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Research Article

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# Use of the Telestroke Mimic Score to Improve Stroke Alert Accuracy Outside the Community Hospital

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## Abstract

***Background and objectives:*** *Stroke represents a devastating diagnosis which has prompted significant efforts to mitigate the time brain is exposed to ischemia, including the activation of stroke alerts to expeditiously evaluate patients. However, there are a number of diseases that mimic stroke symptoms. The goal of this study was to evaluate the accuracy of stroke alerts, elucidate the main mimics, and determine if using the telestroke mimic (TM) score could improve accuracy of stroke diagnosis outside of the community hospital setting.*

***Material and methods:*** *A retrospective evaluation of the stroke database was assessed to determine the accuracy of a stroke alert identifying a stroke diagnosis by emergency medical services (EMS) prior to entering into the emergency department of a community hospital. Stroke mimics were assessed with regard to primary diagnoses. Subsequently, a similar re-analysis of the stroke alert database for accuracy of stroke alerts was performed utilizing the TM score, where a score $\geq$18 created a stroke alert, with lower scores not activating a stroke alert.*

***Results:*** *All stroke alerts were evaluated from 1 Jan 2023 to 31 December 2023. In this period, 316 stroke alerts were activated by EMS. Stroke diagnostic accuracy was 45% with mimics representing 55% of activated alerts. When analyzed in this way, toxic metabolic encephalopathies were the most common mimic, with seizures and psychiatric diseases following. When re-analysed using the TM score, stroke alerts decreased from 316 to 194. Overall diagnostic accuracy improved to 84%. Sensitivity of the TM score for stroke diagnosis was 99.3%, with specificity of 71%. The most frequent mimic diagnosis using the TM score continued to be toxic metabolic encephalopathy, with stroke recrudescence and seizures also being frequently diagnosed.*

***Conclusions:*** *Stroke mimics represent a significant burden in the community prior to entering into the hospital environment. Utilization of the TM score, along with additional education and training of staff, may improve upon the 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, like that used in the assessment of patients with potential ischemic heart disease, has become a rapid response in most hospitals ("stroke alert").

The difficulty is the emphasis of utilizing the stroke alert mechanism to assess for a myriad of symptoms not relating to an ischemic nervous system. In the field outside the hospital environment, emergency medical services (EMS), is the primary service who evaluates and activates these stroke alerts prior to arriving to the hospital setting in preparation of the emergency department (ED) for patient assessment. 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].

EMS personnel are trained in a variety of assessment tools for the evaluation of patients who may have ischemic disease. However, despite this, there is little information on the accuracy of stroke alerts in the field once arriving to the ED. We sought to evaluate the SM fraction of these activations and determine the most frequent final diagnoses of such patients. Moreover, 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 in the community environment setting.

The TM score was created for use in teleneurology to aid in evaluation of patients by electronic means and 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] to simplify the usage and evaluation of the TM score as a model activating stroke alerts. 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.

## Materials and Methods

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 December 2023, of patients subject of a stroke alert activated in the field prior to arriving to the hospital. Included patients were those whom: (1) were greater than 18 years of age; (2) identified as a stroke alert patient prior to arrival to 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.

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 at 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*

Within the stroke database, a total of 330 patients were identified to have had a stroke alert activation by EMS outside the hospital. Exclusions included non-EMS activation (n=9), and patients who were transferred (n=5), leaving 316 unique patients.

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 [1]. The median NIH stroke score (NIHSS) was 5 (range 0-40). Median age was 74 years (range 29-94), with 74 (45%) being men. Atrial fibrillation was present in 50 (19%) with hypertension in 175 (55%).

**Table 1:** Database Clinical Characteristics.

| | |
|---|---|
| Median NIHSS | 5 (0-40) |
| Median Age | 74 (29-94) yrs |
| Males | 141 (45%) |
| Atrial fibrillation | 50 (19%) |
| Hypertension | 175 (55%) |

### *Stroke Alert Accuracy*

We first examined stroke alert accuracy, evaluating the frequency of activation with a diagnosis of stroke. At our hospital 143/316 (45%) stroke alerts from EMS resulted in the diagnosis of stroke, with 173 (55%) being considered SM.

### *Stroke Mimic Diagnosis*

Table 2 shows the most frequent SM diagnosis in patients arriving to the ED for whom a stroke alert had been activated by EMS. The vast majority of SM was toxic metabolic encephalopathy (n=39, including sepsis/hypoxia). Seizures (n=21) were the next most frequent diagnosis, with psychiatric disease (n=11) the third most frequent, followed by migraine (n=9) and vertigo (n=9).

**Table 2:** Stroke Mimic Top Diagnoses.

| **Diagnosis** | **N** |
|---|---|
| Toxic metabolic encephalopathy (including sepsis, hypoxia) | 39 |
| Seizure | 21 |
| Psychiatric disease | 11 |
| Migraine | 9 |
| Vertigo | 9 |

### *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. From the EMS field assessments, the number of stroke alerts decreased from 316 to 194 (Figure 1).

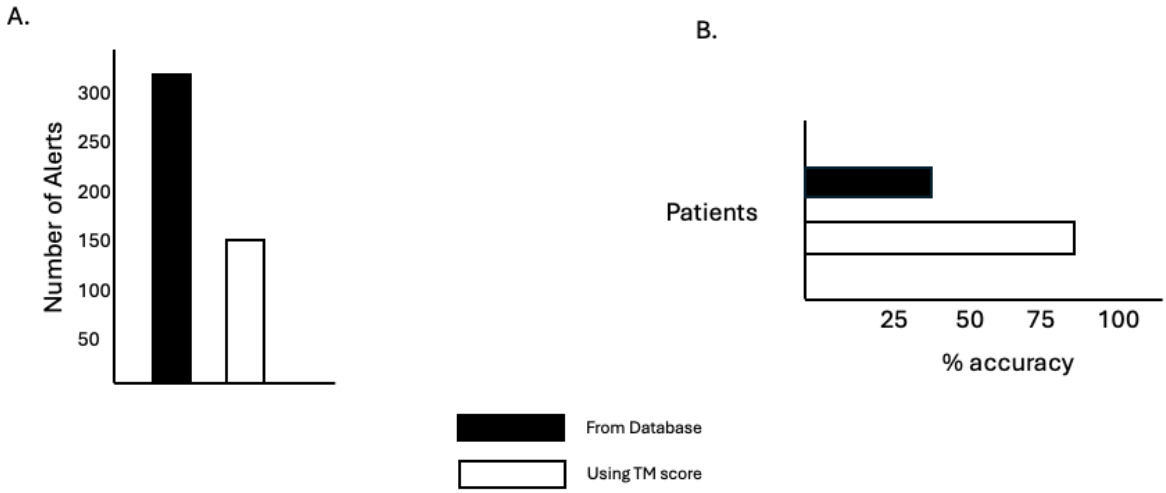


**Figure 1: (A)** Number of stroke alerts declined with use of the telestroke mimic score, from 316 to 194. **(B)** Diagnostic accuracy of patients from the stroke database, with subsequent analysis using the telestroke mimic score revealed overall accuracy increased from 46% to 84%.

Moreover, there was a change in the clinical diagnoses of those with SM compared to the non-differentiated stroke alert with the TM score. Table 3 shows these data, and Figure 1 shows a change in diagnostic accuracy and number of stroke alerts. Overall, the accuracy of diagnosis improved for stroke and stroke mimics, to 84% (265/316). The most frequent SM after use of the TM score continued to be toxic metabolic encephalopathy (n=15), stroke recrudescence (amnestic stroke syndrome) (n=5) being the next most frequent along with seizures (n=5). Psychiatric disease and substance abuse were the next most frequent diagnoses (n=4 apiece).

**Table 3:** Stroke Mimic Top Diagnosis with TM Score*

| |
|---|
| Toxic metabolic encephalopathy (15) |
| Stroke recrudescence (5) |
| Seizures (5) |
| Psychiatric disease (4) |
| Acute substance abuse (4) |

*TM score ≥18, stroke not detected; number in parentheses are numbers of patients

The sensitivity of the TM score was high, with a sensitivity of 99.3% of detecting those with ischemic disease, with one stroke missed using the score. Not unexpectedly, the specificity was lower, at 71%. The patient whose stroke was not anticipated by the TM score was a posterior fossa vertebral artery dissection whose initial blood pressure was significantly elevated, whose symptoms evolved with emergent blood pressure decreases.

## Discussion

Stroke is a treatable medical emergency, and approaches have evolved to take advantage of the advances in medical and endovascular approaches having been shown to improve overall outcomes.

However, with these advances, there have been various studies showing the growing issue of stroke mimics. These can result in inappropriate treatment using ischemic stroke medications for non-stroke indications, to further workups for vascular etiologies as well as interventions on vascular risk factors, which are again not appropriate and do not address the true etiology of the patient pathologies.

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]. We calculate over USD1MM per year of unreimbursed costs for stroke mimics (data not shown). As well, the years of additional ambient exposure of patients to radiation is significant.

We utilized the TM score methodology, and extrapolated a threshold number of 18 to effect stroke alerts using a retrospective approach. We looked to achieve a positive likelihood value of 30% or better, by modelling the Mayo Clinic data [3] where we would maximize the sensitivity to detect stroke, assessing sufficient specificity, to allow for an approximately 3x increased chance of a stroke being present using a given score. By doing this we were able to extract the value of 18 to model.

Toxic metabolic encephalopathy was and is a frequent stroke mimic. A generalized cortical dysfunction can be difficult to address in the field (and in the hospital) compared to the usual localizing signs of ischemic brain to those untrained; moreover, altered mental status has been a frequently 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, and recognition that such global symptoms be not considered a stroke sign. Seizures are a frequent 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 as a criterion of SM for ED patients has also been proposed [1,14]. Psychiatric disease has also been previously described as SM [1,15]. Careful

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 Vertigo was also a primary SM, noted in a number of different studies [16-18]. Indeed, the literature has addressed this with specific clinical exam evaluations to discern central versus peripheral sources of symptoms [1,18], documenting high sensitivity (100%) and specificity (96%) for stroke.

The decreased accuracy in the field of stroke alerts allowed for evaluation of the TM score as a potential way to improve usage of the stroke alert system for diagnosis of stroke and stroke mimics. Notably, a comprehensive review showed an SM rate of about 25% when examining 61 studies [1], compared to 55% found in our evaluation. Utilizing the TM score, the number stroke alerts decreased substantially. With this, we found a high sensitivity to detect stroke, at 99.3%, and an increase in accuracy of overall diagnosis of stroke and stroke mimic of 84%. With this was an accompanying decrease in stroke alerts, declining to 194 from 316. Such a decline allows for a much better utilization of resources by the ED, as well as the infrastructure within the hospital setting once the patient arrives. Such resource utilization improvements allow for diminished real and opportunity costs for the hospital environment, as well as in the EMS field setting.

As well, the diagnosis of SM was interesting in the TM score adjudicated groups. Toxic metabolic encephalopathy continued to be frequent. 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.

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 patients with a pre-hospital EMS stroke alert activation prior to arriving in the ED. 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.