Original Article

The New FA_2ST Stroke Screening Score: An Expanding Recognition to Posterior Circulation Stroke

Warongporn Phuenpathom MD[1], Aurauma Chutinet MD[1,2], Prakitchai Tantipong MD[3], Surachet Eiamthanasinchai MD[4], Nijasri C Suwanwela MD[1,2,5]

[1] Division of Neurology, Department of Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand

[2] Chulalongkorn Stroke Center, King Chulalongkorn Memorial Hospital, Thai Red Cross Society, Bangkok, Thailand

[3] Department of Emergency Medicine, Nopparatrajathanee Hospital, Bangkok, Thailand

[4] Department of Medicine, Surin Hospital, Surin, Thailand

[5] Chula Neuroscience Center, King Chulalongkorn Memorial Hospital, Thai Red Cross Society, Bangkok, Thailand

Background: Rapid screening and intervention are the keys to successful early treatment of stroke. Generally, the conventional FAST stroke screening score has been used by triage nurses to promptly detect acute stroke. However, the conventional FAST score has a limitation in detecting posterior circulation stroke, which results in high mortality rates. Previous studies have shown that adding ataxia could increase the sensitivity of posterior circulation stroke detection.

Objective: To introduce and evaluate the diagnostic performance of a new stroke screening score, FA_2ST score, by adding ataxia to the conventional FAST score.

Materials and Methods: The present study was a cross-sectional study. The new FA_2ST and conventional FAST scores were used by triage nurses in patients presented with acute neurological symptoms within seven days at the emergency department of three different types of hospitals in Thailand. Patients with Glasgow Coma Score less than 9 and those having unstable vital signs were excluded. Final diagnosis was made by a neurologist using clinical and neuroimaging information. The diagnostic performance of the new FA_2ST score was calculated using ROC curve in comparison to the conventional FAST score. The rate of posterior circulation stroke detection was calculated as percentage.

Results: One hundred forty-six patients were studied. Of these, 127 (86%) had acute ischemic stroke and 19 (14%) had other diagnoses. The overall diagnostic performance of the new FA_2ST score was not statistically different with conventional FAST score in terms of area under the curve (0.642 versus 0.684, p=0.221). However, after in-depth analysis, the rate of posterior circulation stroke detection of the new FA_2ST score was higher compared with the conventional FAST score (94.12% versus 82.35%).

Conclusion: The present study introduces the new FA_2ST stroke screening score and emphasizes the importance of posterior circulation stroke detection in acute stroke screening. Future studies should be considered before implementation of this score.

Keywords: Screening score; Acute stroke treatment; Stroke; Emergency neurology

Received 5 February 2021 | Revised 2 June 2021 | Accepted 4 June 2021

J Med Assoc Thai 2021;104(7):1132-9

Website: http://www.jmatonline.com

Stroke is the second leading cause of death worldwide and often results in disability of the patients. Stroke-related disability burden is increasing since 1990 and contributes to large economic burden and decreased quality of life of the patients and caregivers worldwide[1,2]. Rapid screening and intervention are the keys to successful early treatment. Many pre-hospital stroke assessment scores have been delivered and used by paramedics, including the Face Arm Speech Test (FAST)[3], the Los Angeles Prehospital Stroke Screen (LAPSS)[4], the Cincinnati Prehospital Stroke Scale (CPSS)[5], and the Melbourne Ambulance Stroke Screen (MASS)[6]. The conventional FAST stroke screening score, which includes Facial drooping, Arm weakness, Speech difficulty, and Time to call, has generally been used by triage nurses to promptly detect acute stroke. The FAST score is well-recognized for its high sensitivity, specificity, and simplicity. However, it has several limitations including the low sensitivity to detect posterior circulation strokes[7].

The posterior circulation stroke has variable

Correspondence to:

Phuenpathom W.

Division of Neurology, Department of Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.

Phone: +66-81-6988583

Email: wph@chulapd.org

How to cite this article:

Phuenpathom W, Chutinet A, Tantipong P, Eiamthanasinchai S, Suwanwela NC. The New FA_2ST Stroke Screening Score: An Expanding Recognition to Posterior Circulation Stroke. J Med Assoc Thai 2021;104:1132-9.

doi.org/10.35755/jmedassocthai.2021.07.12464

presenting symptoms. The consequences of misdiagnosis may be devastating, and misdiagnosis is potentially preventable[8]. Previous studies have shown that adding ataxia and visual disturbances, which are the symptoms of cerebellar, brainstem, or occipital lobe dysfunction, assist in increasing the sensitivity for posterior circulation stroke detection[9,10]. In the United States, the Balance-Eyes-Face-Arms-Speech-Time (BEFAST) score has been developed based on this rationale. However, the result is that addition of coordination and diplopia assessment to face, arm, and speech assessment do not improve stroke detection in the pre-hospital setting[11]. In Asia, there have been few studies about posterior circulation stroke detection due to developing considerations in this area. Only a single study about FASA score representing Facial drooping, Ataxia, Speech difficulty, and Arm weakness has been performed in King Chulalongkorn Memorial Hospital, Bangkok, Thailand[12]. The present study had been performed in Thailand. The incidences of stroke in Thailand are high, and stroke is also the first leading cause of death as it is in Europe and the United States[13]. The result of the present study demonstrated higher sensitivity of FASA score in comparison to the conventional FAST score. However, there are still many limitations in the present study, including the lack of clear definition of ataxia and the inclusion of patients with non-specific symptoms such as dizziness and altered consciousness. Moreover, only patients at King Chulalongkorn Memorial Hospital were recruited, which resulted in low generalizability.

Therefore, the researchers modified the conventional FAST score into the new FA_2ST score. The other A in the new FA_2ST score in the present study had clear definition of clinical observation from both patients themselves and their relatives. Patients with alteration of consciousness will also be excluded to make the results more specific. The researchers aimed to introduce and evaluate the performance in acute stroke, especially posterior circulation stroke detection of the new FA_2ST score, and compared its diagnostic performance with the conventional FAST score among patients who presented with neurological symptoms at the emergency department in three different hospital settings.

Materials and Methods

Study population

Patients who presented with acute persistent neurological symptoms at the emergency room of three different types of hospitals in Thailand between October and December 2018 were included. The three different types of hospitals were a tertiary care hospital with King Chulalongkorn Memorial Hospital, a suburban hospital with Nopparatrajathanee Hospital, and a provincial hospital with Surin Hospital.

Inclusion criteria

1. Age over or equal to 18 years old.
2. Presenting with persistent neurological symptoms within seven days after the onset.

Exclusion criteria

1. Glasgow Coma Scale score less than 9
2. Unstable vital signs with systolic blood pressure of less than 90 mmHg, BT of 37.8°C or more, HR of 100 or more bpm, RR of more than 24 bpm, and oxygen saturation of less than 90%
3. Inability to be assessed by a screening protocol, for example, limb amputation
4. No prior neurological deficits

Study design

The present study was a cross-sectional study.

Methods

The new FA_2ST score was modified from the conventional FAST score by adding A with clear definition of ataxia (Table 1). The definition of ataxia, facial drooping, arm weakness and speech difficulty were as shown in the definition of terms below. All triage nurses were trained and rechecked for the correction of screening form usage by the researchers. After the recruitment, the information was given to the patient for informed consent. The present research was conducted under approval of the Human Ethics Committees of the Faculty of Medicine, Chulalongkorn University (IRB No.331/62), Nopparatrajathanee Hospital (IRB No.1/2562), and Surin Hospital (IRB No.67/2561).

Two triage nurses, trained by the researchers, used the screening FA_2ST and the FAST score to screen each patient and concluded the results in one form. The baseline characteristics consisting of name, surname, age, gender, telephone number, vital signs, and underlying disease were collected. The modified Rankin Scale (mRS)[14] was also evaluated at baseline. In King Chulalongkorn Memorial Hospital, the primary researcher was the main responsible person. For Nopparatrajathanee Hospital and Surin Hospital, the main responsible persons were Doctor Prakitchai Tantipong and Doctor Surachet Eiamthanasinchai, respectively.

Table 1. The new FA_2ST and the conventional FAST score used in this study

Screening criteria	Yes	No
F: Facial drooping		
• Patient history or observation from a relative of asymmetrical facial fold		
• Asymmetrical facial fold observed when patient smiled		
A: Arm weakness		
• Patient history or observation from a relative of weakness in one arm		
• Patient lifted both arms for 10 seconds and one arm fell or patient was unable to lift one arm		
A: Ataxia		
• Patient history or observation from a relative or triage nurses of the patient showing instability when sitting or standing		
S: Speech		
• Patient history or observation from a relative of dysarthria, change of voice, or an inability or difficulty to produce speech.		
• Patient could not repeat or had difficulty repeating the name of each hospital after triage nurses said the names.		
Total score	FA_2ST	FAST
Total time	Second/minute	

After the screening, patients were divided into screening positive and negative group. The imaging either computed tomography or magnetic resonance imaging was done in all patients in screening positive and in some screening negative group depending on the responsible neurologists' opinions regarding to the resource limitation in some institutions and avoidance of unnecessary exposure to radiation in screening negative group.

In the screening positive group, patients were consequently classified based on the Oxfordshire Community Stroke Project (OCSP) Classification[15]. In screening negative group, patients were finally diagnosed by the neurologists and were scheduled for follow-up of clinical condition at two and six weeks. The mRS was evaluated by neurologists at two and six weeks. Moreover, the imaging would be done if new or deteriorated neurological symptoms were found. The researcher would collect the data by telephone for the non-following up patients.

Definition of terms

The patients recruited in the present study were screened by the new FA_2ST and conventional FAST score. Definition for the new FA_2ST score was as demonstrated below. For conventional FAST score, only facial drooping, arm weakness, and speech difficulty were considered.

Facial drooping was defined by the presence of either of the followings:

1. Patient history or observation from a relative of asymmetrical facial fold
2. Asymmetrical facial fold observed when patient smiled

Arm weakness was defined by the presence of either of the followings:

1. Patient history or observation from a relative of weakness in one arm.
2. Patient lifted both arms for 10 seconds and one arm fell, or patient was unable to lift one arm.

Ataxia was defined by the presence of either of the followings:

1. Patient history or observation from a relative or triage nurses of the patient showing instability when sitting or standing.
2. Subjective sensation of movement, including spinning, turning, tilting, or whirling, of the patient or the surroundings.

Speech difficulty was defined by the presence of either of the followings:

1. Patient history or observation from a relative of dysarthria, change of voice, or an inability or difficulty to produce speech.
2. Patient could not repeat or had difficulty repeating the name of each hospital after triage nurses said the names.

Moreover, the patients who had acute ischemic stroke were patients diagnosed by neurologists in each institution using the OCSP Classification System(15). There were four groups of patients.

1. Lacunar infarcts (LACI) were patients diagnosed of pure motor stroke, pure sensory stroke, sensori-motor stroke, or ataxic hemiparesis.
2. Total anterior circulation infarcts (TACI) were patients who had a combination of new higher cerebral dysfunction such as dysphasia, contralateral

homonymous visual field defect and contralateral motor or sensory deficit of at least two areas from face, arm, or leg.

3. Partial anterior circulation infarcts (PACI) were patients who had only two of the three components of a TACI, or with higher cerebral dysfunction alone, or with a motor or sensory deficit more restricted than those classified as LACI such as confined to one limb.

4. Posterior circulation infarcts (POCI) were patients who had any of ipsilateral cranial nerve palsy with contralateral motor or sensory deficit, bilateral motor or sensory deficit, disorder of conjugate eye movement, cerebellar dysfunction, or isolated homonymous visual field defect.

If there was reluctance in diagnosis, another neurologist in the same institution was consulted from the responsible neurologist. A consensus was performed for a conclusion in diagnosis.

Statistical analysis

The sample size calculation was performed using a formula for precision calculation for sensitivity[16] at estimated sensitivity of 0.95, 95% confidence interval, and error margin of 0.05. The student t-test method was used for continuous variables and the chi-square method was used for categorical variables. The sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, and negative likelihood ratio were calculated. The receiver operating characteristic curve (ROC) and area under the curve (AUC) were analyzed using IBM SPSS Statistics software, version 23.0 (IBM Corp., Armonk, NY, USA). A p-value of less than 0.05 was accepted as statistical significance.

Results

One hundred forty-six patients were recruited in the present study. Ninety-six patients were enrolled at King Chulalongkorn Memorial Hospital. Twenty-five patient each were enrolled at Nopparatrajathanee Hospital and Surin Hospital. For the baseline characteristics, the numbers of patients with diabetes mellitus type 2 in the stroke group were significantly more than in the non-stroke group. However, no significant differences in the other characteristics were observed (Table 2).

After the screening, 136 patients were in the FA_2ST positive group and ten patients were in the FA_2ST negative group. When using the conventional FAST score, 132 patients were in the conventional FAST positive group and 14 patients were in conventional FAST negative group as shown in Figure 1. After complete evaluation by neurologists, 127 patients were diagnosed of acute ischemic stroke and 19 patients were diagnosed of non-stroke. The patients in acute ischemic stroke group were consequently classified by neurologists as OCSP classification as demonstrated in Table 3. Seventeen patients (13.38%) in the acute ischemic stroke group were diagnosed of posterior circulation stroke. For non-stroke group, the diagnosis of the patients is shown in Table 4.

The overall diagnostic performance of the new FA_2ST score was not statistically different with the conventional FAST score in terms of AUC from the comparison of ROC at the same cut point of both scores of 1 with FA_2ST score of 0.642 versus FAST score of 0.684 (p=0.221), as demonstrated in Figure 2. However, the sensitivity and the negative predictive value of the new FA_2ST score were higher than the conventional FAST score with sensitivity at 96.85% versus 95.28% and negative predictive value at 60% versus 57.1% as demonstrated in Table 5. Another important result after in-depth analysis was that the rate of posterior circulation stroke detection

Table 2. Baseline characteristics of the patients in this study

Characteristics	Stroke (n=127); n (%)	Non-stroke (n=19); n (%)	p-value
Female	61 (48.03)	7 (36.84)	0.07
Age (years); mean±SD	64.81±14.11	62.63±12.34	0.53
Underlying disease			
Previous strokes	19 (82.60)	4 (17.40)	0.50
Hypertension	66 (91.67)	6 (8.37)	0.09
Diabetes mellitus type 2	32 (76.19)	10 (23.81)	0.01
Hyperlipidemia	26 (78.79)	7 (21.21)	0.11
Coronary artery disease	9 (75.00)	3 (25.00)	0.20
Cancer	7 (77.78)	2 (22.22)	0.40
Atrial fibrillation	9 (90.00)	1 (10.00)	0.77
Chronic kidney disease	11 (100)	0 (0.00)	0.18
Dilated cardiomyopathy	1 (100)	0 (0.00)	0.70
Hyperthyroid	1 (100)	0 (0.00)	0.70
Dementia	2 (100)	0 (0.00)	0.58

SD=standard deviation

Table 3. OCSP classification of the patients in the acute ischemic stroke group

Diagnosis	Stroke (n=127); n (%)
Partial anterior circulation stroke	27 (21.26)
Lacunar stroke	38 (29.92)
Posterior circulation stroke	17 (13.38)

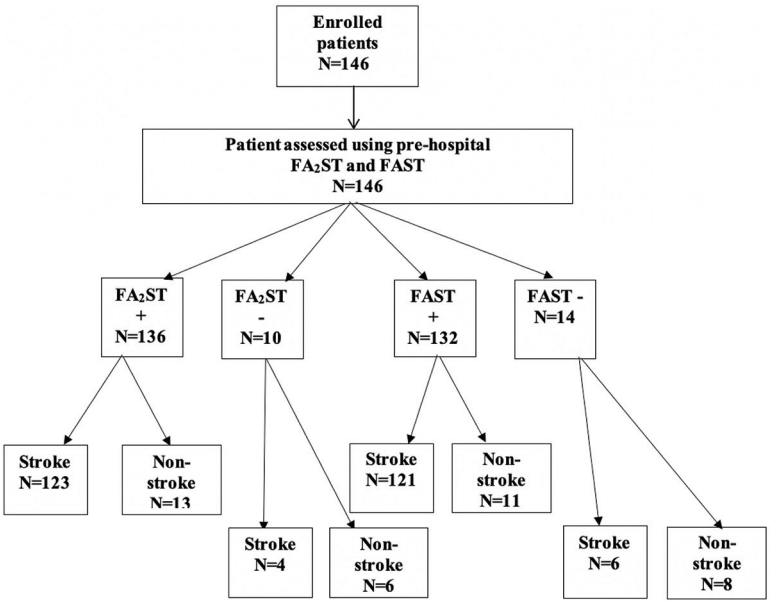

Figure 1. All enrolled patients divided into FA_2ST positive, FA_2ST negative, FAST positive and FAST negative groups. The final diagnoses in the stroke and non-stroke groups are as shown.

Table 4. Diagnostic profiles of the patients in the non-stroke group

Diagnosis	Non-stroke (n=19); n (%)
Migraine	3 (15)
Sepsis	3 (15)
Syncope	2 (11)
Anxiety disorder	2 (11)
Conversion disorder	2 (11)
Subdural hematoma	2 (11)
Depression disorder	1 (5)
Cerebral amyloid angiopathy	1 (5)
Sick sinus syndrome	1 (5)
Plexopathy	1 (5)
Primary CNS lymphoma	1 (5)

CNS=central nervous system

Table 5. The sensitivity, specificity, positive predictive value, negative predictive value and likelihood ratio of overall FA_2ST and FAST scores at 95% confidence interval

Parameter	FA_2ST	FAST
Sensitivity	96.90%	95.30%
Specificity	31.60%	42.10%
Positive predictive value	90.40%	91.70%
Negative predictive value	60.00%	57.10%
Likelihood ratio +	1.42	1.65
Likelihood ratio –	0.10	0.11

by the new FA_2ST score was also higher than the conventional FAST score at 94.12% versus 82.35% (p=0.03).

The clinical outcome with mRS at two and six weeks after final diagnosis is demonstrated in Table 6. No clinical deterioration was observed at the follow-up. A tendency of an improved outcome was noted. For posterior circulation stroke group, ten patients were in the moderate disability group and seven patients were in the moderately severe disability group at inclusion time. After two- and six-weeks follow-up, ten patients improved to no significant and slight disability. Seven patients also improved to slight and moderate disability.

Discussion

The researchers aimed to compare the diagnostic performance of the newly modified posterior circulation stroke screening score, FA_2ST score, with conventional FAST score among the patients who presented with neurological symptoms at the emergency department in three different hospital settings. The overall diagnostic performance of new FA_2ST score is not statistically different with the conventional FAST score in terms of AUC. However, the new FA_2ST score has higher sensitivity and higher negative predictive value in comparison to the conventional FAST score. From in-depth

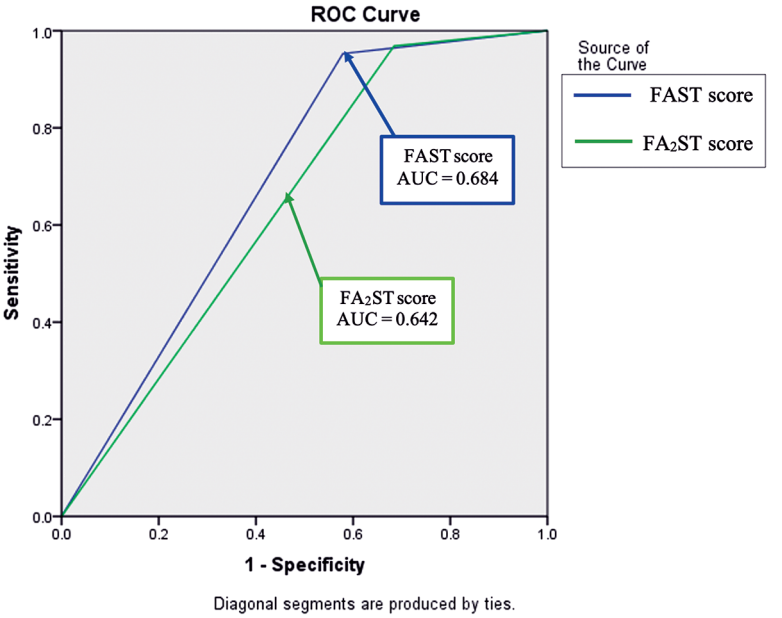

Figure 2. Comparison of area under the curve (AUC) between the new FA_2ST score and conventional FAST score at the same cut point of 1 (FA_2ST score 0.642 vs. FAST score 0.684, p=0.221).

Table 6. Modified Rankin Scale in stroke and non-stroke group after following up at two and six weeks

Modified Rankin Scale	At inclusion; n (%)		Two weeks; n (%)		Six weeks; n (%)	
	Stroke (n=127)	Non-stroke (n=19)	Stroke (n=127)	Non-stroke (n=19)	Stroke (n=127)	Non-stroke (n=19)
0=No symptoms	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (1.60)	7 (36.84)
1=No significant disability. Able to carry out all usual activities despite some symptoms.	0 (0.00)	0 (0.00)	10 (7.90)	8 (42.10)	32 (25.20)	6 (31.58)
2=Slight disability. Unable to perform all previous activities but able to look after own affairs without assistance.	8 (6.3)	4 (21.05)	24 (18.90)	3 (15.8)	42 (33.10)	2 (10.53)
3=Moderate disability. Requires some help, but able to walk without assistance.	82 (64.57)	15 (78.95)	71 (55.90)	8 (42.10)	41 (32.28)	4 (21.05)
4=Moderately severe disability. Unable to walk without assistance and unable to attend to own bodily needs without assistance.	37 (29.13)	0 (0.00)	22 (17.30)	0 (0.00)	10 (7.82)	0 (0.00)
5=Severe disability. Bedridden, incontinent, and requires constant nursing care and attention.	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
6=Dead	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)

analysis, the researchers find that the new FA_2ST score also has higher performance in detection of posterior circulation ischemic stroke in comparison to the conventional FAST score. This contributes to capability in acute stroke screening, especially posterior circulation stroke. Moreover, the present study shows higher sensitivity of the new FA_2ST score with similar prevalence of acute ischemic stroke in comparison with other studies[10,11]. Thus, the present study introduces the new FA_2ST score, which is capable for use in detecting not only acute stroke but also the posterior circulation stroke.

The present study has advantages in that the researchers emphasize the importance of posterior circulation stroke detection, which inadequate consideration of posterior circulation stroke when screening acute stroke is devastating. The use of the new FA_2ST score may reduce mortality rate of patients with posterior circulation stroke as it demonstrated a tendency to improve of mRS score. Implementation of this score in future research for feasibility in posterior circulation stroke detection should be considered. Moreover, to the researchers' best knowledge, this is the first study experimenting new FA_2ST score in

different types of hospitals, including a tertiary care hospital with King Chulalongkorn Memorial Hospital, a suburban hospital with Nopparatrajathanee Hospital, and a provincial hospital with Surin Hospital, which contributes to good generalizability of the present study compared to the previous study.

There are some limitations in the present study. Firstly, the specificity of the new FA_2ST score is not high at 31.58% versus 42.11%. Nevertheless, the researchers have previously stated that this score should be used as a screening score, which accuracy is less important than sensitivity. Secondly, magnetic resonance imaging is not done in all screening negative group due to resource limitation in some institutions. However, after follow-up mRS of patients at two- and six-weeks, there was no deterioration of patients in stroke and non-stroke group.

Conclusion

The present study introduces the new FA_2ST score and emphasizes the importance of posterior circulation stroke detection when screening acute stroke. The overall diagnostic performance of the new FA_2ST score is not statistically different with the conventional FAST score. However, its higher sensitivity and higher rate of posterior circulation stroke detection compared with the conventional FAST score contributes to capability in screening of acute stroke especially posterior circulation stroke. The use of the new FA_2ST score may reduce the mortality rate of patients with posterior circulation stroke. Implementation of this score in future research for feasibility in posterior circulation stroke detection should be considered due to limitations in the present study.

What is already known on this topic?

The FAST score is well-recognized for its high sensitivity, specificity, and simplicity to be used. However, it has several limitations including the low sensitivity to detect posterior circulation strokes.

What this study adds?

This study introduces the new FA_2ST stroke screening score and emphasizes the importance of posterior circulation stroke detection in acute stroke screening. Future studies should be considered before implementation of this score.

Funding disclosure

The present research was funded by Ratchadapisek Sompoch Endowment Fund, Chulalongkorn University, 2018. COA No. 908/2018.

Conflicts of interest

The authors declare no conflict of interest.

References

1. Feigin VL, Forouzanfar MH, Krishnamurthi R, Mensah GA, Connor M, Bennett DA, et al. Global and regional burden of stroke during 1990-2010: findings from the Global Burden of Disease Study 2010. Lancet 2014;383:245-54.
2. Rombough RE, Howse EL, Bagg SD, Bartfay WJ. A comparison of studies on the quality of life of primary caregivers of stroke survivors: a systematic review of the literature. Top Stroke Rehabil 2007;14:69-79.
3. Harbison J, Massey A, Barnett L, Hodge D, Ford GA. Rapid ambulance protocol for acute stroke. Lancet 1999;353:1935.
4. Kidwell CS, Starkman S, Eckstein M, Weems K, Saver JL. Identifying stroke in the field. Prospective validation of the Los Angeles prehospital stroke screen (LAPSS). Stroke 2000;31:71-6.
5. Kothari RU, Pancioli A, Liu T, Brott T, Broderick J. Cincinnati Prehospital Stroke Scale: reproducibility and validity. Ann Emerg Med 1999;33:373-8.
6. Bray JE, Martin J, Cooper G, Barger B, Bernard S, Bladin C. Paramedic identification of stroke: community validation of the melbourne ambulance stroke screen. Cerebrovasc Dis 2005;20:28-33.
7. Harbison J, Hossain O, Jenkinson D, Davis J, Louw SJ, Ford GA. Diagnostic accuracy of stroke referrals from primary care, emergency room physicians, and ambulance staff using the face arm speech test. Stroke 2003;34:71-6.
8. Masuda Y, Tei H, Shimizu S, Uchiyama S. Factors associated with the misdiagnosis of cerebellar infarction. J Stroke Cerebrovasc Dis 2013;22:1125-30.
9. Emsley HC. Posterior circulation stroke: still a Cinderella disease. BMJ 2013;346:f3552.
10. Gadi N, Huwez F. ABCD-E2 for fast negative TIAs/ strokes in middle aged and elderly patients [abstract]. Aging Clin Exp Res 2011;23:199.
11. Pickham D, Valdez A, Demeestere J, Lemmens R, Diaz L, Hopper S, et al. Prognostic value of BEFAST vs. FAST to identify stroke in a prehospital setting. Prehosp Emerg Care 2019;23:195-200.
12. Eiamthanasinchai S, Chutinet A, Suwanwela NC. Validation of the new stroke screening program FAS ABCD2 compare with the Cincinnati Prehospital Stroke Scale (FAST) in King Chulalongkorn Memorial Hospital. J Med Assoc Thai. In press 2020.
13. Division of Non-Communicable Diseases, Ministry of Public Health, Thailand. Mortality rate of non-communicating disease in Thailand [Internet]. 2016 [cited 2017 Mar 15]. Available from: http://www.thaincd.com/info/non-communicable-disease.
14. Wilson JT, Hareendran A, Grant M, Baird T, Schulz

UG, Muir KW, et al. Improving the assessment of outcomes in stroke: use of a structured interview to assign grades on the modified Rankin Scale. Stroke 2002;33:2243-6.
15. Carolei A, Marini C, Di Napoli M, Di Gianfilippo G, Santalucia P, Baldassarre M, et al. High stroke incidence in the prospective community-based L'Aquila registry (1994-1998). First year's results. Stroke 1997;28:2500-6.
16. Negida A, Fahim NK, Negida Y. Sample size calculation guide - Part 4: How to calculate the sample size for a diagnostic test accuracy study based on sensitivity, specificity, and the area under the ROC curve. Adv J Emerg Med 2019;3:e33.