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ORIGINAL ARTICLES

Clinical predictors of an acute stroke Vs. stroke mimic among code stroke patients: A single center retrospective study

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Abstract

Background & Objective: There is an increasing rate of stroke mimics being identified in code stroke pathways, which adds to hospital staff workload and increased financial costs for patients. This study aims to identify clinical predictors that distinguish a true acute stroke from a stroke mimic in code stroke cases and to determine which neurological signs and symptoms are more strongly associated with a confirmed stroke diagnosis. *Methods:* A single-center retrospective cross sectional descriptive study was conducted among code stroke patients seen in the Makati Medical Center emergency room from January 2024 to December 2024. Clinical history, baseline characteristics, neurological symptoms, and neurological signs were collected and compared between patients with acute strokes and stroke mimics. *Results:* A total of 209 patients (66.77%) were true acute strokes and 104 patients (33.23%) were stroke mimics. Hypertension, Type 2 Diabetes Mellitus, and Atrial fibrillation were more frequently observed in true acute strokes, while a history of epilepsy and psychiatric disorder were more frequently observed in stroke mimics. Dysarthria, hemiparesis, and facial asymmetry, were significant predictors of a true stroke diagnosis. While symptoms of seizure like movements, sensory deficits in one arm or one leg, and loss of consciousness were significantly associated with stroke mimics.
Conclusions: This study highlights the high prevalence of stroke mimics in code stroke activations and reinforces the diagnostic value of key neurologic signs and symptoms that are associated with a true stroke. Incorporating evidence-based screening tools like FAST into stroke pathways may help reduce mimic cases and ease the burden on hospital resources.

Keywords: Stroke mimic, code stroke protocol, acute ischemic stroke, predictors

INTRODUCTION

Stroke remains to be one of the leading causes of mortality in the Philippines accounting for about 14% of total deaths, and is one of the leading causes of disability.[1] The use of recombinant tissue plasminogen activator (RTPA) in the management of acute ischemic stroke became available in the year 1999, and since then was considered a gold standard in the treatment of acute stroke in the Philippines, and must be given within the first 3 to 4.5 hours from onset of stroke symptoms.[2]

Due to the time sensitive nature of RTPA, a code stroke clinical pathway was adapted by many hospitals to help streamline the identification and management of acute ischemic stroke and decrease treatment delays. This pathway begins with early identification of stroke symptoms in the ER/ hospital ward, prompt initiation of neuroimaging, administration of RTPA for eligible patients, and has bee successful in shortening treatment delays in many hospitals.[3,4]

Although the code stroke system offers significant advantages in minimizing treatment delays, research indicates a high rate of stroke mimics among these cases.[5] This points to a low diagnostic yield for certain code stroke protocols in use. Additionally, the rising number of false code stroke calls may further contribute to burnout among physicians and healthcare workers, as well as impose an increased financial burden on patients.[6,12]

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The study aims to determine the specific signs and symptoms encountered during code stroke activations and identify which are more correlated with an acute ischemic stroke. This will help provide data to minimize activation of code stroke pathways on "stroke mimic patients" and increase the diagnostic yield of code stroke systems in detecting thrombolysis eligible patients

Objectives

The general objective are to determine the predictors of an acute stroke vs. code stroke diagnosis based on clinical signs and symptoms among code stroke (Neuro Response Team) patients in a single tertiary center in the Philippines

The specific objectives are:

1.) Identify the frequency of the different types of strokes seen among code stroke calls made in the emergency department of a single tertiary center (Acute ischemic stroke, transient ischemic attack, intracerebral hemorrhage, subarachnoid hemorrhage, stroke mimic)
2.) Identify the type and frequency of stroke mimics seen among Code stroke calls in the Emergency Room
3.) Analyze the predictive relationship between specific neurologic symptoms and the likelihood of diagnosing acute ischemic stroke compared stroke mimic diagnoses among patients assessed in the code stroke protocol
4.) Analyze the predictive relationship between neurologic signs based on items in the NIHSS scale and the likelihood of diagnosing acute ischemic stroke compared to stroke mimics among patients assessed in the code stroke protocol

METHODS

The study is a single-center retrospective cross sectional descriptive study done among patients presenting with stroke-like- signs and symptoms seen in the emergency department. Demographic data such as age, sex, comorbidities, and clinical signs and neurologic examination were collected retrospectively from the patients' electronic medical health records, from the period of January 2024 to December 2024.

All adults aged 18 years old and above who consulted the emergency department with stroke-like symptoms within 4.5 hours of onset, for which a neuro response team (code stroke) was activated, were included in this study. Patients with incomplete medical data, pediatric patients, and patients who were discharged against medical advice or transferred to a hospital of choice were excluded.

The study site is a JCI accredited stroke ready hospital in Makati City, Metro Manila, Philippines. The hospital's code stroke team, known locally in the institution as "Neuro Response Team", is composed of a team of neurology residents, radiology technicians, pharmacists, nursing, and paramedical staff, who are called on to the emergency department upon assessment of the emergency department officer for a possible acute stroke patient presenting within 4.5 hours of symptom onset. The following criteria are used by the emergency department officer to activate a neuro response team call: A patient presenting in the ED within 4.5 hours with the following warning signs or symptoms: 1.) Sudden numbness or weakness of the face, arm or leg, especially in one side of the body 2.) Sudden confusion, trouble speaking, or understanding 3.) Sudden trouble seeing on one of both eyes 4.) Sudden trouble walking, dizziness, or loss of balance or coordination 5.) Sudden severe headache with no known cause 6.) First onset seizure.

Upon arrival of the code stroke to the emergency department, A baseline clinical history, neurologic examination, neuroimaging with either CT scan or MRI, and basic labs were done. Diagnosis of a stroke mimic or true stroke was ascertained by the attending neurologist. A stroke was defined as a vascular neurologic disease characterized by a sudden onset of focal neurologic deficit, secondary to blockage of an artery or vein, or secondary to rupture of an artery/aneurysm/vascular malformation, causing bleeding into the brain parenchyma. This was further subdivided into ischemic strokes, hemorrhagic strokes, and transient ischemic attacks (TIAs). A stroke mimic is a clinical syndrome presenting with stroke-like symptoms for which an alternative diagnosis was ascertained by use of neuroimaging or laboratories.

Neurologic symptoms were designated as the symptoms reported by the patient or the caregiver. The symptoms recorded included : seizure like movements, headache, loss of consciousness, unilateral motor weakness in 1 arm, unilateral motor weakness in 1 leg, sensory loss in 1 arm, sensory Loss in 1 leg, hemiparesis, hemisensory loss, loss of consciousness, dizziness/imbalance, dysarthria, and blurring of vision were the neurologic exam findings as observed by the

Table 1: Baseline characteristics of stroke patients and stroke mimics

	Stroke (n = 209, 66.77%)	Stroke Mimic (n = 104, 33.23%)	p-value
Mean age in years (± SD)	57.56 ± 15.87	53.54 ± 20.81	0.0293
Sex:			
Male	53.11% (n = 111)	40.38% (n = 42)	0.0170
Female	46.89% (n = 98)	59.62% (n = 62)	0.0170
Past medical history:			
Hypertension	56.46% (n = 118)	26.92% (n = 28)	p < 0.00001
Type 2 diabetes mellitus	23.44% (n = 49)	14.42% (n = 15)	0.0314
Atrial fibrillation	10.53% (n = 22)	2.88% (n = 3)	0.0094
Epilepsy	0.48% (n = 1)	3.85% (n = 4)	0.0126
Chronic kidney disease	2.87% (n = 6)	4.81% (n = 5)	0.1894
Previous stroke	17.22% (n = 36)	5.77% (n = 6)	0.0026
Cancer	1.91% (n = 4)	3.85% (n = 4)	0.1539
Smoking history	7.18% (n = 15)	0% (n = 0)	0.0026
Psychiatric disorder	1.44% (n = 3)	5.77% (n = 6)	0.0154
ECG abnormalities	0.96% (n = 2)	0% (n = 0)	0.1587

neurologist on duty, and were based on the components of the NIHSS scale which included: Altered Sensorium, Gaze Palsy, Visual Field defects, upper limb paresis, lower limb paresis, hemiparesis, sensory deficit, aphasia, dysarthria, and neglect.

Data processing and analysis

The samples will be selected through purposive sampling. The estimated population size that fit the inclusion criteria is 500. Using a 5% margin of error, the computed sample size is at least 223. The data analysis consisted of descriptive and inferential statistics. Descriptive statistics were used to describe the demographic and clinical characteristics included cases. Qualitative and quantitative data was numerically expressed as frequencies, proportions, and means ± SD, respectively. The odds ratios of various stroke symptoms and stroke signs in determining stroke disease were calculated.

The study protocol was approved by the hospital's Institutional Review Board. Being a retrospective study, a waiver of informed consent was provided.

RESULTS

There were 313 patients included in the study: 209 patients (66.77%) in the stroke group and 104 patients (33.23%) in the stroke mimic group. The mean age in years ($p = 0.0293$) and the proportion of male patients ($p = 0.0170$) in the stroke group is significantly higher when compared to the other group. The most common comorbidities include hypertension, diabetes mellitus and previous stroke. The most common neurologic symptoms include hemiparesis, dysarthria and loss of consciousness.

The baseline characteristics of the included patients were compared between both groups. The stroke group demonstrated significantly higher proportions of hypertension ($p < 0.00001$), type 2 diabetes mellitus ($p = 0.0314$), atrial fibrillation ($p = 0.0094$), previous history of stroke ($p = 0.0026$), smoking history ($p = 0.0026$) On the other hand, the stroke mimic group exhibited significantly higher proportions of epilepsy ($p = 0.126$), and psychiatric disorder ($p = 0.0154$).

Table 2 above shows a summary of the final diagnoses of the acute strokes and stroke mimics. Among those verified with acute strokes, the majority (49.2%) of the cases were acute ischemic strokes followed by transient ischemic attacks and intracerebral hemorrhage. For the stroke mimics, syncope comprised a bulk of diagnosis, amounting to 24.03 % of all the stroke mimics in the study. This is followed by seizure, encephalopathy, and headache disorders.

Table 3 above summarizes the frequency of neurologic symptoms reported among patients with acute strokes and stroke mimics. The stroke group had a significantly higher proportion of hemiparesis ($p < 0.00001$), hemianesthesia ($p = 0.00003$), facial asymmetry ($p = 0.0087$) and dysarthria ($p < 0.00001$). The stroke mimic group had a significantly higher proportion of seizure-like movements ($p < 0.00001$), loss of consciousness ($p < 0.00001$), and sensory deficit in 1 arm or leg ($p < 0.00001$).

Table 2: Final diagnosis of strokes and stroke mimics

Strokes	**66.77% (n = 209)**
Acute Ischemic Stroke	49.2% (n = 103)
Intracerebral Hemorrhage	23.44% (n = 49)
Transient Ischemic Attack	27.27% (n = 57)
Mimics	**33.23% (n = 104)**
BPPV	2.88% (n = 3)
CNS Infection	0.96% (n = 1)
Encephalitis	1.92% (n = 2)
Encephalopathy	13.46% (n = 14)
Epidural Hematoma	0.95% (n = 1)
Headache	8.65% (n = 9)
Neoplasm	2.88% (n = 3)
Peripheral nerve disorder/radiculopathy	7.69% (n =8)
Seizure	22.12% (n = 23)
Somatization Disorder	7.69% (n = 8)
Syncope	24.03% (n = 25)
Hypertensive Urgency	2.88%(n = 3)
Post-Stroke recrudescence	2.88% (n = 2)
Vertebrobasilar Insufficiency	2.88% (n = 2)

The crude odds ratios of different symptoms that may be attributed to the presence of stroke were obtained, with the corresponding 95% confidence interval and p-values detailed in the table above. Among the variables listed, the presence of hemianesthesia showed the highest odds ratio (10.9709), while the presence of seizure-like movements demonstrated the lowest odds ratio (0.1283). Significant odds ratios were noted in seizure like movements ($p < 0.0001$), loss of consciousness ($p < 0.0001$), hemiparesis ($p < 0.0001$), sensory deficit in 1 arm or leg ($p = 0.0001$), hemianesthesia ($p = 0.0011$), facial asymmetry ($p = 0.0208$) and dysarthria ($p < 0.0001$).

The neurologic signs derived from NIHSS of stroke and stroke mimic patients were also compared. The stroke group showed significantly higher proportions of altered mental status, disorder of eye movement, visual field defect, facial palsy, hemiparesis, aphasia and dysarthria. The stroke mimic group on the other hand had a significantly higher proportion of lower limb monoparesis. The rest of the variables were not significant.

Lastly, the crude odds ratios of neurologic signs that may be attributed to the presence of stroke were obtained, with the corresponding 95% confidence interval and p-values likewise mentioned in the table above. Among the neurologic signs listed, the presence of facial palsy showed the highest

Table 3: Frequency of reported symptoms of acute strokes vs. stroke mimics

Neurologic symptoms:	**Stroke**	**Stroke Mimic**	**P-value**
Seizure-like movements	4.31% (n = 9)	25.96% (n = 27)	p < 0.00001
Dizziness	16.27% (n = 34)	12.50% (n = 13)	0.1894
Loss of consciousness	13.40% (n = 28)	33.65% (n = 35)	p < 0.00001
Motor weakness in 1 arm or leg	8.13% (n = 17)	11.54% (n = 12)	0.1635
Hemiparesis	45.93% (n = 96)	10.58% (n = 11)	p < 0.00001
Sensory deficit in 1 arm or leg	2.39% (n = 5)	15.38% (n = 16)	p < 0.00001
Hemianesthesia	17.70% (n = 37)	1.92% (n = 2)	0.00003
Facial asymmetry	17.70% (n = 37)	7.69% (n = 8)	0.0087
Headache	16.75% (n = 35)	10.58% (n = 11)	0.0735
Blurring of vision/Visual field defect	2.87% (n = 6)	2.88% (n = 3)	0.4960
Aphasia	9.09% (n = 19)	5.77% (n = 6)	0.1539
Dysarthria	34.45% (n = 72)	11.54% (n = 12)	p < 0.00001

Table 4: Odds ratios of various stroke symptoms

Symptoms	Stroke		
	Odds Ratio	95% Confidence Interval	p-value
Seizure-like movements	0.1283	0.0577 to 0.2853	p < 0.0001
Dizziness	1.3600	0.6838 to 2.7047	0.3807
Loss of consciousness	0.3050	0.1726 to 0.5388	p < 0.0001
Motor weakness in 1 arm or leg	0.6788	0.3113 to 1.4803	0.3301
Hemiparesis	7.1826	3.6331 to 14.2001	p < 0.0001
Sensory deficit in 1 arm or leg	0.1348	0.0479 to 0.3794	0.0001
Hemianesthesia	10.9709	2.5894 to 46.4823	0.0011
Facial asymmetry	2.5814	1.1553 to 5.7679	0.0208
Headache	1.7006	0.8255 to 3.5035	0.1499
Blurring of vision/visual field defect	0.9951	0.2438 to 4.0608	0.9945
Aphasia	1.6333	0.6319 to 4.2219	0.3113
Dysarthria	4.0292	2.0705 to 7.8410	p < 0.0001

odds ratio (11.7893), while the presence of upper limb monoparesis demonstrated the lowest odds ratio (0.4878). Significant odds ratios were noted in facial palsy (p < 0.0001), hemiparesis (p < 0.0001), aphasia (p = 0.0256) and dysarthria (p = 0.001).

DISCUSION

The study had a stroke mimic rate among code stroke calls was 33.23%, which is slightly higher than a study done at a local tertiary hospital which had a mimic rate of 25.38% over a period of 5 years.[6] Compared to other studies on code stroke calls in the emergency department, a study in Taiwan had a much lower mimic rate of 10%[9] while a study in Korea had a similar stroke mimic rate of 30% over a period of one year.[8]

For baseline characteristics, we found that females, prior history of epilepsy, and history of psychiatric disorder were more frequently encountered in the stroke mimic group, while cardiovascular risk factors such as a hypertension, type 2 diabetes mellitus, atrial fibrillation, and smoking history all showed significantly higher frequencies in the stroke group and were similar to previous reports.[10,11,8] For the stroke mimic diagnoses, this study had a significantly higher proportion of syncope cases at 24%,. This value is higher than a local study which had a syncope rate of 4.6%[6], and higher than foreign studies which had a syncope rate ranging from 1% to 5%.[8,9,7] This variation likely represents inherent differences in inclusion criteria and screening methods for code stroke activation among institutions. Seizure is the second most commonly encountered stroke mimic in the emergency department at 22%, and has consistently been shown to be one of

Table 5: Frequency of neurologic signs (from NIHSS) of stroke patients and stroke mimics

Neurologic signs (from NIHSS)	Stroke (n = 209, 66.77%)	Stroke Mimic (n = 104, 33.23%)	p-value
Altered mental status	21.53% (n = 45)	12.50% (n = 13)	0.0262
Disorder of eye movement	14.35% (n = 30)	0% (n = 0)	p < 0.00001
Visual field defect	4.31% (n = 9)	0% (n = 0)	0.0158
Facial palsy	37.32% (n = 78)	4.81% (n = 5)	p < 0.00001
Upper limb monoparesis	1.91% (n = 4)	3.85% (n = 4)	0.1539
Lower limb monoparesis	0% (n = 0)	2.88% (n = 3)	0.0068
Hemiparesis	56.46% (n = 118)	10.58% (n = 11)	p < 0.00001
Sensory disturbance	22.97% (n = 48)	17.31% (n = 18)	0.1230
Aphasia	13.40% (n = 28)	4.81% (n = 5)	0.0099
Dysarthria	25.36% (n = 53)	4.81% (n = 5)	p < 0.00001
Neglect	0.96% (n = 2)	0% (n = 0)	0.1587

the most common stroke mimic in several other reports.[6,8,11,12]

This study found that hemiparesis, dysarthria, and facial asymmetry were significant indicators associated with a stroke diagnosis during code stroke activations in the emergency department. This was significant regardless if it was a symptom described by the patient/caregiver/ or a neurologic sign noted by the neurologist in the NIHSS scale. These are consistent with findings from similar studies which observed an increased likelihood of an acute stroke diagnosis in patients presenting with signs/symptoms of hemiparesis, dysarthria, and facial asymmetry [8][13]. It highlights the consistency and reliability of these findings in the accurate diagnosis of acute ischemic stroke in the acute emergency room setting.

The presence of these signs and symptoms further reinforces the diagnostic value of FAST as an adequate screening tool in detecting acute ischemic stroke patients in the emergency room setting. The FAST tool is a simple hospital screening test to identify possible acute ischemic stroke patients, composed of symptoms of facial asymmetry, dysarthria, arm weakness. A meta-analysis by Chen et al. showed that FAST had a high sensitivity of 0.77 and specificity of 0.60 in detecting acute ischemic stroke patients.[14]

The combination of stroke signs that were commonly observed in acute strokes— facial palsy, hemiparesis, aphasia, dysarthria, and gaze deviation—are characteristic of ischemic strokes involving the middle cerebral artery (MCA) territory. Neurological deficits in ischemic stroke typically correspond to the vascular distribution of the affected artery, which is why certain patterns of symptoms tend to occur together. In the context of this study, MCA-related signs were commonly seen.

Symptoms of seizure-like movements, loss of consciousness, isolated sensory deficits in one arm or leg, and neurologic sign of upper limb monoparesis were associated with a diagnosis of a stroke mimic. This is consistent with the results reported by Kim *et al*.[8] Loss of consciousness is not a specific indicator of stroke and can occur in a range of other medical or neurological conditions, including encephalopathy, syncope, and seizure disorders. Similarly, seizure-like movements, as reported by patients or caregivers, are not reliable predictors of acute ischemic stroke for several reasons. These reports are often subjective and depend heavily on the patient's/caregiver's interpretation. What may be perceived as a seizure by the patient or caregiver may not be an actual seizure when evaluated by the neurologist. Even as seizure-like activity is determined to be epileptic in nature, it remains a nonspecific sign, as seizures can result from several other neurologic or medical conditions, such as brain tumors, intracerebral hemorrhage, or metabolic disturbances.[15] Moreover, as supported by multiple studies[6,8,11,12], seizures are among the most common causes of stroke mimics in the emergency department setting, and thus highly non-specific in the diagnosis of acute stroke.

Interestingly, this study showed some key differences in terms of sensory deficits reported by the patients. Sensory deficits, if localized to one arm or leg, were more predictive of a stroke mimic diagnosis, while sensory deficits that were reported over an entire half/hemisphere of the body (hemianesthesia) were more predictive of an acute stroke diagnosis. This is likely due to anatomic distribution of sensory deficits which favors a stroke. Sensory deficits distributed over a hemisphere of the body typically points to an intracerebral localization of the lesion, whereas a sensory deficit localized in one arm or leg may be attributed to a dermatomal distribution of a nerve as seen in localized radiculopathy.

Notable discrepancies were also observed between the neurologic signs and symptoms reported. Loss of consciousness, as a neurologic symptom reported by patients or caregivers, had a stronger association with a diagnosis of stroke mimic. In contrast, altered mental status, as a neurologic sign identified by a neurologist during examination in the NIHSS scale, showed a stronger association with a diagnosis of acute stroke. This difference likely reflects variations in interpretation and clinical context of the finding. Patient/caregiver reported "Loss of consciousness" is a broad, nonspecific symptom that may cover conditions such as syncope or seizures. On the other hand, "altered sensorium" as assessed by a neurologist is a more specific neurologic finding, often pointing to underlying metabolic or structural disturbances within the nervous system.

In conclusion, this study highlights the high prevalence of stroke mimics among code stroke activations in the emergency department, and further reinforces the diagnostic value of specific neurologic signs and symptoms, such as hemiparesis, dysarthria, and facial asymmetry, which are strongly associated with a diagnosis of a true stroke. Symptoms of seizure-like movements, loss of consciousness, and isolated limb sensory deficits were more indicative of stroke mimics, highlighting the importance of a more detailed

Table 6: Odds ratios of various neurologic signs

Neurologic signs (from NIHSS)	Stroke		
	Odds Ratio	95% Confidence Interval	p-value
Altered mental status	1.9207	0.9846 to 3.7469	0.0556
Facial palsy	11.7893	4.6001 to 30.2141	p < 0.0001
Upper limb monoparesis	0.4878	0.1195 to 1.9908	0.3171
Hemiparesis	10.9630	5.5422 to 21.6861	p < 0.0001
Sensory disturbance	1.4244	0.7805 to 2.5998	0.2491
Aphasia	3.0630	1.1466 to 8.1826	0.0256
Dysarthria	6.7269	2.5992 to 17.4097	0.0001

clinical assessment beyond patient-reported symptoms. It is recommended that evidence-based clinical screening tools, such as the FAST screening tool, be incorporated into code stroke activation pathways to help reduce the rate of stroke mimics and lessen the overall burden on hospital staff.

The limitations of this study are first, as a retrospective study conducted through medical review of patient's electronic medical record, there are some limitations when it comes to controlling bias and variability in the way neurologic signs and symptoms are interpreted by the medical examiners .Moreover, as a single-center study , the findings may have restricted generalizability , as practices and inclusion criteria for activating the code stroke pathway can vary considerably across different hospitals and institutions.

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