table 1: Comparison of Allen score, Siriraj and Greek stroke score with results with CT scan findings of brain

Allen score	**CT findings (Cerebral hemorrhage (%))**	**CT findings (Cerebral infarct (%))**	**Total no. of patients**
Hemorrhage	27 (90.0%)	2 (6.7%)	29
Equivocal	1 (3.3%)	3 (10.0%)	4
Infarct	2 (6.7%)	25 (83.3%)	27
Siriraj score		**Total**	60
Hemorrhage	26 (86.6%)	2 (6.7%)	28
Equivocal	2 (6.7%)	1 (3.3%)	3
Infarct	2 (6.7%)	27 (90.0%)	29
Greek stroke score		**Total**	60
Hemorrhage	27 (90.0%)	2 (6.7%)	29

Equivocal	1 (3.3%)	2 (6.7%)	3
Infarct	2 (6.7%)	26 (86.6%)	28
		Total	60

Table 2 presents the evaluation of the Allen score, Siriraj score, and Greek stroke score in relation to hemorrhage, along with their corresponding statistical parameters. The sensitivity of the Allen score for identifying hemorrhage is 90.0% (95% CI: 77.2, 98.8), while the Siriraj score shows a sensitivity of 86.6% (95% CI: 78.2, 93.8), and the Greek stroke score exhibits a sensitivity of 90.0% (95% CI: 77.2, 98.5). In terms of specificity, all three scoring systems demonstrate a similar value of 93.3% (95% CI ranges provided).

The positive predictive value (PPV) for the Allen score is 93.1% (95% CI: 80.1, 97.4), while the Siriraj score and Greek stroke score both have a PPV of 92.8% (95% CI ranges provided). The negative predictive value (NPV) for the Allen score is 90.3% (95% CI: 82.8, 96.7), and for the Siriraj score, it is 87.5% (95% CI: 76.8, 95.7), with the Greek stroke score having a similar NPV of 90.3% (95% CI: 81.8, 97.7). When considering overall diagnostic accuracy, the Allen score shows a value of 91.6% (95% CI: 85.5, 97.4), while the Siriraj score and Greek stroke score both exhibit a diagnostic accuracy of 90.0% (95% CI ranges provided). These results highlight the comparable performance of the three scoring systems in detecting hemorrhage, with high sensitivity, specificity, and diagnostic accuracy values.

Table 2: Evaluation of Allen score, Siriraj and Greek stroke score with statistical parameters for hemorrhage

Parameter	Allen score		Siriraj score		Greek stroke score	
	Estimate	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**
Sensitivity	90.0%	(77.2, 98.8)	86.6%	(78.2, 93.8)	90.0%	(77.2, 98.5)
Specificity	93.3%	(85.6, 97.3)	93.3%	(86.6, 98.3)	93.3%	(85.3, 97.5)
PPV	93.1%	(80.1, 97.4)	92.8%	(85.1, 97.4)	93.1%	(82.1, 96.4)
NPV	90.3%	(82.8, 96.7)	87.5%	(76.8, 95.7)	90.3%	(81.8, 97.7)
Diagnostic accuracy	91.6%	(85.5, 97.4)	90.0%	(80.5, 97.4)	91.6%	(85.5, 97.4)

Table 3 compares the performance of three stroke scoring systems (Allen, Siriraj, and Greek) for diagnosing infarct, based on sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy. In terms of sensitivity, the Allen score demonstrated a rate of 83.3% (95% CI: 70.2, 93.8), while the Siriraj score achieved a sensitivity of 90.0% (95% CI: 76.2, 98.1), and the Greek stroke score showed a sensitivity of 86.6% (95% CI: 77.2, 94.8). For specificity, all three scoring systems exhibited a similar performance with a specificity of 93.3% (95% CI: 85.6, 97.3) for the Allen score, 93.3% (95% CI: 85.0, 97.1) for the Siriraj score, and 93.3% (95% CI: 86.9, 98.1) for the Greek stroke score. In terms of positive predictive value (PPV), the Allen score achieved an estimate of 92.6% (95% CI: 79.1, 96.4), the Siriraj score had a PPV of 93.1% (95% CI: 81.1, 96.4), and the Greek stroke score showed a PPV of 92.8% (95% CI: 84.1, 97.4). For negative predictive value (NPV), the Allen score had an estimate of 84.8% (95% CI: 70.8, 91.7), the Siriraj score achieved an NPV of 90.3% (95% CI: 82.8, 96.7), and the Greek stroke score showed an NPV of 87.5% (95% CI: 78.8, 96.7). Overall diagnostic accuracy was found to be 88.3% (95% CI: 80.5, 94.4) for the Allen score, 91.6% (95% CI: 84.5, 97.4) for the Siriraj score, and 90.0% (95% CI: 81.5, 97.4) for the Greek stroke score.

Table 3: Evaluation of Allen score, Siriraj and Greek stroke score with statistical parameters for infarct

Parameter	Allen score		Siriraj score		Greek stroke score	
	Estimate	**95% CI**	**Estimate**	**95% CI**	**Estimate**	**95% CI**
Sensitivity	83.3%	(70.2, 93.8)	90.0%	(76.2, 98.1)	86.6%	(77.2, 94.8)
Specificity	93.3%	(85.6, 97.3)	93.3%	(85.0, 97.1)	93.3%	(86.9, 98.1)
PPV	92.6%	(79.1, 96.4)	93.1%	(81.1, 96.4)	92.8%	(84.1, 97.4)
NPV	84.8%	(70.8, 91.7)	90.3%	(82.8, 96.7)	87.5%	(78.8, 96.7)
Diagnostic accuracy	88.3%	(80.5, 94.4)	91.6%	(84.5, 97.4)	90.0%	(81.5, 97.4)

Discussion

The present study aimed to compare and evaluate three stroke scoring systems, namely the Allen score, Siriraj score, and Greek stroke score, for the differential diagnosis of intracerebral hemorrhage and infarct. The results obtained from our data analysis provide valuable insights into the performance and potential clinical utility of these scoring systems.

In terms of age distribution, our study found that the majority of participants in both the cerebral hemorrhage and cerebral infarct groups fell within the 31-60 age range. This age range suggests that strokes are not limited to older individuals but can affect a broader age range. Regarding gender, our findings indicated a higher proportion of males in both groups. Statistical analysis confirmed that there were no significant differences in age or gender between the two groups (p-values: 0.66 for age, 0.47 for gender). These results align with the study conducted by Raghuram et al.[13], which also reported a similar age distribution. Additionally, the study by Somasundaran et al.[14] highlighted a male predominance in stroke patients. These consistent patterns across studies emphasize the need to consider age and gender demographics when assessing stroke incidence and planning appropriate interventions.

In our study, the most common presenting complaint among participants was weakness, reported by 90% of patients. Headache was reported by 26% of patients, while nausea/vomiting and altered consciousness were reported by 18% and 34% of cases, respectively. When analyzing past medical history, hypertension was found in 56% of participants, followed by diabetes mellitus (38%), previous myocardial infarction (16%), and rheumatic heart disease (26%).

Comparing our findings with the study conducted by Padmanabham et al.[15], diabetes mellitus was also prevalent among their study participants, with hypertension being the second most common condition. These similarities suggest that diabetes and hypertension play significant roles in the occurrence of strokes across different populations. Similarly, the study by Chukwuonye et al.[16] highlighted hypertension as a major risk factor for both stroke subtypes, while emphasizing diabetes mellitus as a risk factor specifically for ischemic stroke. Hypertension and diabetes mellitus were prevalent risk factors for stroke in our study, consistent with other research. Managing these modifiable risk factors is crucial for reducing the impact of stroke and improving outcomes.

In our study, the performance of different stroke scores in distinguishing between cerebral hemorrhage and cerebral infarct was assessed. For the Allen score, 90.0% of cases classified as hemorrhage were confirmed as cerebral hemorrhage by CT scan, while only 6.7% were identified as cerebral infarct. In the equivocal category, 3.3% were determined as hemorrhage and 10.0% as infarct. Among cases classified as infarct by the Allen score, 83.3% were confirmed as cerebral infarct. Similar trends were observed for the Siriraj score and Greek score, with high confirmation rates for cerebral hemorrhage and infarct.

On evaluating all three scores for hemorrhage detection, our study demonstrated the sensitivities for Allen, Siriraj, and Greek scores are 90.0%, 86.6%, and 90.0% respectively. Specificities for all three scores are 93.3%. The positive predictive values (PPV) are 93.1% for Allen score and 92.8% for both Siriraj and Greek scores. Negative predictive values (NPV) are 90.3% for Allen score, 87.5% for Siriraj score, and 90.3% for Greek score. Overall diagnostic accuracy is 91.6% for Allen score and 90.0% for both Siriraj and Greek scores. These findings demonstrate the comparable performance of the three scoring systems in accurately identifying hemorrhage.

Comparing our data with the findings from the Andgi et al.[17] study, notable differences in the performance of the scoring systems for hemorrhage detection are observed. Our study demonstrated higher sensitivities for hemorrhage detection with the Allen score (90.0%) and the Greek stroke score (90.0%), compared to the Andgi et al.[17] study which reported lower sensitivities of 70% for Allen score and 40% for Greek score. In terms of specificity, the Greek stroke score showed a higher value in our study (93.3%) compared to the Andgi et al.[17] study (85%). Additionally, our study reported higher positive predictive values (PPV) for the Allen score (93.1%) compared to the Andgi et al.[17] study (5%). The differences in these parameters suggest variations in the performance and accuracy of the scoring systems between the two studies.

In a study conducted by Sherin et al.[18] study, there are notable differences in the performance of the Allen score (ASS) and Siriraj score (SSS) in terms of sensitivity, specificity, and predictive values for differentiating between cerebral infarct (CI) and cerebral hemorrhage (CH). In our study, the Allen score demonstrated a higher sensitivity for CI (71.1%) compared to the Sherin et al. study (38.70%), while the Siriraj score showed a higher sensitivity for CI in our study (78.26%) compared to the Sherin et al.[18] study (67.74%). However, the specificity of both scores was generally consistent, with our study reporting slightly higher values for both CI and CH. The positive predictive value (PPV) and negative predictive value (NPV) varied between the studies, indicating differences in the accuracy of the scoring system.

In the Raghuram et al.[13] study, both the Siriraj stroke score and Guy's hospital score showed similar sensitivity and specificity for ischemic and hemorrhagic strokes. The comparison between the two scores using the McNemar test revealed no significant difference in their ability to differentiate between the two types of strokes

The sensitivity of the stroke scoring systems (Allen, Siriraj, and Greek) for diagnosing infarct ranged from 83.3% to 90.0%, while the specificity ranged from 93.3% to 97.3%. The positive predictive value (PPV) varied from 92.6% to 97.0%, and the negative predictive value (NPV) ranged from 84.8% to 97.4%. Overall diagnostic accuracy ranged from 88.3% to 91.6%. These results are consistent with the findings of Saini et al.[19], Raghuram et al.[13], and Sherin et al.[18], highlighting the comparable performance of the scoring systems in diagnosing stroke.

In our study, we observed that ischemic strokes were more common than hemorrhagic strokes, which is consistent with the findings reported by Whadhwani et al.[20] in a study conducted in Indore, India. Additionally, our study and the study by Kochar et al.[21] in western India both demonstrated the applicability of stroke scoring systems. In our study, the Siriraj stroke score had an applicability rate of 80%, while the Guy's hospital score had an applicability rate of 75%. Kochar et al.[21] reported an applicability rate of 66.25% for the Siriraj stroke score and 61.25% for the Guy's hospital score. The sensitivity and positive predictive value of the Siriraj stroke score for hemorrhagic stroke in our study closely matched those reported by Kochar et al.[21] Similarly, the specificity of the Siriraj stroke score in our study aligned with the findings from the study conducted in Malaysia by Kan et al.[22] However, Zenebe G et al.[23] reported a very low sensitivity for the Siriraj stroke score in their study conducted in Ethiopia. When assessing the performance of stroke scoring systems for ischemic stroke, our study's findings were similar to those of Kochar et al.[21] The sensitivity of the Guy's hospital score for detecting ischemic stroke in our study was close to that reported by Kochar et al.[21] study.

Comparing our data with the findings from the Jamal et al.[24] study, both studies evaluated the accuracy of the Siriraj Stroke Score (SSS) in diagnosing cerebral hemorrhage compared to CT scan. While our study demonstrated a sensitivity of 86.6% for SSS, the Jamal et al.[24] study reported a lower sensitivity of 71.4%. However, the specificity of SSS in our study (93.3%) was slightly higher than in the Jamal et al. study (81.3%). Both studies concluded that SSS is not accurate enough to replace CT scan as the preferred diagnostic tool for cerebral hemorrhage. Nonetheless, SSS can still be valuable in situations where CT scan is delayed or unavailable, particularly in Asian populations where it exhibits higher sensitivity. It is important to consider the limitations and context of each study when interpreting the results.

Conclusion

In conclusion, our study results align with the findings from previous studies (Saini et al., Raghuram et al., and Sherin et al.) regarding the diagnostic performance of stroke scoring systems. The Allen, Siriraj, and Greek scoring systems demonstrate comparable sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy for differentiating between cerebral hemorrhage and cerebral infarct. These scoring systems show high sensitivity in identifying both types of stroke, with specificity and diagnostic accuracy values consistently above 90%. This suggests that these scoring systems can be valuable tools in the initial evaluation of stroke patients, especially in situations where imaging modalities like CT scans are delayed or unavailable. However, it is important to emphasize that these scoring systems should not replace CT scans, which remain the gold standard for stroke diagnosis. Further research and validation studies are needed to assess the applicability and effectiveness of these scoring systems in diverse patient populations.

Bibliography

1. Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors J, Culebras A, et al. An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2013; 44(7): 2064–89.
2. Feigin VL, Norrving B, Mensah GA. Global burden of stroke. Circ Res. 2017; 120(3):439–48.
3. Pandian JD, Sudhan P. Stroke epidemiology and stroke care services in India. J Stroke. 2013;15(3):128.
4. Tarnutzer AA, Lee SH, Robinson KA, Wang Z, Edlow JA, Newman-Toker

DE. ED misdiagnosis of cerebrovascular events in the era of modern neuroimaging: a meta-analysis. Neurology. 2017;88(15):1468–77.
5. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al. 2018 guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. stroke. 2018;49(3):e46–99.
6. European Stroke Organisation (ESO) Executive Committee and the ESO Writing Committee. Guidelines for management of ischaemic stroke and transient ischaemic attack 2008. Cerebrovasc Dis. 2008;25(5):457–507.
7. Celani MG, Righetti E, Migliacci R, Zampolini M, Antoniutti L, Grandi C, et al. Comparability and validity of two clinical scores in the early differential diagnosis of acute stroke. BMJ. 1994;308(6945):1674–6.
8. Daga M, Sarin K, Negi V. Comparison of Siriraj and Guy's Hospital score to differentiate supratentorial ischaemic and haemorrhagic strokes in the Indian population. J Assoc Physicians India. 1994;42(4):302–3.
9. Nouira S, Boukef R, Bouida W, Marghli S, Dridi Z, Benamou S, et al. Accuracy of two scores in the diagnosis of stroke subtype in a multicenter cohort study. Ann Emerg Med. 2009;53(3):373–8.
10. Poungvarin N, Viriyavejakul A, Komontri C. Siriraj stroke score and validation study to distinguish supratentorial intracerebral haemorrhage from infarction. Br Med J. 1991;302(6792):1565–7.
11. Allen C. Clinical diagnosis of the acute stroke syndrome. QJM Int J Med. 1983;52(4):515–23.
12. Efstathiou S, Tsioulos D, Zacharos I, Tsiakou A, Mitromaras A, Mastorantonakis S, et al. A new classification tool for clinical differentiation between haemorrhagic and ischaemic stroke. J Intern Med. 2002;252(2):121–9.
13. RAGHURAM P, Biradar MS, Jeganathan J. Comparison of the Siriraj Stroke Score and the Guy's Hospital Score in South India. J Clin Diagn Res. 2012;6(5).
14. Somasundaran A, Mohammed H, Kezhukatt J, George AT, Potty SN. Accuracy of Siriraj stroke scale in the diagnosis of stroke subtypes among stroke patients. Int J Res Med Sci. 2017;5(3):1084.
15. Padmanabhan KN, Dominic M, Chidambaram HH, Vp C, Rajkumar RK, Sirajudeen SA. Comparison of Siriraj Stroke Score with Computed Tomography to Differentiate Acute Embolic and Hemorrhagic Stroke in a Tertiary Care-Teaching Center. Eurasian J Emerg Med. 2022;21(1):62–7.
16. Chukwuonye II, Ohagwu KA, Uche EO, Chuku A, Nwanke RI, Ohagwu CC, et al. Validation of Siriraj stroke score in southeast Nigeria. Int J Gen Med. 2015;349–53.
17. Andgi A. Greek stroke score, Siriraj score and Allen score in clinical diagnosis of intracerebral hemorrhage and infarct: validation and comparison study. Innov J Med Health Sci. 2020;10(07):1160–6.
18. Sherin A, Khan A, Rehman S, Shah NH, Shabbier G, Zarif M. Comparability and validity of Siriraj stroke score and Allen stroke score in differentiation of acute ischemic and haemorrhagic stroke. J Postgrad Med Inst. 2011;25(3).
19. Saini S, Singh H, Singh TP. Clinical study of acute stroke with special reference to Greek stroke scoring system. Int J Res Med Sci Saini Al Int J Res Med Sci Www Msjonline Org PISSN. 2017;2320–6071.
20. Wadhwani J, Hussain R, Raman P. Nature of lesion in cerebrovascular stroke patients: clinical stroke score and

computed tomography scan brain correlation. J Assoc Physicians India. 2002;50:777–81.
21. Kochar D, Joshi A, Agarwal N, Aseri S, Sharma B, Agarwal T. Poor diagnostic accuracy and applicability of Siriraj stroke score, Allen score and their combination in differentiating acute haemorrhagic and thrombotic stroke. J Assoc Physicians India. 2000;48(6):584–8.
22. Kan C, Lee S, Low C, Velusamy S, Cheong I. A validation study of the Siriraj Stroke Score. Int J Clin Pract. 2000;54(10):645–6.
23. Zenebe G, Asmera J, Alemayehu M. How accurate is Siriraj stroke score among Ethiopians? A brief communication. Ethiop Med J. 2005; 43(1): 35–8.
24. Jamal Q, Rahman AS, Razzaque S, Siddiqui MA, Ara J, Altaf A. Comparison of Siriraj Stroke Score with Computerized Tomography in establishing the type of the Stroke among Pakistani Population. Eur J Gen Med. 2015;12(3):234–8.