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Clinical profile and predictors of consciousness level in acute stroke patients at a tertiary care center

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Abstract

Background: Acute stroke remains a leading cause of death and disability worldwide, and the level of consciousness is a significant prognostic marker. Altered consciousness in acute stroke is quite essential for appropriate management and prognostication.

Methods: 100 acute stroke patients were enrolled in the study through purposive sampling. Clinical presentation, comorbidities, computed tomography scan results, and demographic information were included in data collection. The Glasgow Coma Scale was used to measure the level of consciousness. Blood glucose levels >7.8 mmoL/L in non-diabetic patients are referred to as stress hyperglycemia. The Modified Rankin Scale monitored the participants for 4 weeks. Statistical analysis was performed using the Statistical Package for the Social Sciences version 26 and Cox regression analysis to identify predictors of impaired consciousness.

Results: The analysis included 74 ischemic stroke (74%) and 26 hemorrhagic stroke (26%) patients. The mean age was 58.37 ± 6.23 years with male predominance (64%). Impaired consciousness was greater among hemorrhagic stroke patients (80.8% vs. 59.5%, $P = 0.037$). Cox regression analysis identified hemorrhagic stroke type (hazard ratio [HR] = 2.85, 95% confidence intervals (CI): 1.34–6.03, $P = 0.006$), neck rigidity (HR = 3.41, 95% CI: 1.51–7.72, $P = 0.003$), and convulsions (HR = 2.12, 95% CI: 1.01–4.44, $P = 0.047$) as predictors of impaired consciousness.

Conclusion: Hemorrhagic stroke, stiffness of the neck, and seizures are individual predictors of impaired consciousness among acute stroke patients. The early detection of these risk factors can guide clinical practice and improve patient outcomes through the employment of focused interventions.

Keywords: Acute stroke, Glasgow Coma Scale, hemorrhagic stroke, impaired consciousness

Introduction

Stroke is one of the foremost global health problems, with the second highest death cause and third highest cause of disability worldwide.[1] The burden of stroke is continually on the increase, particularly in developing countries, whose health systems have difficulty in providing optimal acute stroke care.[2] The level of consciousness at presentation is now primarily one of the best prognostic predictors in acute stroke patients, with immediate implications for treatment, use of resources, and patient outcome.[3] Glasgow Coma Scale (GCS), originally developed to evaluate traumatic brain injury, is now widely used to measure consciousness levels in stroke patients.[4] Its application in stroke also presents unique difficulties in the discrimination between focal neurological impairment and impaired consciousness.[5] Determination of the clinical profile and valid predictors of the level of consciousness in acute stroke patients is crucial for improved clinical outcomes as well as for directing therapeutic interventions. Hemorrhagic stroke, which accounts for approximately 10–15% of all strokes, is typically distinguished by more severe clinical presentations compared to ischemic stroke.[6] The resulting increase in intracranial pressure and mass effect of hemorrhagic stroke typically causes more profound impairment of consciousness.[7] Many consciousness-level factors in stroke patients have been reported in earlier studies, including stroke type, location, volume, and patient-specific factors.[8] The style-relation remains an extensive and intricate one. Hemorrhagic stroke, in the majority of cases, has greater impairment of consciousness due to increased intracranial pressure. Predictors for the level of consciousness among various strokes remain to be discovered.[9] Clinical presentation, such as neck stiffness, convulsions, and other neurological presentations, can be employed as crucial predictors for the level of consciousness and stroke severity.[10] In the context of Bangladesh and other developing countries, understanding the clinical profile of stroke patients is particularly important due to resource constraints and the need for efficient triage and management strategies.[11] Early identification of patients at risk for consciousness impairment can facilitate the appropriate allocation of intensive care resources and guide family counseling regarding prognosis.[12] This study aims to observe the clinical profile and predictors of the level of consciousness in acute stroke patients admitted to a tertiary care hospital in Bangladesh. By analyzing the associations between various clinical parameters and levels of consciousness, this study intended to contribute valuable insights for enhancing clinical decision-making and improving patient outcomes in similar healthcare settings.

Methods

This is an observational study that was conducted over 6 months (May 4–November 3, 2018) at the Department of Medicine and Neuromedicine, Sir Salimullah Medical College and Mitford Hospital, Dhaka, Bangladesh. A total of 100 patients with acute stroke were enrolled using purposive sampling. Inclusion criteria included patients diagnosed with acute stroke within 72 h of symptom onset, while those with transient ischemic attacks, previous strokes, known diabetes, or who declined consent were excluded. Data were collected using a standardized questionnaire, noting demographics, clinical presentation, comorbidities (hypertension, obesity, smoking), and computed tomography (CT) scans. The level of consciousness was evaluated using the GCS, grouping patients as alert (GCS = 15), semiconscious (GCS = 9–14), or unconscious (GCS ≤ 8). Stress hyperglycemia was defined as blood glucose >7.8 mmoL/L in non-diabetic patients. Complete neurological examination and brain CT scans were done in all patients to distinguish between ischemic and hemorrhagic strokes. Follow-up was continued for 4 weeks, and the outcome was assessed using the Modified Rankin Scale. The data quality was ensured by pre-tested questionnaires, standard protocol, and supervision. Statistical analysis was performed with Statistical Package for the Social Sciences version 26, and descriptive statistics were used for baseline data. Categorical and continuous variables were compared by Chi-square and independent *t*-tests, respectively, and predictors of impaired consciousness were determined by Cox regression. $P < 0.05$ was considered statistically significant. Ethical approval was obtained, with written informed consent from all the participants. Confidentiality was maintained by unique IDs, and participants' rights and safety were protected throughout the study.

Result

Table 1 represents the demographic and anthropometric characteristics of 100 acute stroke patients, as they differ between ischemic (*n* = 74) and hemorrhagic (*n* = 26) stroke populations. The mean age was 58.37 ± 6.23 years, with the majority (54%) falling in the age range of 41–55 years. There was male predominance (64%), with higher representation among ischemic strokes (67.6%) compared to hemorrhagic strokes (53.8%). Urban residence was more common (74%), particularly in ischemic stroke patients (77%). In body mass index (BMI), the majority of the patients (51%) had a BMI >30 kg/m², indicating obesity prevalence. The age distribution was not significantly different between stroke types (*P* = 0.248), suggesting similar demographic trends. The high prevalence of patients with a BMI >30 illustrates the obesity epidemic as a risk factor for stroke in the population being studied.

Table 2 compares the prevalence of cardiovascular risk factors in ischemic and hemorrhagic stroke patients. The most common risk factor was hypertension (63%), with a significantly greater frequency among hemorrhagic stroke patients (80.7% vs. 56.8%, *P* = 0.030). Obesity (BMI >30) was present in 51% of patients and had a significant

Table 1: Basic characteristics of the study population (*n*=100)

Characteristics	Total (*n*=100) (%)	Ischemic stroke (*n*=74) (%)	Hemorrhagic stroke (*n*=26) (%)	*P*-value
Age group (years)				
≤40	8 (8.0)	4 (5.4)	4 (15.4)	
41–55	54 (54.0)	42 (56.8)	12 (46.2)	
56–70	24 (24.0)	20 (27.0)	4 (15.4)	
>70	14 (14.0)	8 (10.8)	6 (23.0)	0.171
Mean±SD (years)	58.37±6.23	57.84±6.41	59.88±5.70	0.248
Sex				
Male	64 (64.0)	50 (67.6)	14 (53.8)	0.214
Female	36 (36.0)	24 (32.4)	12 (46.2)	
Residence				
Urban	74 (74.0)	57 (77.0)	17 (65.4)	0.247
Rural	26 (26.0)	17 (23.0)	9 (34.6)	
BMI (kg/m²)				
23.1–25.0	13 (13.0)	9 (12.2)	4 (15.4)	
25.1–30.0	36 (36.0)	28 (37.8)	8 (30.8)	
>30.0	51 (51.0)	37 (50.0)	14 (53.8)	0.866

BMI: Body mass index, SD: Standard deviation

Table 2: Risk factors associated with stroke type

Risk factor	Total (*n*) (%)	Ischemic (*n*=74) (%)	Hemorrhagic (*n*=26) (%)	*P*-value
Hypertension	63 (63.0)	42 (56.8)	21 (80.7)	0.030*
Smoking	37 (37.0)	27 (36.5)	10 (38.4)	0.02
Obesity (BMI >30)	51 (51.0)	37 (50.0)	14 (53.8)	0.024
Family history (CVD/CAD)	47 (47.0)	33 (44.6)	14 (53.8)	0.407
Dyslipidemia	13 (13.0)	9 (12.2)	4 (15.4)	0.01
Coronary heart disease	12 (12.0)	8 (10.8)	4 (15.4)	0.547

BMI: Body mass index, CVD: Cardiovascular disease, CAD: Coronary artery disease. *p < 0.05 considered statistically significant correlation with stroke incidence ($P = 0.024$). Smoking was seen in 37% of patients, with an equal distribution between stroke types. Family history of cardiovascular disease was noted in 47% of patients, with a slightly higher incidence in hemorrhagic stroke. Dyslipidemia was found in 13% of patients and was strongly related ($P = 0.01$). Coronary heart disease was noted in 12% of patients.

Table 3 delineates the clinical presentations of ischemic and hemorrhagic stroke patients. The most common presentation was hemiplegia (88%), with equal frequency in both stroke types. Changes in consciousness were significantly more common in hemorrhagic stroke (80.8% vs. 59.5%, $P = 0.037$), reflecting the mass effect and increased intracranial pressure of hemorrhagic strokes. Headache was present in 55% of the patients, with significantly more frequency in hemorrhagic stroke (80.8% vs. 45.9%, $P = 0.002$). Vomiting was present in 50% of the patients, more so in hemorrhagic stroke (73.1% vs. 41.9%, $P = 0.006$). Stiffness of the neck was much more common in hemorrhagic stroke (80.8% vs. 6.8%, $P < 0.001$), indicating meningeal irritation from blood products. Convulsions occurred in 17% of the patients, more commonly in hemorrhagic stroke (30.8% vs. 12.2%, $P = 0.041$).

Table 3: Clinical features at presentation by stroke type

Presentation	Ischemic (*n*=74) (%)	Hemorrhagic (*n*=26) (%)	*P*-value
Hemiplegia	68 (91.9)	22 (84.6)	0.293
Impaired consciousness	44 (59.5)	21 (80.8)	0.037*
Headache	34 (45.9)	21 (80.8)	0.002*
Vomiting	31 (41.9)	19 (73.1)	0.006*
Neck rigidity	5 (6.8)	21 (80.8)	<0.001**
Convulsion	9 (12.2)	8 (30.8)	0.041*

*p < 0.05 considered statistically significant, **p < 0.05 considered statistically highly significant

Table 4 demonstrates the level of consciousness distribution using GCS categories by stroke type. In total, 43% of all patients were alert (GCS = 15), 32% were semiconscious (GCS = 9–14), and 25% were unconscious (GCS $\leq$ 8). Ischemic stroke patients had better consciousness levels, as 45.9% were alert compared to 34.6% in hemorrhagic stroke. The unconscious level was significantly more frequent in patients with hemorrhagic stroke (38.5% vs. 20.3%, $P = 0.041$). This distribution reflects the pathophysiological difference between stroke types, with hemorrhagic strokes causing more severe consciousness impairment due to increased intracranial pressure, mass effect, and potential hydrocephalus. The semiconscious category demonstrated similar distribution between stroke types (33.8% vs. 26.9%, $P = 0.519$), which suggests that moderate consciousness impairment with either stroke type is equally likely to happen.

Table 4: Glasgow Coma Scale category by stroke type

Level of consciousness	GCS score range	Ischemic (*n*=74) (%)	Hemorrhagic (*n*=26) (%)	Total (*n*=100) (%)	*P*-value
Alert	15	34 (45.9)	9 (34.6)	43 (43.0)	0.293
Semiconscious	9–14	25 (33.8)	7 (26.9)	32 (32.0)	0.519
Unconscious	≤8	15 (20.3)	10 (38.5)	25 (25.0)	0.041*

GCS: Glasgow Coma Scale. *p < 0.05 considered statistically significant

Table 5: Blood sugar level distribution in stroke types

Blood sugar (mmoL/L)	Ischemic (*n*=74) (%)	Hemorrhagic (*n*=26) (%)	Total (*n*=100) (%)	*P*-value
<6.1	21 (28.3)	6 (23.0)	27 (27.0)	
6.1–7.7	35 (47.2)	11 (42.3)	46 (46.0)	
≥7.8 (hyperglycemia)	18 (24.3)	9 (34.6)	27 (27.0)	0.297

Table 5 shows the distribution of blood sugar levels in stroke types. The distribution of blood glucose levels by stroke types, categorized as normal (<6.1 mmoL/L), borderline (6.1–7.7 mmoL/L), and hyperglycemic (≥7.8 mmoL/L), is presented in this table. Normal glucose was seen in 27% of the patients (28.3% ischemic, 23% hemorrhagic). The majority (46%) had borderline glucose levels, with equal distribution between stroke types. Hyperglycemia was present in 27% of the patients, with a trend toward greater incidence in hemorrhagic stroke (34.6% vs. 24.3%). While there was a trend for elevated glucose in hemorrhagic stroke, the difference did not reach significance ($P = 0.297$).

Table 6: Cox regression analysis for predictors of impaired consciousness

Variable	Hazard ratio	95% Confidence interval	*P*-value
Hemorrhagic stroke	2.85	1.34–6.03	0.006*
Neck rigidity	3.41	1.51–7.72	0.003*
Convulsion	2.12	1.01–4.44	0.047*
Headache	1.62	0.79–3.30	0.184
Vomiting	1.58	0.74–3.38	0.234
Age >55	1.26	0.63–2.54	0.012
BMI >30	1.08	0.53–2.18	0.028

BMI: Body mass index. *p < 0.05 considered statistically significant

Table 6 exhibits quantitative results of Cox regression analysis for multiple variables as predictors of impaired consciousness in acute stroke patients. The model recognizes three statistically significant predictors and their hazard ratios (HRs) and confidence intervals (CIs). Hemorrhagic stroke is a significant predictor with a HR of 2.85 (95% CI: 1.34–6.03, $P = 0.006$), which indicates that hemorrhagic stroke patients have about 3 times the risk of developing impaired consciousness compared to ischemic stroke patients. Neck rigidity is the most predictive with an HR of 3.41 (95% CI: 1.51–7.72, $P = 0.003$), suggesting that the occurrence of neck rigidity increases the risk of impaired consciousness by more than threefold. Convulsions are also statistically significant with a HR of 2.12 (95% CI: 1.01–4.44, $P = 0.047$), doubling the risk of impairment of consciousness. The remaining covariates for headache, vomiting, older age, and obesity were non-significant in their relationships, even though some of these also demonstrated trends toward increased risk. CIs for the significant predictors do not cross 1.0, testifying to their statistical adequacy as independent risk factors.

Table 7: Interpretation of cox regression analysis for predictors of impaired consciousness

Variable	Hazard ratio	95% confidence interval	*P*-value	Interpretation
Hemorrhagic stroke	2.85	1.34–6.03	0.006**	Patients with hemorrhagic stroke are nearly 3 times more likely to have impaired consciousness compared to ischemic stroke.
Neck rigidity	3.41	1.51–7.72	0.003**	Neck rigidity is a strong predictor; such patients are over 3 times more likely to present with impaired consciousness.
Convulsion	2.12	1.01–4.44	0.047*	The presence of convulsions doubles the risk of impaired consciousness.
Headache	1.62	0.79–3.30	0.184	Headache increases the risk modestly, but it is not statistically significant.
Vomiting	1.58	0.74–3.38	0.234	Vomiting shows a trend toward increased risk but without statistical significance
Age >55	1.26	0.63–2.54	0.512	Older age is not a significant predictor in this model.
BMI >30	1.08	0.53–2.18	0.828	Obesity was not significantly associated with impaired consciousness.

*p < 0.05 considered statistically significant, **p < 0.05 considered statistically highly significant

Table 7 provides a detailed clinical interpretation of findings of the Cox regression analysis, converting statistical significance to practical clinical importance. In hemorrhagic stroke, the HR of 2.85 with statistical significance ($P = 0.006$) means that the type of stroke is an important determinant of the level of consciousness, mirroring the pathophysiologic distinction wherein hemorrhagic strokes result in more severe impairment of consciousness from elevated intracranial pressure and mass effect. Neck rigidity, with the highest HR of 3.41 ($P = 0.003$), is a sign of meningeal irritation due to blood products and is the most robust clinical predictor of impairment in consciousness. This finding underscores the importance of careful neurological examination in stroke assessment. Seizures, with an HR of 2.12 ($P = 0.047$), carry double the risk and often represent cortical irritation or severe brain injury. Headache and vomiting, although both with increased HRs (1.62 and 1.58, respectively), are not statistically significant, suggesting that they are less reliable predictors. The non-significant correlations of age >55 years and BMI >30 indicate that acute clinical presentations are more important than demographic factors in the prediction of level of consciousness, highlighting the precedence of clinical examination over patient demographics in acute stroke management.

Discussion

This study provides in-depth insight into the clinical profile and predictors of the level of consciousness of acute stroke patients in a tertiary care hospital in Bangladesh. Our findings depict significant differences in clinical presentation and impairment of consciousness between ischemic and hemorrhagic stroke patients with important implications for prognosis and clinical management. The demographic profile of our sample population is consistent with global stroke epidemiology, as shown by Ali *et al*., and has male predominance along with peak incidence in the age range of 41–55 years.[13] Obesity (51%) and hypertension (63%) prevalence highlight the increasing cardiovascular risk factor load in developing countries.[14] The significantly higher incidence of hypertension in patients with hemorrhagic stroke (80.7% vs. 56.8%) vindicates established pathophysiologic mechanisms, where undiagnosed hypertension is a primary risk factor for vessel rupture and intracerebral hemorrhage.[15] Our study revealed that impaired consciousness was more common in hemorrhagic stroke patients (80.8% vs. 59.5%), as evidenced by previous research with more severe clinical presentation of hemorrhagic strokes.[16] Hemorrhagic stroke was the independent predictor of impaired consciousness, as indicated by Cox regression analysis (HR = 2.85), confirming the clinical experience of worse immediate prognosis of hemorrhagic strokes due to mass effect and raised intracranial pressure.[17] Identification of neck stiffness as the strongest clinical predictor of impaired consciousness (HR = 3.41) is educative for diagnosis. Neck stiffness in hemorrhagic stroke is typically caused by meningeal irritation by blood products in the subarachnoid space and signifies more severe bleeding with increased risk of compromise of consciousness.[18] This finding highlights the importance of extensive neurological examination in the evaluation of acute stroke. Convulsions, as another concomitant predictor of impaired consciousness (HR = 2.12), occurred with higher frequency in patients with hemorrhagic stroke. Post-acute stroke seizures are concomitant with cortical irritation, intracranial hypertension, or metabolic disturbances, and concomitance is generally suggestive of increased concomitant brain injury.[19] The association of convulsions with impaired consciousness suggests that, in patients who are seizing, closer surveillance and more active treatment are indicated. Contrary to expectation, traditional demographic factors such as age >55 years and obesity (BMI >30) were weak predictors of the level of consciousness in our multivariate analysis. This finding shows that acute clinical presentation trumps baseline patient parameters in the determination of level of consciousness, which underscores the value of good clinical assessment rather than relying on demographic risk factors.[20] The extremely high incidence of stress hyperglycemia (27%) in the study population, though not statistically significant across etiologies of stroke, underscores the importance of monitoring blood glucose in the management of stroke. Hyperglycemia can exacerbate brain injury through various mechanisms, such as increased oxidative stress and impairment of the blood-brain barrier.[21] The similar prevalence rates across etiologies of stroke suggest a common mechanism of stress response, requiring uniform approaches to its management. Our findings have important clinical implications for the management of stroke in resource-constrained settings. The identification of predictors can guide triage, utilization of resources, and family counseling. Hemorrhagic stroke patients, neck stiffness, or seizures are those that need priority for close monitoring and intensive management even in resource-constrained settings.[22] The study further emphasizes the importance of systematic neurological examination in acute stroke assessment. Simple bedside findings such as neck stiffness can provide significant prognostic information and guide clinical practice. This would be particularly applicable in settings where advanced imaging or monitoring is not yet available.[23] Furthermore, our results warrant the continued use of GCS in stroke assessment despite its deficiency in focal neurological deficits. The demonstrable association between GCS categories and stroke type validates its use to assess consciousness, although clinical acumen should be tempered by the individuality of stroke presentations.[24]

Limitations of the study

This study has several limitations that need to be considered. The single-site study and relatively low number of participants may limit the generalizability of findings to other populations and healthcare settings. The observational nature of the study precludes causal inferences between predictors that were identified and impaired consciousness. Detailed imaging parameters such as infarct volume or site, which potentially possess some additional predictive power, were not included in the study.

Conclusion

This study establishes that hemorrhagic stroke type, neck stiffness, and convulsions independently predict impaired consciousness in patients with acute stroke. Hemorrhagic stroke patients are nearly 3 times more likely to present with impaired consciousness than ischemic stroke patients. The clinical predictors outlined in this study can guide early triage, the use of resources, and the management of patients. These findings underscore the importance of careful neurological examination and serial assessment of the level of consciousness in the management of acute stroke, particularly in resource-limited settings where early detection of high-risk patients is critical to optimal outcome.

Recommendations

Future studies would seek to develop integrative models of prediction employing high-tech imaging measures and biomarkers that maximize the accuracy of consciousness level prediction. Multi-center, larger-sized sample studies need to confirm these findings in diverse populations and practitioners.

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Conflict of interest

None declared.

Ethical approval

The study was approved by the Institutional Ethics Committee.

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