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Research Article

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Improving Stroke Alert Accuracy within a Community Hospital Setting: Use of the TeleStroke Mimic Score

Bertrand Liang MD PhD[1,2*]

[1]Department of Neurology, Penrose Hospital, Colorado Springs, CO
[2]Department of Neurology, University of Colorado Anschutz School of Medicine, Aurora CO.

[*]**Corresponding author:** 2222 N. Nevada Ave., Suite 5001, Colorado Springs CO 80907; ph.719-776-3580; fax 719-776-3599; Email: Bertrand.liang900@commonspirit.org

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Abstract

Background and Purpose: *Stroke alerts are used to quickly identify patients who may be experiencing stroke. However, there are diseases mimicking stroke. This study's goal was to evaluate accuracy of stroke alerts, elucidate main mimics, and determine if the telestroke mimic (TM) score could improve accuracy of stroke diagnosis in a community hospital.*

Methods: *A stroke database retrospective evaluation assessed accuracy of stroke alerts, identifying stroke diagnosis both on the inpatient wards and separately in the emergency department (ED). Subsequently, a similar re-analysis of the stroke alert database for accuracy of stroke alerts was performed utilizing the TM score, where a score ≥18 created a stroke alert, with lower scores not activating a stroke alert.*

Results: *Stroke alerts were evaluated from 1 Jan 2023 to 31 March 2024. Inpatient, 206 stroke alerts were recorded, with 288 in ED. Stroke diagnostic accuracy was 21% in the former, and 31% in the latter. Toxic metabolic encephalopathies were the most common mimic inpatient; migraine and seizures were most frequent in ED. When re-analyzed using the TM score, stroke alerts decreased to 100 for inpatients and 135 for ED patients. Diagnostic accuracy improved to 72% for inpatients, and 79% for ED patients. Sensitivity of the TM score for stroke diagnosis was 100% and 93% for inpatients and ED patients, respectively.*

Conclusions: *Stroke mimics represent a significant burden in the community hospital. Utilization of TM score, along with additional education, may improve upon diagnosis and evaluation of patients with stroke and stroke mimics.*

Keywords: *stroke, stroke mimic, telestroke mimic score, stroke scales.*

Introduction

Stroke represents both a potentially devastating emergent clinical scenario and one where medical and endovascular approaches have revolutionized approaches and outcome. However, the emphasis toward revascularization has created an emphasis on quick decision making to best minimize damage to a potentially ischemic brain. Indeed, the creation of a stroke alert system, similar to that used in the assessment of patients with potential ischemic heart disease, has become a rapid response in most hospitals ("stroke alert").

The difficulty within this rubric is the emphasis of utilizing the stroke alert mechanism to assess for a myriad of symptoms that may not relate to an ischemic nervous system. While many stroke alerts are called by field emergency medical services (EMS), a certain percentage are manifest inside hospitals on the floors, as well as within the emergency department (ED). A given percentage of these patients will be "stroke mimics" (SM), i.e. non-stroke patients who have been initially diagnosed with stroke. Recent reviews [1,2] have suggested such SM may account for up to 30% of patient diagnosis and up to 17% may be treated with thrombolytics [3,4].

In our hospital, stroke alerts may be activated by any individual believing there is a stroke ongoing. We sought to evaluate the SM fraction of these activations and determine the most frequent final diagnoses of such patients, both on the ward and in the emergency department. We also investigated the use of the telestroke mimic score [5] (TM) in discriminating those patients who were SM versus those suffering from a stroke, to assess whether such a score would improve the accuracy of a stroke alert diagnosing a stroke within the inpatient and ED settings.

The TM score was created for use in teleneurology to aid in evaluation of patients by electronic means. In particular, the TM score was developed to provide a guide toward providing an index suggesting the likelihood of ischemic disease. There are several components of the TM score: age multiplied by 0.2, history of atrial fibrillation (+6), history of hypertension (+3), history of seizures (-6), presence of facial droop (+9), and NIH stroke score greater than 14 (+5). Adding these together provides an overall score, with higher scores indicative of a higher chance of stroke, and a lower score with a less likelihood of stroke. The score has been validated in multiple studies [3,4,6], and the sensitivity has further been defined [3]. Herein, we evaluated a static score calculated from previous studies in the literature [3] in order to simplify the evaluation of the TM score to model use in stroke alerts. The Mayo Clinic experience demonstrated high sensitivity to the diagnosis of stroke when scores were ≥23, and a high specificity, namely of a SM, when scores were ≤10. We utilized a score of ≥18 as a threshold suggesting the diagnosis of stroke evaluation (i.e. effecting a stroke alert), with a score of <18 evaluated as a SM (viz. not as a stroke alert) on a retrospective basis, with determination of accuracy of stroke alerts in this context.

Methods and Data Analysis

All patients who were subject to a stroke alert are captured in a database local to Penrose Hospital, a community hospital in Colorado Springs, Colorado USA, required as a Stroke Center by the Joint Commission. A retrospective analysis of the stroke alert database at this hospital was conducted from 1 January 2023 to 31 March 2024, of patients subject of a stroke alert. Included patients were those whom: (1) were greater than 18 years of age; (2) identified as a stroke alert patient on the wards or in the emergency department at the time of the alert; and (3) were followed in our hospital and not transferred to another facility (where records would not be available). An SM was defined as a stroke alert which did not result in the diagnosis of stroke. The data was sorted by the location at the time when the stroke alert was activated, either on the inpatient wards, or within the emergency department (ED).

Stroke alerts at our hospital are associated with a neurologist evaluation, CT/CT angiogram imaging examination typically, and CT perfusion study evaluation if judged to be necessary. An MRI scan is also obtained in virtually every patient after initial evaluation. Patients were followed by the neurology service subsequently, allowing for final diagnoses. Documentation in the electronic medical record was available for patient analysis to discern clinical characteristics, which were recorded using nonpatient name identifiers; subsequent to raw data collection, all use identifiers were destroyed thus not allowing any path to the original stroke data set patient names.

This data analysis used Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, IBM Corp., Version 27.0, Armonk, NY) to calculate descriptive summary statistics (medians). This work was done as part of a quality improvement effort within the hospital, without collection of patient identifiers nor demographics, and as a result not requiring oversight by an institutional review board and was considered a quality assurance activity as per DHHS regulations.

Results

Patients

Patients were accessed between 1 January 2023 to 31 March 2024. Within the stroke database, a total of 531 patients were identified to have had a stroke alert activation either in the ED or within the hospital wards. Of these, 230 were inpatients and 301 were within the ED. For inpatients, exclusions included no alert/cancelled (n=7), inadvertent ED patient (n=11), and duplicate (n=6); for ED patients, exclusions included not an ED patient (n=2), duplicate (n=5), outside hospital alert (n=1), patient left against medical advice (n=3), alert cancelled (n=1) and care transferred (n=1). The total number of ward patients thus analyzed was 206, and that for the ED was 288. Figure 1 summarizes these patient exclusions.

Figure 1. Stroke alert database: patients analyzed

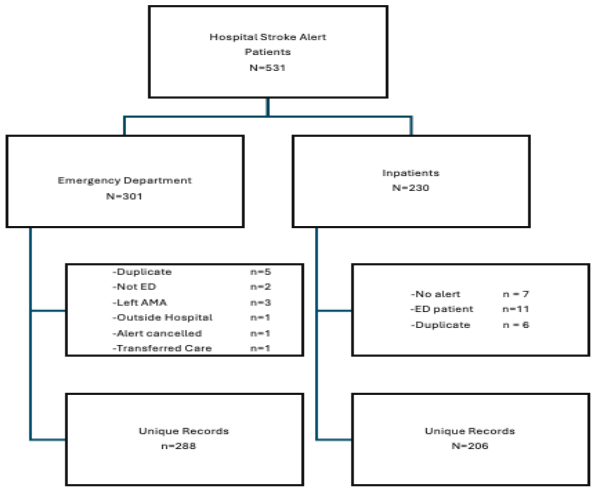

Figure 1: Inclusion of patients analyzed.

Table 1 shows the clinical characteristics of the patients when a stroke alert was activated. In general, these patients were similar to those noted in other studies (see Pohl et al. [1] and references therein). The median NIH stroke score (NIHSS) in ward patients was 6, while in the ED it was 5. Hypertension was frequent in our patient population, representing 60% in both the inpatient (n=123) and ED (n=174) groups. Atrial fibrillation was present in 24% of the inpatient group (n=50), and 17% (n=48) of the ED patients. Fifty five percent (n=114) of inpatients were males, with a median age of 72 (28-94) years; corresponding data in the ED patients was 48% (n=138) and 68 (22-96) years.

Table 1: Database Clinical Characteristics.

	Inpatients (n=206)	**Emergency Department** (n=288)
Median NIHSS	6 (0-35)	5 (0-36)
Median Age	72 (28-94) yrs	68 (22-96) yrs
Males	114 (55%)	138 (48%)
Atrial fibrillation	50 (24%)	48 (17%)
Hypertension	123 (60%)	174 (60%)

Stroke Alert Accuracy

We first examined stroke alert accuracy, evaluating the frequency of activation with a diagnosis of stroke. In our hospital 43/206 (21%) stroke alerts from the inpatient units, including the inpatient floors and the ICUs, resulted in the diagnosis of stroke, with 162/206 (79%) being considered SM. Similarly, 88/288 (31%) patients' resident in the ED when a stroke alert was activated were ultimately diagnosed with stroke, and 200/288 (69%) were considered SM. To be clear, these were stroke alerts activated in the ED, rather than in the field by EMS.

Stroke Mimic Diagnosis

Table 2 shows the most frequent SM diagnosis in ward patients and those patients resident in the ED. Interestingly, the ultimate diagnosis of SM from the inpatient units was different than that of the ED. The vast majority of SM on the ward was toxic metabolic encephalopathy (n=60, including sepsis), with the incidence triple that of the next most frequent diagnosis, seizures (n=20). Migraine (n=7), hypotension (n=7) and psychiatric disease (n=6) followed in frequency.

In contrast, in the ED, migraine (n=24), vertigo (n=21) and psychiatric disease (n=21) were the most frequent SM diagnoses, with hypertensive urgency/encephalopathy (n=18) and seizures (n=17) numerous as well in the ED cohort.

Table 2: Stroke Mimic Top Diagnoses

A. Inpatient

Diagnosis	N
Toxic metabolic encephalopathy	60
Seizure	20
Migraine	7
Hypotension	7
Psychiatric disease	6

B. Emergency Department

Diagnosis	**N**
Migraine	24
Vertigo	21
Psychiatric disease	21
Hypertensive urgency/encephalopathy	18
Seizure	17

TM score evaluation

TM score was calculated from the clinical characteristics obtained from the electronic medical record. Subsequently, evaluation of stroke alert frequency, SM diagnoses, and sensitivity and specificity of the score in the stroke alert database was determined. Using the TM score and the threshold score of 18, the number of alerts decreased in both inpatient and ED clinical settings. On the inpatient side, the number of stroke alerts decreased from 206 to 100, and for ED patients, stroke alerts decreased from 288 to 135 when evaluated with the TM score (Figure 2A).

Figure 2. Diagnostic accuracy and number alerts with/without TM score

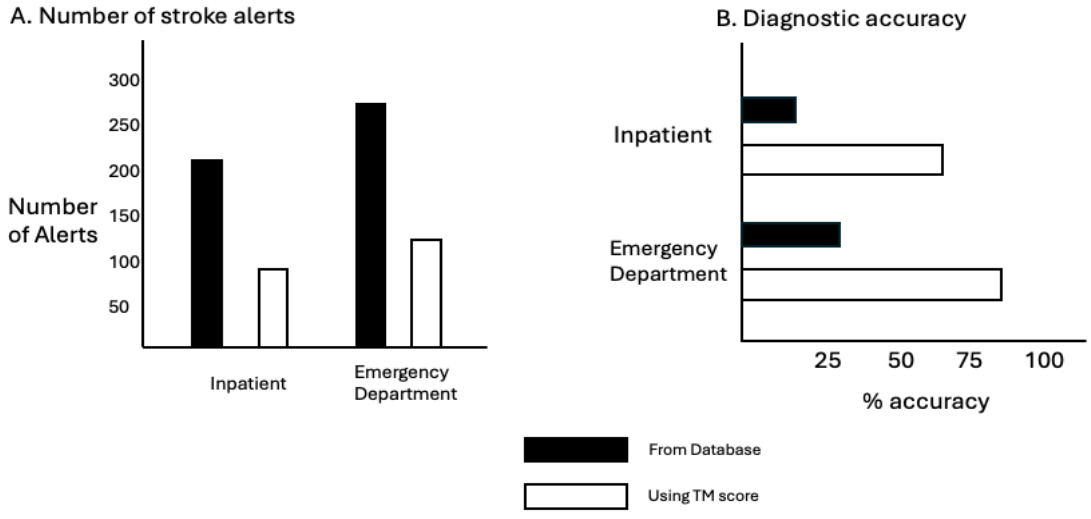

Figure 2: (A) Improved diagnostic accuracy of patients from the stroke database, with subsequent analysis using the telestroke mimic score. (B) Decline in number of stroke alerts with use of the telestroke mimic score.

Moreover, there was a change in the clinical characteristics of those with SM compared to the non-differentiated stroke alert with the TM score. Table 3 shows these data, and Figure 2B shows a change in diagnostic accuracy and number of stroke alerts. Overall, the accuracy of diagnosis improved for stroke and stroke mimics, to 72% (148/206) for inpatients, and 79% (228/288) for ED patients. The most frequent SM after use of the TM score continued to be toxic metabolic encephalopathy for inpatients, with hypertensive urgency/encephalopathy being the most frequent SM in the ED. Ward patient most frequent SM diagnosis also included congestive heart failure (n=4), seizures (n=3), stroke recrudescence (n=3) and psychiatric disease (n=3). For ED patients, subsequent diagnosis for SM with the TM score evaluation included vertigo (n=6), toxic metabolic encephalopathy (n=6), stroke recrudescence (n=4) and Bell's Palsy (n=4).

Table 3: Stroke Mimic Top Diagnosis with TM Score*

Inpatient	Emergency Department
Toxic metabolic encephalopathy (24)	Hypertensive urgency/encephalopathy (7)
Congestive Heart Failure (4)	Vertigo (6)
Seizures (3)	Toxic metabolic encephalopathy (6)
Stroke recrudescence (3)	Stroke recrudescence (4)
Psychiatric disease (3)	Bell's Palsy (4)
*TM score >18, stroke not detected; number in parentheses are numbers of patients.	

Importantly, the sensitivity of the TM score was high. When evaluated on the ward, the TM score had a sensitivity of 100% of detecting those with ischemic disease, with no strokes missed using the score. Not unexpectedly, the specificity was lower, at 71%. Similarly, within the ED, using the TM threshold score of 18 demonstrated 93% sensitivity to detect stroke. In this group, 6 (7%) strokes were misdiagnosed as other entities. Interestingly, these types of strokes included an internal carotid artery occlusion in a patient with severe mucormycosis, a bilateral thalamic stroke in a patient with occluded artery of Percheron, a retinal artery branch occlusion, pontine punctate stroke, a small posterior fossa subarachnoid hemorrhage, and a multifocal stroke secondary to a hypercoagulable syndrome. Unusual comorbidities and/or clinical scenarios show clinical judgement continues to be relevant within the context of the scoring system. Specificity, like that in the inpatient experience, was lower, at 74%.

Discussion

The potential for stroke diagnosis as a treatable medical emergency has resulted in the emphasis on prompt diagnosis and workup in a myriad of clinical settings. Stroke alerts have been a manifestation of such emphasis, to provide expeditious management and treatment of such patients, particularly with the advances in both medical and endovascular approaches currently within the armamentarium of the stroke team.

However, there have been various studies showing the growing pragmatic concern of those diagnoses which do not represent ischemic disease. These represent a significant issue, from potential treatment using ischemic stroke medications, to further workups for vascular etiologies as well as interventions on vascular risk factors, representing a time and effort cost versus more appropriate approaches/treatments.

Moreover, the economic costs are not insignificant, from utilization of infrastructure and personnel which can translate to millions of dollars [8]. Indeed, the further expense when considering excess costs of treatment (thrombolysis) of SM patients exceeds that of patients with other neurologic conditions [8]. Finally, the years of additional ambient exposure of patients to radiation, as well as unnecessary tests and procedures, cannot be underemphasized.

We utilized the TM score methodology, and extrapolated a threshold number of 18 to effect stroke alerts using a retrospective approach. We modeled this using the Mayo Clinic data [3] to obtain a positive likelihood value of at least 30% (data not shown). In our study, we opted to evaluate ED versus ward stroke alert as separate categories, as our anecdotal experience suggested differences in diagnoses seen overall. Indeed, we observed diverse patient diagnoses in these cohorts, with toxic metabolic encephalopathies overwhelmingly present as a SM on the inpatient wards. The frequency of toxic metabolic encephalopathy diagnosis may be due to the difficulty in non-neurologist staff's ability to discern a generalized cortical dysfunction to the usual localizing signs of ischemic brain, and/or the rubric of "altered mental status" as a mistaken etiology of acute stroke. Other studies have documented similar results [1,9,10] with recommendations of detailed serum evaluations as well as bedside toxicology for assessment. Seizures have also been well described as a SM, and appropriate history is paramount in avoiding confusing epileptiform activity/postictal states as strokes [11-13]. A recent study demonstrated migraine as a significant SM diagnosis, representing approximately 10% of SM [14]. Again, emphasis on addressing gaps and training and more comprehensive education was suggested; potentially adding migraine as a consideration for ED patients has also been proposed [1,14]. Finally, hypotension and psychiatric disease have also been previously described as SM [1,15]. Careful documentation of both static and orthostatic blood pressure are key to avoid an SM diagnosis in the former; experience in the examination of patients, with the understanding of characteristics of psychogenic presentation (e.g. previous psychiatric disease, atypical/fluctuating symptoms, inconsistent physical examination findings) can aid in assessment of these diverse types of patients.

In the ED, the SM diagnoses were more varied. Interestingly, migraine continues to be a diagnosis for which stroke alerts were activated, despite most ED providers having significant experience. This may relate to our hospital policy of universal availability of stroke alerts for any personnel and requires further evaluation. Vertigo was also a primary SM, noted in a number of different studies [16-18]. Indeed, several commentaries in the literature specifically address vertigo as SM, and document tangible clinical exam evaluations to discern central versus peripheral sources of symptoms [1,18], which

document high sensitivity (100%) and specificity (96%) for stroke. Similar to the ward experience, psychiatric disorders and seizures were also frequent SM. Nonetheless, the TM threshold score seemed to be able to discriminate stroke versus SM at least some patients with migraine, psychiatric disease and hypertensive urgency/encephalopathy in the ED environment.

In our hospital, hypertensive urgency/encephalopathy was a frequent SM. In these cases, the typical manifestation was a significantly elevated blood pressure, usually greater than 200/100 which was associated with altered mental status without localizing neurologic signs in most cases. In every event, reduction of blood pressure was associated with recovery to baseline. The frequency noted in our hospital may reflect a local environmental issue, as this has not been previously reported in other reviews [1,2,7]. This may also reflect the lack of knowledge from the ED providers on the nature of this clinical scenario, a lack of training of staff, a novel observation manifest as SM, or combination of these factors. Further evaluation is warranted in subsequent studies.

The low accuracy of stroke alerts within our hospital afforded an opportunity to evaluate an approach to improve on the diagnosis of SM. With the policy to allow any individual to affect a stroke alert, in comparison our accuracy was significantly below that reported in the literature, where a comprehensive review showed an SM rate of about 25% when examining 61 studies [1], compared to 69-79% found in our evaluation. Utilizing the TM score approach, we devised a static score where we simulated activating a stroke alert with a score of 18 and above, and determined sensitivity, specificity, number of strokes missed, and SM diagnoses resultant from this approach.

Using the TM score, the number stroke alerts decreased substantially, both inpatient and in ED patients. Despite this, the sensitivity of detecting a stroke was still high–100% in the inpatient arena, and 93% within the ED. Like the NIHSS, the bias of the TM score is more towards anterior circulation strokes–nonetheless almost all strokes were detected and the small amount that were not represented atypical syndromes where imaging would have been obtained in any event. As well, the diagnosis of SM was interesting in the TM score adjudicated groups. Toxic metabolic encephalopathy continued to be frequent, but now was found both inpatient and within the ED. This tended to be older patients, where a large proportion of the TM score was driven by age. As well, stroke recrudescence (an amnestic stroke syndrome) also became apparent as a more frequently observed SM, most likely due to a combination of age as well as localizing symptoms. Recommendations to assess these patients has revolved around CT perfusion and diffusion weighted and ADC MRI imaging [1,7,13] but such modalities – particularly MRI - often are not available within the context of emergent evaluation. Nonetheless, within the aspects of this study, the TM score had high sensitivity, specificity, and reduced the number of stroke alerts with minimum strokes missed.

In one other extensive study evaluating stroke mimic scores, particularly on the inpatient setting, Sari et al. [19] found limited efficacy in evaluating various stroke scales (including TM) for SM within the inpatient environment. The hospital type was different than our community hospital setting, with their study being at an academic medical center in a large city (Chicago), staffed by residents in training, rather than a particular staff of providers. As well, the context of use of static scores was not evaluated. Moreover, that hospital was highly specialized; indeed, risk factors associated with stroke included cardiovascular procedures and thrombocytopenia, as well as more standard localizing findings such as gaze deviation and leg weakness. Further evaluation in different settings will be needed to investigate these discrepancies.

The limitation of this study revolves around the retrospective nature of the evaluation, as well as being a single institution assessment. Further, all charts were reviewed by single examiner, and reflected reported clinical characteristics reported and seen in the electronic medical record. Nonetheless, the evaluation utilized a consistent documentation format, as well as ongoing follow-up by the neurology service. The ability to discern the components of the TM score was readily available. However, any generalizability of results will require a prospective study utilizing the TM score, the threshold value, and determination of subsequent outcomes.

Conclusion

We found the incidence of SM to be very high in our cohort of inpatients and patients' resident in the ED when stroke alerts were activated. Utilizing the TM score with a threshold value of 18 to effect a stroke alert, the accuracy of the diagnosis of stroke and stroke mimics increased, with the number of stroke alerts decreasing, with excellent sensitivity to detect stroke. Use of the TM score in concert with additional training and education of staff may provide better accuracy with decreased resource utilization in the diagnosis and treatment of stroke.

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Author contributions: BCL conceived, collected data, and wrote all versions of the manuscript.

Statements and Declarations:

Ethical considerations: This work was done as part of a quality improvement effort within the hospital, without collection of patient identifiers nor demographics, and as a result not requiring oversight by an institutional review board and was considered a quality assurance activity as per DHHS regulations.

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References

1. Pohl M, Hesszenberger D, Kapus K et al. Ischemic stroke mimics: A comprehensive review. *J Clin Neurosci* 2021, 93:174-182. doi: 10.1016/j.jocn.2021.09.025.
2. Buck BH, Akhtar N, Alrohimi A, Khan K, Shuaib A. Stroke mimics: incidence, etiology, clinical features and treatment. *Ann Med* 2021, 53:420-436. doi: 10.1080/07853890.2021.1890205.
3. Carlin R, Zhang N, Demaerschalk BM. Validation of the Telestroke Mimic Score in Mayo Clinic population. *J Stroke Cerebrovasc Dis* 2021, 30:106021. doi: 10.1016/j.jstrokecerebrovasdis.2021.106021.
4. Asaithambi G, Castle AL, Sperl MA et al. Thrombolytic treatment to stroke mimic patients via telestroke. *Clin Neurol Neurosurg* 2017, 153:5-7. doi: 10.1016/j.clineuro.2016.12.007.
5. Ali SF, Viswanathan A, Singhal AB et al. The Telestroke Mimic(TM)-Score: A Prediction Rule for Identifying Stroke Mimics Evaluated in a Telestroke Network. *J Am Heart Assoc* 2014, 3:e000838. doi: 10.1161/JAHA.114.000838.
6. Ali SF, Hubert GJ, Switzer J et al. Validating the Telestroke Mimic (TM) Score: A Prediction Rule for Identifying Stroke Mimics Evaluated over Telestroke Networks. *Stroke* 2018, 49:688-692. doi: 10.1161/strokeaha.117.018758.
7. Tu TM, Tan GZ, Saffari SE et al. External validation of stroke mimic prediction scales in the emergency department. *BMC Neurology* 2020, 20:269. doi: 10.1186/s12883-020-01846-6.
8. Liberman AL, Choi H-J, French DD, Prabhakaran S. Is the Cost-effectiveness of Stroke Thrombolysis Affected by Proportion of Stroke Mimics? *Stroke* 2019, 50:463-68. doi: 10.1161/strokeaha.118.022857.
9. Wareing W, Dhotore B, Jahawish K. Hyponatremic encephalopathy: an unusual stroke mimic. *BMJ Case Rep* 2015, 2015(jan23 2) bcr201 4207397.
10. Arokszallasi T, Balogh E, CsibaL, Fekete I, Feket K, Olah L. Acute alcohol intoxication may cause delay in stroke treatment – case reports. *BMC Neurol* 2019, 19:14. doi: 10.1186/s12883-019-1241-6.
11. Tobin WO, Heitz JG, Bobrow BJ, Demaerschalk BM. Identificaionof strok mimics in the emergency department setting. *J Brain Dis* 2009, 1:19-22. doi: 10.4137/jcnsd.s2280
12. Feher C, Gurdan Z, Gombos K, Koltai K et al. Strokes: mimics and chameleons. *Pract Neurol* 2013, 13:21-8. doi: 10.1016/j.jocn.2021.09.025
13. Hedna VS, Shukla PP, Waters MF. Seizure Mimicking Stroke: Role of CT Perfusion. *J Clin Imaging Sci* 2012, 2:32. doi: 10.4103/2156-7514.97728.
14. Farid A and Naqvi A. The Burden of Stroke Mimics Among Hyperacute Stroke Unit Attendees with Special Emphasis of Migraine: A 10-year Evaluation. *Cureus* 16(5): e59700. doi: 10.7799/cureus.59700.
15. Jones AT, O'Connell NK, David AS. Epidemiology of functional stroke mimic patients: a systematic review and meta analysis. *Eur J Neurol* 2021, 27:18-26. 10.1111/ene.14069.
16. Atzema CL, Grewal K, Lu H, Kapral MK, Kulkarni G, Austin PC. Outcomes among patients discharged from the emergency department with a diagnosis of peripheral vertigo. *Ann Neurol* 2006, 79:32-41. doi: 10.1002/ana.24521
17. Saber Tehrani AS, Kattah JC, Kerber KA et al. Diagnosing Stroke in Acute Dizziness and Vertgo: Pitfalls and Pearls. *Stroke* 2018, 49:788-95. doi: 10.1161/STROKEAHA.117.016979
18. Kattah JC, Talkad AV, Wang DZ, Hsie Y-H, Newman-Toker DE. HINTS to Diagnose Stroke in the Acute Vestibular syndrome. *Stroke* 2009, 40:3504-10. doi: 10.1161/strokeaha.109.551234.
19. Sari A, Saley Velez FG, Muntz N, Bulwa Z, Prabhakaran S. Validating Existing Scales for Identification of Acute Stroke in an Inpatient Setting. *Neurohospitalist* 2023, 13: 137-143. doi: 10.1177/19418744221144343.