RESEARCH PAPER

Hyperglycemia in Acute Cerebrovascular Accident - A Study of Outcome in Terms of Morbidity and Mortality

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ABSTRACT
Introduction
Acute stroke remains a leading cause of global mortality and disability. Admission hyperglycemia is a common, modifiable factor linked to poorer outcomes, though its impact on recovery duration and mortality in diverse clinical settings requires further characterization.
Aims and Objectives
This study aimed to assess the association between admission hyperglycemia and in-hospital mortality, recovery duration, and clinical outcomes in acute stroke patients. Secondary objectives included analyzing prognostic factors like stroke severity and complications.
Materials and Methods
A hospital-based observational study included 93 consecutively admitted acute stroke patients. Demographics, clinical parameters, laboratory investigations (including blood glucose, renal function, electrolytes), treatment details, and outcomes (mortality, modified Rankin Scale [mRS], National Institutes of Health Stroke Scale [NIHSS], recovery duration) were recorded. Statistical analysis included descriptive statistics and bivariate analysis (chi-square/t-test).
Results
The cohort was elderly (71.24% ≥60 years), with a slight male predominance (55.91%). Hyperglycemia (BGL >140 mg/dl) was present in 48.39% of patients. Normoglycemia at admission was a strong independent protective factor against mortality (91.67% survival vs. 8.33%, p=0.01). Excellent early neurological status (mRS 0-2 or NIHSS <8 at admission/48 hours) predicted 100% survival (p<0.001). Hyperglycemia did not significantly affect recovery duration among survivors (p=0.28). Common complications included renal failure (60%) and infections (40%).
Conclusion
Admission normoglycemia and mild early neurological deficits are powerful predictors of survival in acute stroke. Implementing stringent glucose management and early neurological assessment protocols is crucial for improving outcomes.
Keywords: Acute Stroke, Hyperglycemia, Mortality, NIHSS, mRS, Prognostic Factors.
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INTRODUCTION

Cerebrovascular accident (CVA), commonly referred to as stroke, is an acute neurological disorder characterized by a sudden compromise of cerebral blood flow, resulting in focal neurological deficits. Stroke represents a major global health concern, being the second leading cause of mortality worldwide and a significant contributor to long-term disability and morbidity [1]. Globally, strokes are classified into ischemic and hemorrhagic types. Ischemic strokes, which account for approximately 62% of all cases, occur due to obstruction of cerebral arteries, while hemorrhagic strokes include intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH), contributing to 28% and 10% of cases, respectively [2]. The understanding of ischemic stroke subtypes is further refined by the Trial of Org 10172 in Acute Stroke Treatment (TOAST) classification, which identifies large vessel disease, small vessel disease, and cardioembolism as primary etiologies. Large vessel disease encompasses pathologies such as atherosclerosis, arterial dissection, and artery-to-artery embolism. Small vessel disease is typically caused by lipohyalinosis and microatheroma formation, whereas cardioembolic strokes arise from conditions including atrial fibrillation, valvular heart disease, mechanical heart valves, and cardiomyopathies [3,4–7].Hemorrhagic strokes, although less frequent, are associated with high mortality and morbidity. Subarachnoid hemorrhage predominantly results from ruptured intracranial aneurysms. Less common causes include arteriovenous malformations, dural venous sinus thrombosis, and drug-induced vascular injury from substances such as amphetamines and cocaine. Contributing risk factors include hypertension, smoking, excessive alcohol consumption, advanced age, and coagulopathies [8,9]. Intracerebral hemorrhage, the second most prevalent hemorrhagic subtype, arises from rupture of small penetrating arteries, often due to chronic hypertensive vasculopathy or cerebral amyloid angiopathy. Additional factors contributing to ICH include systemic coagulopathies, vascular malformations, use of sympathomimetic drugs, and anticoagulant or antiplatelet therapy [10].The global burden of stroke continues to rise, particularly in low- and middle-income countries, where limited access to healthcare and preventive strategies exacerbates morbidity and mortality. In India, stroke incidence ranges from 119 to 145 per 100,000 population annually, ranking as the fourth leading cause of mortality and fifth leading cause of disability. Urban populations demonstrate a higher prevalence compared to rural regions, and notably, a significant proportion of stroke cases occur in individuals younger than 50 years, highlighting a shift toward younger age groups compared to Western populations.Understanding the epidemiology, classification, and risk factors of stroke is essential for early recognition, prevention, and management. Comprehensive knowledge of ischemic and hemorrhagic mechanisms, along with patient-specific risk profiles, can inform targeted therapeutic strategies and reduce the substantial global and regional burden associated with cerebrovascular accidents.

Stroke is a leading cause of global mortality and disability, primarily categorized into ischemic (arterial blockage) and hemorrhagic (bleeding) types. Its burden is rising, especially in low- and middle-income countries, with a notable trend toward younger age groups in regions like India. Understanding its epidemiology, classifications, and risk factors is essential for effective prevention and targeted treatment strategies.

MATERIALS AND METHODS

Study design: This study was designed as an observational cross-sectional study.

Place of study: The study was conducted at in Medicine ward and MICU, Durgapur steel plant hospital, Durgapur, West Bengal.

Period of study: The study duration was 12 months

Study Population: The study population comprised all patients diagnosed with Cerebrovascular Accident (CVA) admitted to the Medicine department of Durgapur Steel Plant Hospital, who met the inclusion criteria.

Sample size: The sample size was finalized to be 93.

Inclusion Criteria:

- Patients admitted with Cerebrovascular Accident (CVA).
- Patients who were admitted within twenty-four hours of the onset of symptoms.
- Blood sugar was recorded within twenty-four hours of the onset of the stroke.

Exclusion criteria:

- Patients admitted after twenty-four hours of stroke onset.
- Patients presenting with stroke-like symptoms, but diagnosed with other illnesses

Study Variable:

- Demographic Variables
- Age (categorized)
- Gender
- Clinical History & Comorbidities
- Stroke Presentation & Type
- IV. Admission Clinical Parameters
- Vital Signs:
- Stroke Severity Scales
- Key Laboratory Investigations (at Admission)
- Treatment Variables
- Hospital Course Variables
- Outcome Variables

Statistical Analysis: For statistical analysis, data were initially entered into a Microsoft Excel spreadsheet and then analyzed using SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism (version 5). Numerical variables were summarized using means and standard deviations, while Data were entered into Excel and analyzed using SPSS and GraphPad Prism. Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correlations in paired data. Chi-square tests (including Fisher's exact test for small sample sizes) were used for categorical data comparisons. P-values ≤ 0.05 were considered statistically significant.

RESULT

Table 1: Distribution of Study Participants by Age Group and Gender (%)

Parameter	Category	Percentage (%)
Age Group (in completed years)	40–49	7.53
	50–59	20.43
	60–69	35.48
	70–79	25.81
	≥80	10.75
Gender	Male	55.91
	Female	44.09

Table 2: Clinical and Demographic Characteristics of Study Participants (%)

Parameter	Category	Percentage (%)
History of Diabetes Mellitus	Yes	44.09
	No	55.91
History of Stroke	Yes	22.58
	No	77.42
Type of Stroke	Ischemic	86.02
	Hemorrhagic	13.98
Pulse Rate (per minute)	<90	20.43
	90–109	58.06
	≥110	21.51
Systemic Blood Pressure (mmHg)	<120	18.28
	120–140	59.14
	>140	22.58
Diastolic Blood Pressure (mmHg)	<80	84.95
	80–90	12.9
	>90	2.15
Respiratory Rate (per minute)	<12	15.05
	12–20	59.14
	>20	25.81

Table 3: Laboratory Investigations of Study Participants (n=93)

Lab Investigation (Reference Range)	Controlled / Normal, N	Uncontrolled / Abnormal, N
S. Urea (20–40 mg/dl)	76	17
S. Uric Acid (3.5–7.2 mg/dl)	88	5
S. Creatinine (0.7–1.2 mg/dl)	62	31
S. Bilirubin (0.1–1.2 mg/dl)	73	20
S. Sodium (135–145 mEq/L)	56	37
S. Potassium (3.5–5.5 mEq/L)	60	33
S. Albumin (>3.5 g/dl)	81	12

Table 4: Baseline Characteristics, Clinical Management, and Outcomes of Ischemic Stroke Patients Stratified by Glycemic Status

Parameter	Category	Frequency (N)	Percentage (%)
Group Assigned (Based on BGL*)	Hyperglycemic (BGL > 140 mg/dl)	45	48.39
	Normoglycemic (BGL < 140 mg/dl)	48	51.61
Reporting Time to Hospital	< 6 hours	58	62.37
	≥ 6 hours	35	37.63
Treatment Received	Thrombolysis	52	55.91
	Antiplatelet and Physiotherapy	28	30.11
	Craniotomy	10	10.75
	Advised Craniotomy, but refused	3	3.23
Duration of Hospital Stay (Days)	< 7 days	38	40.86
	7–14 days	28	30.11
	> 14 days	27	29.03
Need for Mechanical Ventilation	Yes	26	27.96
	No	67	72.04
History of Complications	Yes	35	37.63
	No	58	62.37
Complications (Among 35 Patients with History)	Infections	14	40
	Renal failure	21	60
Outcome	Alive	77	82.8
	Dead	16	17.2

Table 5: Mean Duration of Recovery Stratified by Glycemic Status and Stroke Type

Variable	Group	Mean	SD	P value
Duration of Recovery (Days)	Patients with Hyperglycemia (N=33)	10.54	3.84	0.28
	Patients without Hyperglycemia (N=44)	11.57	4.35	
Duration of Recovery (Days)	Ischemic (N=66)	10.95	3.91	0.39
	Haemorrhagic (N=11)	12.09	5.18	

Table 6: Factors associated with Good Outcome of patient

Variable	Alive (N=77)	Dead (N=16)	P value
Age ≤ 60 years	29 (90.63%)	3 (9.38)	0.14
Female sex	34 (82.93%)	7 (17.07)	0.98
No History of DM	44 (84.62%)	8 (15.38)	0.6
No History of HTN	38 (80.85%)	9 (19.15)	0.61
No Previous Stroke	59 (89.39%)	7 (10.61)	0.02
Ischemic Stroke	66 (82.50%)	14 (17.50)	0.9
Pulse Rate < 110/min	59 (80.82%)	14 (19.18)	0.54
SBP < 140 mmHg	71 (81.61%)	16 (18.39)	0.31
DBP < 90 mmHg	71 (82.56%)	15 (17.44)	0.9
Respiratory Rate < 20/min	52 (81.25%)	12 (18.75)	0.79
RBS at Admission <140 mg/dL	44 (91.67%)	4 (8.33)	0.01
Blood Sugar at 6 hrs <140 mg/dL	38 (76.00%)	12 (24.00)	0.06
Blood Sugar at 12 hrs <140 mg/dL	27 (90.70%)	2 (9.30)	0.07
Blood Sugar at 24 hrs <140 mg/dL	20 (80.85%)	8 (19.15)	0.07
S. Urea, Controlled	62 (81.58%)	14 (18.42)	0.8
S. Creatinine, Controlled	53 (85.48%)	9 (14.52)	0.33
S. Albumin, Normal	70 (82.35%)	15 (17.65)	0.79
S. Sodium, Normal	47 (83.93%)	9 (16.07)	0.72
S. Potassium, Normal	49 (81.67%)	11 (18.33)	0.35
S. Uric Acid, Controlled	73 (82.95%)	15 (17.05)	0.82
S. Bilirubin, Controlled	61 (83.56%)	12 (16.44)	0.7
Reporting Time <6 hrs	48 (82.76%)	10 (17.24)	0.9
Hospital Stay <10 days	37 (92.50%)	3 (7.50)	0.03
No Need for Mechanical Ventilation	61 (91.04%)	6 (8.96)	0.001
No Complications	54 (94.74%)	3 (5.26)	<0.001
mRS score at Admission 0-2	37 (100.00%)	0 (0.00)	<0.001
mRS score at 48 hrs 0-2	45 (100.00%)	0 (0.00)	<0.001
NIHSS score at Admission <8	36 (100.00%)	0 (0.00)	<0.001
NIHSS score at 48 hrs <8	46 (100.00%)	0 (0.00)	<0.001

Figure 1: Distribution of Study Participants by Age Group and Gender (%)

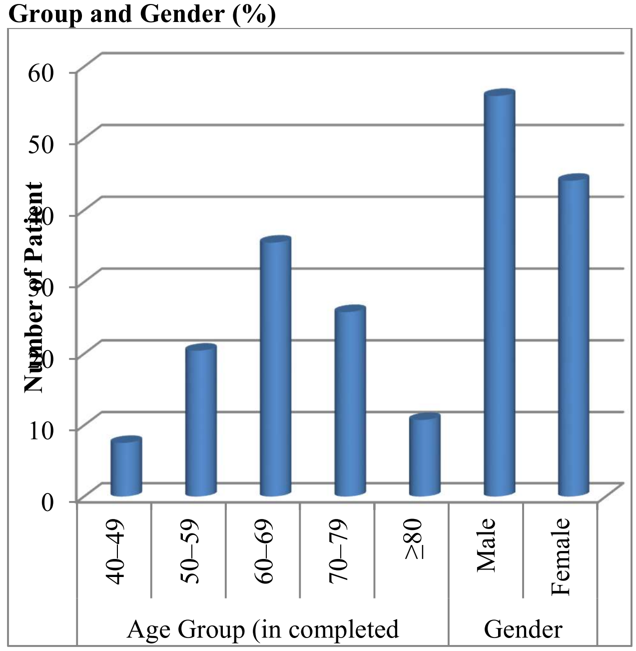
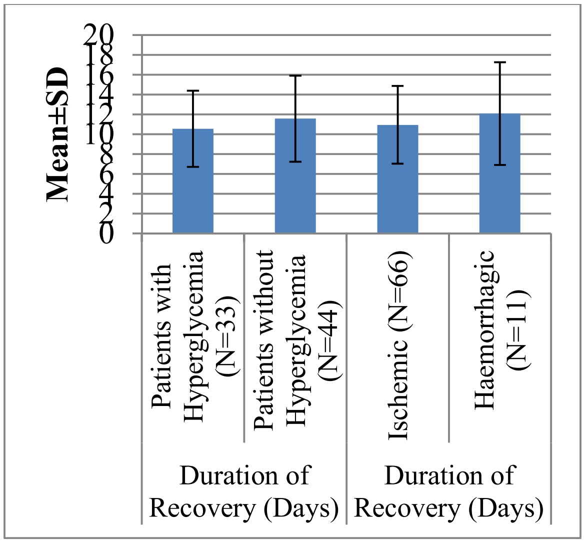


Figure 2: Mean Duration of Recovery Stratified by Glycemic Status and Stroke Type



The study enrolled a total of 93 patients diagnosed with acute stroke. Analysis of the baseline demographic profile revealed a predominantly elderly cohort, with the majority of patients (71.24%) being 60 years of age or older. The most common age group was 60–69 years, accounting for 35.48% of participants. This was followed by patients aged 70–79 years (25.81%), 50–59 years (20.43%), ≥80 years (10.75%), and 40–49 years (7.53%). In terms of gender distribution, there was a slight male predominance, with males constituting 55.91% of the study population and females comprising the remaining 44.09%.

The study enrolled a total of 93 patients diagnosed with acute stroke. Analysis of the baseline demographic and clinical profile revealed a predominantly elderly cohort, with the majority of patients (71.24%) being 60 years of age or older, and a slight male predominance (55.91%). Regarding comorbidities, 44.09% had a history of Diabetes Mellitus, while 22.58% had a previous history of stroke. The vast majority of strokes were ischemic in nature (86.02%). Vital sign parameters at admission showed that most patients were normotensive, with 59.14% presenting with a systolic blood pressure within the 120–140 mmHg range and 84.95% with a diastolic pressure below 80 mmHg. Most patients (58.06%) had a pulse rate between 90–109 beats per minute, and the majority (59.14%) had a respiratory rate within the normal range of 12–20 breaths per minute.

Laboratory investigations upon admission revealed specific patterns of metabolic and electrolyte status among the 93 stroke patients. The majority of patients had controlled serum levels of Uric Acid (N=88, 94.6%) and Albumin (N=81, 87.1%). Serum Urea was also within the normal range for most patients (N=76, 81.7%). However, a significant proportion of the cohort exhibited electrolyte imbalances, with Serum Sodium being abnormal in 37 patients (39.8%) and Serum Potassium in 33 patients (35.5%). Notably, renal function appeared compromised in a substantial subset, as indicated by elevated Serum Creatinine levels in 31 patients (33.3%). Serum Bilirubin was elevated in 20 patients (21.5%).

Based on admission blood glucose levels (BGL), the cohort was nearly equally divided into hyperglycemic (BGL > 140 mg/dl, 48.39%) and normoglycemic (BGL < 140 mg/dl, 51.61%) groups. The majority of patients (62.37%) presented to the hospital within 6 hours of symptom onset. Regarding acute management, thrombolysis was the most common treatment (55.91%), followed by antiplatelet therapy with physiotherapy (30.11%); a minority required or were advised to undergo craniotomy (13.98% combined). The duration of hospital stay varied, with 40.86% staying less than 7 days, 30.11% staying 7–14 days, and 29.03% requiring more than 14 days of hospitalization. A significant proportion of patients (27.96%) required mechanical ventilation. Complications during hospitalization were reported in 37.63% of patients, with renal failure (60%) being more frequent than infections (40%) among those with complications. Ultimately, the majority of patients survived to discharge (82.8%), with a mortality rate of 17.2%.

The mean duration of recovery among survivors was analyzed based on glycemic status and stroke type. Patients presenting with hyperglycemia (N=33) had a mean recovery time of 10.54 days (SD ± 3.84), while normoglycemic patients (N=44) had a mean of 11.57 days (SD ± 4.35). This difference was not statistically significant (p=0.28). Similarly, when stratified by stroke type, patients with ischemic stroke (N=66) had a mean recovery duration of 10.95 days (SD ± 3.91), compared to 12.09 days (SD ± 5.18) for those with hemorrhagic stroke (N=11). This difference was also not statistically significant (p=0.39).

Bivariate analysis identified several factors significantly associated with reduced in-hospital mortality among acute stroke patients. Normoglycemia at admission (RBS <140 mg/dL) was strongly protective, with 91.67% of normoglycemic patients surviving compared to only 8.33% mortality (p=0.01). Key indicators of a less severe clinical course were also significant protective factors: a hospital stay of less than 10 days (92.50% survival, p=0.03), no need for mechanical ventilation (91.04% survival, p=0.001), and the absence of complications (94.74% survival, p<0.001). Furthermore, excellent early neurological status was a powerful predictor of survival: 100% of patients with a good functional status (mRS 0-2) or mild stroke severity (NIHSS <8) at admission and at 48 hours survived (p<0.001 for all). A history of no previous stroke was also associated with significantly higher survival (89.39%, p=0.02).

DISCUSSION

This study of 93 acute stroke patients highlights the critical role of admission hyperglycemia, with nearly half (48.39%) presenting with BGL >140 mg/dl and normoglycemia emerging as a strong independent protective factor against mortality (p=0.01), a finding consistent with established literature linking acute hyperglycemia to exacerbated cerebral injury and worse outcomes [16, 17]. Our results further validate key prognostic indicators, as a mild NIHSS score (<8) or good functional status (mRS 0-2) at admission and 48 hours predicted 100% survival, aligning with studies that emphasize early neurological assessment [19], while the absence of complications, shorter hospital stays, and no need for mechanical ventilation were also significantly associated with survival, reflecting a less severe clinical course [18]. Interestingly, hyperglycemia did not significantly affect recovery duration among survivors (p=0.28), nor did stroke subtype (p=0.39), though the latter contrasts with some reports of longer hemorrhagic stroke recovery [20], potentially due to our smaller hemorrhagic sample. The high prevalence of electrolyte imbalances and renal dysfunction underscores the systemic metabolic disruption in stroke, necessitating vigilant monitoring. In conclusion, our findings reinforce admission hyperglycemia as a modifiable risk factor and early neurological scores as vital prognostic tools, advocating for stringent glucose and electrolyte management protocols from emergency care onward to improve outcomes in this predominantly elderly cohort.

CONCLUSION

In summary, this study reaffirms that admission hyperglycemia is a significant and modifiable predictor of mortality in acute stroke patients, underscoring the urgent need for systematic glucose monitoring and management from the point of emergency care. Early assessment using validated scales such as the NIHSS and mRS provides crucial prognostic information that can guide clinical decision-making and patient counseling. Additionally, the frequent occurrence of metabolic and electrolyte disturbances highlights the importance of comprehensive supportive care alongside acute stroke interventions. Implementing standardized protocols for glycemic control, electrolyte balance, and complication prevention could substantially improve survival and functional outcomes in stroke care, particularly in elderly populations.

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