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ORIGINAL ARTICLE

Causes of Early Deterioration of Acute Ischemic Stroke Patients Inside Intensive Care Units

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Abstract

Background: **Ischemic stroke is defined as the sudden onset of focal neurologic deficits of ischemic etiology lasting at least 24 h, without hemorrhage on brain imaging. Early neurological deterioration (END) in acute ischemic stroke is a prevalent occurrence. END has a severe long-term and short-term impact on patient outcomes.**

Aim: **To determine the different causes of early deterioration of ischemic cerebrovascular stroke inside stroke units within the first 72 h.**

Patients and methods: **This study was done in El-Maady Military Hospital. The study included 177 patients with acute ischemic stroke.**

Results: **Deterioration of the case means one or more grades increase of the NIHSS after 72 h. Radiologically, in 1st CT 70.1% of the cases had no abnormality but after 72 h all cases showed abnormalities, 35.6% of the studied cases had change in NIH-Ss ≥ 2, which reflect worsening of the case. Significant increase in DM, HPT, IHD, duration of DM, HTN and mean initial NIH-Ss among worsening cases compared to nonworsening cases. Old age, DM, HTN, lesion in pontine and midbrain lesion, large and massive lesions, pneumonia, high TLC, low oxygen and high initial NIH-Ss were risk factors for maladaptive behavior.**

Conclusion: **Ultrasound provides valuable information about the possibility of aggravating stroke symptoms at some point during the intense phase.**

Keywords: Acute ischemic stroke, Cerebra-vascular stroke, Early neurological deterioration

1. Introduction

Ischemia stroke is defined as a localized neurological deficit that has a sudden onset and is caused by an ischemic aetiology, lasts at least 24 h, and is not associated with bleeding on brain imaging. Early neurological deterioration (END) is a common occurrence in acute ischemic stroke. END has major long-term and short-term consequences for the patient's outcome.[1]

The outcomes of stroke injuries are severe and long-lasting, imposing a significant burden on both the individual patient and society.[2]

Every year, around 22 million people worldwide suffer from a stroke. In 2005, stroke was responsible for an estimated 5.7 million deaths, with 87% of these deaths happening in poor and middle-income nations.[3]

Ischemic strokes represent roughly 87% of all strokes., with the remainder being hemorrhagic. Inside areas of ischemia, bleeding can occur, a process known as "hemorrhagic transformation".[4] Ischemic stroke is caused by a lack of adequate blood flow to perfuse brain tissue. Ischemic stroke can be induced by one of three major mechanisms: thrombosis, embolism, or global ischemia.[5]

The National Institutes of Health Stroke Scale (NIHSS) is a standardized examination that is extensively used and considered standard practise for evaluating individuals with suspected stroke.[6]

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Early neurological deterioration (END) is a common occurrence in acute ischemic stroke. The underlying mechanisms are diverse. The severity of the original stroke, major vascular blockage, atrial fibrillation, diabetes mellitus, hypo-tension, and diabetes mellitus are all clinical predictors of END.[7]

END has the potential to have major effects for the patient's short and long-term outcomes. Therefore, prevention and treatment of END should be done as soon as possible and as vigorously as possible. The underlying causes are largely neurological, as opposed to the later stages of stroke, when systemic variables (such as infection, electrolyte abnormalities, cardiac ischaemia, venous thromboembolism, and so on) play a larger role.[7]

Therefore, this study aim to predict and assess the different causes of early deterioration of ischemic cerebrovascular stroke inside stroke units within the first 72 h.

2. Patients and methods

This prospective case-series study was done in El-Maady Military Hospital. The study included the total number of patients with acute ischemic stroke who were admitted to ICU units in a 6-month period. These patients were presenting with a clinical diagnosis of acute ischemic stroke with suspected symptom onset within the preceding 12 h.

Age more than 18 years, Male and female, Patients with first-ever acute-ischemic stroke, acute-ischemic stroke after onset and were admitted to ICU units, Duration; in the first 72 h after onset and patients done CT and/or MRI brain were included.

Pediatric patients with stroke, Hepatic or renal disease, ventricular aneurysm, unstable angina, heart failure, myocardial infarction, vascular malformations, aneurysms, cancer, and brain surgery, and Hemorrhagic stroke (intracerebral hemorrhage or subarachnoid hemorrhage) were excluded.

Clinical assessment, which includes demographic data, a medical history details with special attention to prior medical history gathered from the patients themselves or their relatives, general examination, and extensive neurological examination. The stroke severity was initially measured on admission using the National Institutes of Health Stroke Scale (NIHSS), both during the first 12 h of stroke onset and 5–7 days later (second visit). Full routine laboratory investigations (random blood glucose level, white blood cell count, kidney function tests, liver function tests, C-reactive protein, ESR and electrolytes). Radiological investigations (computed tomography of the brain, chest, carotid arteries, MRI, and echocardiography), and Trans-thoracic echocardiography.

Deterioration of acute ischemic stroke of the case means an increase of two or more NIHSS grades in consciousness level, speech, vision, leg and arm motor function. Early neurological deterioration (END) was defined as an increase of 2 points in the NIHSS score within 72 h.

3. Results

Demographic data of the included patients shows that the age ranged from 48 to 84 years with mean 66.1 years, and BMI ranged from 19 to 40 kg/m^2 with mean 26.35 kg/m^2. Regarding sex 51.4% of the cases were female. Also 82.5% were right handed, most common occupations were house wife's and retired (33.3% & 29.4% respectively) and 87% were married.

The mean initial GCS among the studied cases was 14.44, while after 72 h mean was 13.65 with statistical significant decrease, and mean initial NIH-Ss among the studied cases was 7.56, while after 72 h mean was 9.24 with statistical significant increase.

There was a statistical significance increase in the frequency of DM, HPT and IHD and duration of DM

Table 1. Demographic data of the studied cases.

Variable	(n = 177)
Age: (years)	
Mean ± SD	66.1 ± 10.78
Range	48–84
BMI: (kg/m^2)	
Mean ± SD	26.35 ± 4.62
Range	19–40
Variable	***N* (%)**
Sex:	
Male	86 (48.6)
Female	91 (51.4)
Handiness:	
Right	146 (82.5)
Left	31 (17.5)
Occupation:	
House wife	59 (33.3)
Retired	52 (29.4)
Skilled worker	30 (16.9)
Specialist	36 (20.3)
Marital status:	
Married	154 (87)
Widow	23 (13)

Table 2. GCS and NIH-Ss among the studied cases.

Variable	GCS	NIHSs
initial:		
Mean ± SD	14.44 ± 0.98	7.56 ± 3.63
Range	10–15	7 (3–18)
After 72 h		
Mean ± SD	13.65 ± 1.86	9.24 ± 5.39
Range	9–15	8 (3–22)
***P* Value**	<0.001**	<0.001**

Table 3. Relation between risk factor and stroke worsening among the studied cases.

Variable	No worsening ($n = 114$) *N* (%)	Worsening ($n = 63$) *N* (%)	χ^2	*P*
Smoking:				
No	88 (67.7)	42 (32.3)	2.31	0.13 NS
Yes	26 (55.3)	21 (44.7)		
Family history:				
-ve	93 (63.7)	53 (36.3)	0.18	0.67 NS
+ve	21 (67.7)	10 (32.3)		
DM: Duration of DM				
No	66 (78.6)	18 (21.4)	**13.99**	**<0.001****
Yes	48 (51.6)	45 (48.4)		
Median (Range)	10 (7–15)	20 (5–30)	**3.28^**	**0.001***
HTN: Duration of HTN:				
No	27 (100)	0 (0)	**17.61**	**<0.001****
Yes	87 (58)	63 (42)		
Median (Range)	8 (3–20)	13 (5–20)	**3.86^**	**<0.001****
IHD:				
No	83 (74.8)	28 (25.2)	**13.96**	**<0.001****
Yes	31 (47)	35 (53)		
AF:				
No	101 (65.2)	54 (34.8)	0.31	0.58 NS
Yes:	13 (59.1)	9 (40.9)		

Table 5. Relation between laboratory findings and oxygen saturation and stroke worsening among the studied cases.

Variable	No worsening ($n = 114$)	Worsening ($n = 63$)	t/MW	*P*
Hb: (gm/dl)				
Mean ± SD	11.98 ± 1.19	12.12 ± 1.21	0.73	0.47 NS
Range	9.9–14	10–14		
WBCs: (x10^3/mm^3)				
Mean ± SD	5.34 ± 1.06	11.13 ± 5	**7.40**	**<0.001****
Median (Range)	5.15 (3.8–8)	13 (4.6–18)		
Na: (mEq/L)				
Mean ± SD	140.38 ± 4.09	135.59 ± 6.39	**6.07**	**<0.001****
Range	130–146	125–145		
K: (mmol/L)				
Mean ± SD	4.06 ± 0.26	3.84 ± 0.31	**4.86**	**<0.001****
Range	3.6–4.5	3.2–4.3		
Pyuria: (cell/mm^3)				
0 to 6 N(%)	83 (76.1%)	26 (23.9%)		
10 to 20 N(%)	22 (61.1%)	14 (38.9%)	χ^2 **25.1**	**<0.001****
> 20 N(%)	9 (28.1%)	23 (71.9%)		
O_2: (%)				
Mean ± SD	97.92 ± 1.56	91.52 ± 2.87	**19.23**	**<0.001****
Range	92–99	88–96		

& HTN among worsening cases compared to non-worsening cases.

There was a statistical significance increase in the frequency of Dens artery sign and Potine infarction in initial CT and Pontine + Midbrain and Cerebellar + Occipital lesions in follow-up CT, edema and Hg in MRI, pontine and midbrain in lesion site, large and massive lesions size and pneumonia among worsening cases compared to non-worsening cases.

Table 4. Relation between radiological findings and stroke worsening among the studied cases.

Variable	No worsening ($n = 114$) *N* (%)	Worsening ($n = 63$) *N* (%)	χ^2	*P*
initial CT:				
NAD	97 (78.2)	27 (21.8)		
Dens artery sign	9 (28.1)	23 (71.9)	**38.17**	**<0.001****
Potine infarction	0 (0)	4 (100)		
Rt lesion	8 (47.1)	9 (52.9)		
Follow up CT:				
Pontine	9 (47.4)	10 (52.6)		
Mid brain	4 (100)	0 (0)	**57.31**	**<0.001****
Pontine + Midbrain	0 (0)	4 (100)		
Cerebellar + Occipital	0 (0)	9 (100)		
LT lesion	40 (53.6)	36 (47.4)		
Rt lesion	61 (93.8)	4 (6.2)		
MRI:				
Recent infarction	114 (76)	36 (24)		
Recent infarction + edema	0 (0)	23 (100)	**57.65**	**<0.001****
Recent infarction + edema + Hg	0 (0)	4 (100)		
Site:				
Lt	44 (100)	0 (0)		
Pontine	9 (100)	0 (0)	**78.24**	**<0.001****
Pontine + Midbrain	0 (0)	27 (100)		
Right	61 (62.9)	36 (37.1)		
Size:				
Small	57 (100)	0 (0)		
Moderate	48 (63.2)	28 (36.8)	**81.38**	**<0.001****
Large	9 (52.9)	8 (47.1)		
Massive	0 (0)	27 (100)		
CT chest:				
Free	114 (81.4)	26 (18.6)	**84.65**	**<0.001****
Pneumonia	0 (0)	37 (100)		

Table 6. Multivariate analysis of factors associated with worsening of stroke among the studied cases.

Variable	B	S.E.	Wald	*P*	AOR	95% C.I	
Age > 68 years	**1.761**	**0.807**	**4.762**	**0.029***	**2.816**	**1.196**	**8.271**
Left hand	0.304	0.178	2.912	0.088	1.355	0.956	1.921
Widow	−0.262	0.179	2.126	0.145	0.770	0.541	1.094
Diabetic	**0.752**	**0.153**	**24.109**	**<0.001****	**2.121**	**1.571**	**8.864**
Diabetes duration > 20 years	**0.534**	**0.220**	**5.897**	**0.015***	**1.705**	**1.108**	**3.623**
Hypertensive	**0.858**	**0.529**	**2.628**	**<0.001****	**2.424**	**0.150**	**7.196**
HTN duration > 15 years	**0.380**	**0.162**	**5.458**	**0.019***	**1.684**	**1.498**	**5.941**
IHD	−0.020	0.154	0.018	0.894	0.980	0.724	1.326
Abnormal initial CT	0.569	0.416	1.870	0.171	1.767	0.781	3.995
Pontine + Midbrain	**0.399**	**0.174**	**5.262**	**0.022***	**1.491**	**1.060**	**2.096**
Cerebellar + Occipital	−0.117	0.240	0.236	0.627	0.890	0.556	1.424
Hemorrhage and edema in MRI	−0.056	0.144	0.150	0.698	0.946	0.713	1.254
Large and massive lesion	**0.781**	**0.164**	**11.170**	**<0.001****	**3.195**	**1.866**	**10.648**
Pneumonia	**0.544**	**0.147**	**13.723**	**<0.001****	**3.580**	**1.435**	**9.774**
High TLC	**0.534**	**0.220**	**5.897**	**0.015***	**1.705**	**1.108**	**2.623**
Low Na	0.256	0.147	3.042	0.081	1.292	0.969	1.723
Low K	−0.152	0.160	0.903	0.342	0.859	0.628	1.175
Pyuria	−0.069	0.161	0.185	0.667	0.933	0.681	1.279
Low oxygen	**0.439**	**0.158**	**7.692**	**0.006***	**2.645**	**1.473**	**8.879**
High initial NIH-Ss > 9	**0.534**	**0.220**	**5.897**	**0.001***	**3.705**	**1.108**	**6.623**

There was a statistical significance increase in mean WBCs count, frequency of pyuria and decreases in NA, K and O_2 among worsening cases compared to non worsening cases. Sd: Standard deviation t:Indepnedant *t* test MW: Mann Whitney test.

Old age, DM and its duration, HTN and its duration, lesion in pontine and midbrain lesion, large and massive lesions, pneumonia, High TLC, low oxygen and high initial NIH-Ss was risk factor for maladaptive behavior (OR = 2.82, 2.12, 1.71, 2.42, 1.68, 1.49, 3.2, 3.58, 1.71, 2.64 and 3.71, respectively) (Tables 1–6).

4. Discussion

Stroke is one of the leading causes of death and disability globally.[8] Early neurological deterioration (END) has been noticed in forty percent of patients suffering from acute-ischemic-stroke.[9]

Our study focused on the different causes of early deterioration of ischemic cerebrovascular stroke inside stroke units within the first 72 h.

In this study, the age varied between 48 and 84 years, with median 66.1 years. This is consistent with **Idrovo** et al.[10] who quoted mean ages between 31 and 88 year. In our study, 51.4% of admissions were female. Patients with stroke in their family history. Another possibility is that oestrogen has a positive effect on brain circulation.[11]

Radiologically, in 1st CT 70.1% of the cases had no abnormality but after 72 h all cases showed abnormalities, most frequent were lesions in Lt side (42.9%) and in Rt side (36.7%). In MRI all cases had recent infarction in 13% associated with edema and in 2.3% associated with edema and Hg. The most common sites of lesions were Lt MCA (20.3%), RT parieto-temporal (153%) and RT Parietal (14.7%). Large lesion was founded in 9.6% of the cases and massive in 15.3%. Finally, 20.9% of the cases had pneumonia.

In addition to, **Li** et al.[12] looked into the morphometric prognostic utility of magnetic resonance imaging for early neurological deterioration (END) in patients with acute pontine infarction. They proposed that the maximal length multiplied by thickness may be used to predict progression in patients with isolated acute pontine infarction. The extent of the pontine stroke along the conduction pathway may play a role in the worsening.

In our study, mean initial GCS among the studied cases was 14.44, while after 72 h mean was 13.65 with statistical significant decrease in GCS after 72 h compare to initial.

In terms of stroke severity, It is a proven method for determining the severity of the initial stroke. The scale is a 15-item neurologic examination stroke scale that offers a quantitative measure of stroke-related neurologic impairment. It is used to evaluate the effect of acute ischemic stroke on levels of consciousness, language, neglect, visual-field loss, extraocular movement, motor strength, ataxia, dysarthria, and sensory loss. It was appropriate for our investigation due to its simplicity and minimal interobserver variability. We assess the patient's ability to respond to questions and carry out exercises. Ratings for each item range from 3 to 5, with 0 being normal **Fonarow *et al.***[13]

In our study, mean initial NIH-Ss among the studied cases was 7.56, while after 72 h, mean was 9.24 with statistical significant increase in NIH-Ss after 72 h compared to initial.

According to previous study **Poudel** et al.[14] observed that three-month prognosis in stroke patients. Upon admission predicted seven-day mortality in ICUs in a study conducted in Nepal, although the study did not look at long-term predictors of outcomes in acute stroke patients. In terms of ICU admission, scores demonstrated no predictive value.[15] Furthurmore **Güngen** et al.[16] investigated the factors that influence ICU admission and mortality in stroke patients, as well as the effect of a pulmonary rehabilitation programme on stroke patients.

In our study, 35.6% of the studied cases had change in NIH-Ss ≥ 2 which reflect worsening of the case. Consistent with our findings, An END stroke occurs in 10–40% of AIS patients.[17] According to **Siegler** et al.[18] regardless of the criteria, END is consistently linked to poor three-month clinical outcomes.

In our study, the statistical significant increase in mean age, left handiness and widow marital status, among worsening cases compared to nonworsening cases. As per previous findings **Geng** et al.[19] investigated END risk factors in acute ischemic stroke patients in a group of 340 (32.0%) patients. The ages of the patients varied between 18 and 96 years and BMI ranged from seventeen to thirty-six kg/m.

In our study, there was a statistical significant increase in the frequency of DM, HPT, IHD, duration of DM and HTN among worsening cases compared to non-worsening cases. According to **Geng** et al.,[19] END is substantially related with increasing diabetes and hypertension. Moreover, **Huang** et al.[20] investigated whether endovascular treatment (EVT) influenced the incidence of END in patients with acute-ischemic-stroke, in comparison to intravenous thrombolysis alone. Diabetes mellitus was more prevalent in the END group than in the non-END group. There were no statistically significant differences between the two groups in diabetes mellitus after matching. In our study, the END group had more females and had poorer neurologic impairment than the non-END group. Furthermore, **Huang** et al.[20] discovered that the number of females in the END group was increased and neurologic impairment was identified instead of non-END group.

In our study, there was a statistical significance increase in mean WBCs count and frequency of pyuria and decrease in NA, K and O_2 among worsening cases compared to non-worsening cases. Furthermore, **Geng** et al.[19] discovered that END was substantially related to various blood laboratory values. Although, **Geng** et al.[19] results showed a independently significant predictors of END predictors NIHSS score and Diabetes at admission time with mortality over the follow-up period. Furthermore, older age, Obesity, high CRP levels, and coronary heart disease were linked to poor consequence. Currently, **Huang** et al.[20] discovered that uric acid level, glucose level, and therapeutic interventions were significant predictors of END in the study. Indeed, **Huang** et al.[20] suggested that hyperuricemia, hyperglycemia, and EVT associated with E.N.D in Acute Ischemic Stroke, taking into consideration any confounding factors.

In our study, there was statistically sigficant rise in the frequency of Dens artery sign and Potine infarction in initial CT and Pontine + Midbrain and Cerebellar + Occipital lesions in follow-up CT, edema and Hg in MRI, pontine and midbrain in the lesion site, large and massive lesions size and pneumonia among worsening cases compared to non-worsening cases. In addition to **Weimar** et al.[21] found that The most common neurologic causes of worsening in patients with worsening of any important neurologic function 48–72 h after hospital admission were progressive infarction (31.8%) and increased intracranial pressure (18.8%).

4.1. Conclusion

Aside from the severity of the initial stroke and any medical comorbidities, Brain imaging and laboratory findings. Correcting hyperthermia, hyperglycemia, or high-elevation in blood pressure during the acute stage can minimize the likelihood of END. Patients at risk of END should be followed in ICU.

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Conflict of interest

The authors declared that there were no conflicts of Interest.

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