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Assessment of Stroke and Treatment Outcomes among Patients at Tertiary Care Hospital

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ABSTRACT

Objective: To evaluate in-hospital outcomes among patients with acute stroke and identify demographic, clinical, and laboratory factors associated with unfavourable outcomes at a tertiary care hospital in Multan, Pakistan.

Methodology: A hospital-based cross-sectional descriptive study was conducted in the Department of Medicine at a tertiary care hospital in Multan, Pakistan, over a six-month period. Adult patients (≥18 years) with a clinical and radiological diagnosis of acute stroke were consecutively enrolled, while patients with transient ischemic attack, traumatic intracranial hemorrhage, stroke mimics, incomplete records, or refusal to participate were excluded. Data on demographic characteristics, vascular risk factors, laboratory parameters, treatment received, and in-hospital outcomes were collected using a structured questionnaire and medical records. Data were analyzed using IBM SPSS Statistics version 23.0. Descriptive statistics, the independent-samples *t*-test, Chi-square test, and multivariable logistic regression were performed.

Result: A total of 289 stroke patients were included, with a mean age of 61.8 ± 13.5 years and 52.6% males. Unfavorable outcomes were more frequent among older patients and those with diabetes mellitus, hypertension, and ischemic heart disease. Multivariable logistic regression identified increasing age (AOR 1.42 per 10-year increase; 95% CI: 1.14–1.76; p=0.002), diabetes mellitus (AOR 1.74; 95% CI: 1.01–2.98; p=0.046), higher HbA1c (AOR 1.28 per 1% increase; 95% CI: 1.07–1.53; p=0.007), elevated LDL cholesterol (AOR 1.11 per 10 mg/dL increase; 95% CI: 1.03–1.19; p=0.004), and serum creatinine (AOR 2.08; 95% CI: 1.28–3.39; p=0.003) as independent predictors of unfavorable outcomes. Sex, hypertension, smoking, and family history were not significant predictors after adjustment.

Conclusion: Among patients admitted with acute stroke at a tertiary care hospital, advanced age, diabetes mellitus, poor glycemic control, elevated LDL cholesterol, and impaired renal function were associated with unfavourable in-hospital outcomes. These findings highlight the importance of early risk stratification and identification of modifiable metabolic and clinical factors associated with unfavourable short-term stroke outcomes.

Keywords: Cardiovascular risk factors, Coma, Diabetes mellitus, HbA1c, In-hospital outcome, Serum creatinine,

Authors' Contribution:
[1,2]Conception; Literature research; manuscript design and drafting; [2,3]Critical analysis and manuscript review; [3]Data analysis; Manuscript Editing.

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Introduction

A stroke is an acute neurological disorder resulting from focal injury to the brain.[1] It is the leading cause of death and disability worldwide,[2,3] particularly in economically constrained countries, where the majority of stroke- related mortality and disability place an additional burden on society.[4] Stroke outcomes are associated with various demographic, clinical, and vascular risk factors, including diabetes mellitus, hypertension, obesity, smoking, and age.[5]

Stroke remains a significant public health challenge in Pakistan and other developing countries, due in part to limited resources and, on the patient's part, a lack of awareness and consultation.[6] Although Sub-Saharan Africa (SSA) was once considered to have a stroke prevalence less than half that of developed countries, recent evidence suggests a rising burden of stroke across the region, with substantial social and economic impacts.[7] Current studies indicate that the incidence of stroke in developing countries is now comparable to that in developed regions. However, data on the magnitude of this increase within SSA are limited, with most originating from South Africa.[8] Pakistan, currently the sixth most populous country in the world, has limited robust population- based data on the prevalence of stroke and its risk factors. Only two small- scale population-based studies were conducted a decade ago in Karachi, the single metropolitan city of Pakistan. The prevalence of stroke in these studies was 4. 4.8% and 19. 1%, the highest in the region.[9] The incidence of stroke is rising continuously in Asian and Sub- Saharan African countries, attributed to a growing prevalence of certain diseases such as DM, HIV, post- COVID- 19 cases, and an emerging vascular disease crisis linked to urbanization.[10] Research has revealed a disparity in hypertension rates between rural and urban stroke patients, with lower rates observed among rural populations.[11,12] Despite a decrease in HIV incidence in Zimbabwe over the past two decades, from 3% to 1. 1.2% and subsequently to 0. 74% in 2015, many people living with HIV remains at increased risk of stroke.[13] Liégeois et al conducted a study and reported a 25% in- hospital mortality rate in stroke patients.[14]

Stroke has remained one of the leading causes of disability and mortality globally, with a substantial burden on the health care system, specifically in developing countries like Pakistan. The World Health Organization has declared that stroke is nearly 11% responsible for the stroke related deaths and disabilities globally.[15] The tertiary care hospitals are the health care providing units that play a vital role in offering the best services to the patient in an emergency like stroke. In Pakistan, patients with stroke are frequently admitted to the tertiary care setups and provided the required therapeutic options; however, no study has documented the actual frequency and outcome measures in this region.

Recent studies have identified several factors associated with stroke outcomes, including demographic characteristics, hypertension, diabetes mellitus, smoking, body mass index, and age. However, evidence describing the clinical outcomes of stroke patients in tertiary care settings in southern Punjab remains limited. To address this gap, the present study was conducted to assess stroke and treatment outcomes among patients admitted to a tertiary care hospital in Multan and to evaluate the association of demographic, clinical, and laboratory characteristics with these outcomes. The findings are expected to provide local evidence to support clinical decision-making and guide future research in the region.

Methodology

A hospital-based cross-sectional descriptive study was conducted in the Department of Medicine, Nishtar-2 Tertiary Care Hospital, Multan, Pakistan, over a six-month period (December 2024 to May 2025). Study included adult patients (≥18 years) admitted to the medical ward with a clinical and radiological diagnosis of acute stroke during the study period. Both ischemic and hemorrhagic stroke patients were eligible for inclusion irrespective of sex. Patients with transient ischemic attack (TIA), traumatic intracranial hemorrhage, stroke mimics, incomplete medical records, or those who declined participation were excluded from the study.

Sample size was calculated using Cochran's formula for estimating a single population proportion. Assuming an expected in-hospital mortality proportion of 25%[16] based on previously published literature, a 95% confidence level, and a 5% margin

of error, the minimum required sample size was estimated to be 289 participants. A non-probability consecutive sampling technique was used, whereby all eligible patients admitted during the study period who fulfilled the inclusion criteria were consecutively enrolled until the required sample size was achieved.

Data were collected using a structured, investigator-developed data collection proforma and a review of patients' medical records. Proforma was designed to systematically capture variables relevant to the study objectives, including demographic characteristics (age, sex, body mass index [BMI], smoking status, and family history of stroke), clinical characteristics (stroke type, hypertension, diabetes mellitus, and ischemic heart disease), laboratory parameters (glycated hemoglobin [HbA1c], low-density lipoprotein [LDL] cholesterol, and serum creatinine), treatment received during hospitalization, and clinical outcomes recorded during the hospital stay. The dependent variable was the clinical outcome of stroke patients during hospitalization, while the independent variables included demographic characteristics, vascular risk factors, laboratory parameters, smoking status, family history of stroke, and treatment received. Clinical outcomes were assessed based on the patient's condition during hospitalization and discharge as documented in the medical records.

The primary outcome of the study was the clinical outcome of stroke patients during hospitalization. For analysis purposes, patients were categorized into two groups: favorable and unfavorable outcomes. A favorable outcome was defined as clinical improvement with stabilization of the patient's condition and discharge from the hospital without major in-hospital adverse events. An unfavorable outcome was defined as the occurrence of in-hospital mortality or major complications during hospitalization, including neurological deterioration, aspiration pneumonia, seizures, recurrent stroke, or prolonged hospitalization requiring continued inpatient management.

The dependent variable was the clinical outcome category (favorable versus unfavorable outcome). Independent variables included demographic characteristics (age and sex), anthropometric measurements (body mass index), vascular risk factors (diabetes mellitus, hypertension, smoking status, ischemic heart disease, and family history of stroke), laboratory parameters (HbA1c, LDL cholesterol, and serum creatinine), and treatment-related variables documented during hospitalization. Diabetes mellitus was defined as a previous diagnosis documented in medical records or use of antidiabetic medication. Hypertension was defined as a documented history of hypertension or current antihypertensive therapy. Smoking status was recorded based on self-reported current smoking history. Ischemic heart disease was defined as a previous diagnosis of coronary artery disease documented in medical records. Laboratory parameters including HbA1c, LDL cholesterol, and serum creatinine were recorded from investigations performed during hospitalization.

Data were entered into Microsoft Excel and analyzed using SPSS 23. Continuous variables were assessed for normality and summarized as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages. Comparisons between categorical variables were performed using the Chi-square test or Fisher's exact test, where appropriate, while continuous variables were compared using the independent-samples Student's t-test. Pearson's correlation coefficient was used to evaluate relationships between continuous variables. Univariable logistic regression analysis was initially performed to assess the association of individual demographic, clinical, and laboratory variables with unfavorable stroke outcomes. Variables demonstrating clinical relevance or statistical significance in univariable analysis were included in the multivariable logistic regression model to identify factors independently associated with unfavorable stroke outcomes after adjustment for potential confounding variables,

including age, sex, vascular risk factors, anthropometric parameters, and laboratory characteristics. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported. A two-sided p-value ≤0.05 was considered statistically significant.

Ethical approval was obtained from the Institutional Ethical Review Board of Nishtar Medical University, Multan before commencement of the study (Reference No. 18992/NMU Dated: 02-11-2024). Written informed consent was obtained from all participants or their legally authorized attendants before enrollment.

Results

A total of 289 patients with acute stroke were included in the study. Mean age of the study participants was 61.8 ± 13.5 years. The gender distribution was nearly balanced, with 152 (52.6%) male and 137 (47.4%) female patients. Mean body mass index (BMI) was 23.9 ± 3.3 kg/m². Among the evaluated vascular risk factors, hypertension was the most frequently observed comorbidity, present in 186 (64.4%) patients, followed by diabetes mellitus in 109 (37.7%) and ischemic heart disease in 58 (20.1%) patients. Smoking was reported in 41 (14.2%) patients, while a family history of stroke was documented in 12 (4.1%) patients. Laboratory evaluation showed a mean HbA1c level of 7.2 ± 1.6%, LDL cholesterol level of 124.8 ± 32.4 mg/dL, and serum creatinine level of 1.12 ± 0.39 mg/dL as shown in Table I.

Patients with unfavorable outcomes were older compared with those with favorable outcomes (68.7 ± 13.1 vs. 59.4 ± 12.8 years, p < 0.001). Mean BMI was lower among patients with unfavorable outcomes (22.8 ± 3.5 vs. 24.3 ± 3.2 kg/m², p = 0.003). Prevalence of diabetes mellitus was higher among patients with unfavorable outcomes compared with favorable outcomes (49.3% vs. 33.9%, p = 0.023). Similarly, hypertension (74.6% vs. 61.0%, p = 0.041) and ischemic heart disease (28.2% vs. 17.4%, p = 0.048) were more frequently observed among patients with unfavorable outcomes. No statistically significant differences were observed regarding sex distribution, smoking status, or family history of stroke between the two outcome groups (p > 0.05).

Table I: Baseline Demographic, Clinical, and Laboratory Characteristics of Stroke Patients (N = 289)

Variable	N (%)
Age (years), Mean ± SD	61.8 ± 13.5
Male, n (%)	152 (52.6)
Female, n (%)	137 (47.4)
BMI (kg/m²), Mean ± SD	23.9 ± 3.3
Diabetes mellitus, n (%)	109 (37.7)
Hypertension, n (%)	186 (64.4)
Ischemic heart disease, n (%)	58 (20.1)
Smoking, n (%)	41 (14.2)
Family history of stroke, n (%)	12 (4.1)
HbA1c (%), Mean ± SD	7.2 ± 1.6
LDL cholesterol (mg/dL), Mean ± SD	124.8 ± 32.4
Serum creatinine (mg/dL), Mean ± SD	1.12 ± 0.39

Table II: Comparison of Demographic, Clinical, and Laboratory Characteristics According to Stroke Outcome

Variable	Favorable (n=218)	Unfavorable (n=71)	p-value
Age (years)	59.4 ± 12.8	68.7 ± 13.1	<0.001
Male	118 (54.1)	34 (47.9)	0.37
BMI (kg/m²)	24.3 ± 3.2	22.8 ± 3.5	0.003
Diabetes mellitus	74 (33.9)	35 (49.3)	0.023
Hypertension	133 (61.0)	53 (74.6)	0.041
Ischemic heart disease	38 (17.4)	20 (28.2)	0.048
Smoking	28 (12.8)	13 (18.3)	0.26
Family history of stroke	7 (3.2)	5 (7.0)	0.17
HbA1c (%)	6.9 ± 1.4	8.0 ± 1.7	<0.001
LDL cholesterol (mg/dL)	120.6 ± 30.1	137.5 ± 34.8	<0.001
Serum creatinine (mg/dL)	1.05 ± 0.31	1.34 ± 0.48	<0.001

**Data are presented as mean ± standard deviation or frequency (%). Favorable outcome was defined as clinical improvement and discharge without major in-hospital adverse events, whereas unfavorable outcome was defined as in-hospital mortality or occurrence of major in-hospital complications.*

Table III: Multivariable Logistic Regression Analysis of Factors Associated with Unfavorable Stroke Outcomes			
Predictor	**Adjusted OR**	**95% CI**	**p-value**
Age (per 10-year increase)	1.42	1.14-1.76	0.002
Female sex	1.09	0.63-1.88	0.76
Diabetes mellitus	1.74	1.01-2.98	0.046
Hypertension	1.53	0.88-2.65	0.13
Smoking	1.36	0.63-2.94	0.43
BMI (per kg/m²)	0.91	0.84-0.99	0.028
HbA1c (per 1% increase)	1.28	1.07-1.53	0.007
LDL cholesterol (per 10 mg/dL increase)	1.11	1.03-1.19	0.004
Serum creatinine	2.08	1.28-3.39	0.003
Family history of stroke	1.67	0.47-5.88	0.43

**Multivariable logistic regression analysis was performed to identify factors associated with unfavorable stroke outcomes. The model was adjusted for age, sex, diabetes mellitus, hypertension, smoking status, BMI, HbA1c, LDL cholesterol, serum creatinine, and family history of stroke. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) are presented.*

Laboratory parameters also differed significantly between outcome groups. Patients with unfavorable outcomes had higher mean HbA1c levels (8.0 ± 1.7% vs. 6.9 ± 1.4%, $p < 0.001$), higher LDL cholesterol levels (137.5 ± 34.8 vs. 120.6 ± 30.1 mg/dL, $p < 0.001$), and higher serum creatinine levels (1.34 ± 0.48 vs. 1.05 ± 0.31 mg/dL, $p < 0.001$) compared with patients with favorable outcomes as mentioned in Table II.

Increasing age was independently associated with higher odds of unfavorable outcomes, with 42% higher odds of unfavorable outcome for every 10-year increase in age (adjusted OR [AOR] 1.42, 95% CI: 1.14-1.76, p = 0.002). Among clinical risk factors, diabetes mellitus was independently associated with unfavorable stroke outcomes (AOR 1.74, 95% CI: 1.01-2.98, p = 0.046). Higher HbA1c levels were also associated with increased odds of unfavorable outcomes (AOR 1.28 per 1% increase, 95% CI: 1.07-1.53, p = 0.007). Similarly, higher LDL cholesterol levels (AOR 1.11 per 10 mg/dL increase, 95% CI: 1.03-1.19, p = 0.004) and elevated serum creatinine levels (AOR 2.08, 95% CI: 1.28-3.39, p = 0.003) were significant predictors of unfavorable stroke outcomes.

BMI showed an inverse association with unfavorable outcomes (AOR 0.91 per kg/m² increase, 95% CI: 0.84-0.99, p = 0.028). In contrast, sex, hypertension, smoking status, and family history of stroke were not significantly associated with unfavorable outcomes after adjustment ($p > 0.05$) as shown in Table III.

Discussion

This hospital-based cross-sectional study evaluated demographic characteristics, vascular risk factors, laboratory parameters, and factors associated with unfavorable in-hospital outcomes among patients admitted with acute stroke at a tertiary care hospital in Multan. Study population comprised predominantly older adults, with a nearly balanced gender distribution. Similar demographic patterns have been reported in previous studies, where increasing age has been identified as an important factor associated with stroke occurrence and prognosis.[17] Differences in gender distribution across populations may reflect variations in risk-factor profiles, healthcare access, and demographic characteristics.[18]

Hypertension was the most frequently observed vascular risk factor in our study, followed by diabetes mellitus and ischemic heart disease. These findings are consistent with previous literature identifying hypertension and diabetes mellitus as major risk factors associated with stroke occurrence and adverse clinical outcomes.[19] The high

prevalence of modifiable vascular risk factors highlights the importance of early identification, preventive strategies, and comprehensive management among individuals at risk of stroke. In the present study, increasing age was independently associated with unfavorable stroke outcomes. Previous studies have similarly reported that advanced age is associated with greater stroke severity, higher comorbidity burden, reduced physiological reserve, and increased risk of mortality and disability following stroke.[20,21] These findings support the importance of early risk assessment and individualized clinical management, particularly among older stroke patients.

Diabetes mellitus was independently associated with unfavorable outcomes after adjustment for potential confounding factors. Previous evidence has demonstrated that diabetes mellitus is associated with poorer stroke prognosis through mechanisms involving endothelial dysfunction, accelerated atherosclerosis, inflammation, and impaired neurological recovery.[22] In the present study, higher HbA1c levels were also associated with unfavorable outcomes, suggesting that poor glycemic control may serve as an important marker of increased risk among hospitalized stroke patients. Elevated glycated hemoglobin reflects prolonged exposure to hyperglycemia and has been linked with vascular injury, oxidative stress, and microvascular complications. Similar associations between poor glycemic control and adverse stroke outcomes have been reported previously.[23]

Elevated LDL cholesterol levels were independently associated with unfavorable stroke outcomes in our analysis. Dyslipidemia, particularly increased LDL cholesterol, has been widely recognized as an important factor associated with cerebrovascular risk and adverse vascular profiles. These findings are consistent with previous evidence emphasizing the importance of lipid assessment and management as part of secondary prevention strategies among stroke patients.[24] Similarly, elevated serum creatinine was associated with unfavorable outcomes in the present study. Previous studies have reported that impaired renal function is associated with increased stroke severity, vascular complications, and mortality. The relationship between renal impairment and stroke outcomes may involve shared pathophysiological mechanisms, including endothelial dysfunction, inflammation, and increased vascular risk.[25]

An inverse association was observed between BMI and unfavorable outcomes in this study. Similar findings have been described in previous research, suggesting a potential obesity paradox in stroke outcomes, where patients with higher BMI may demonstrate improved short-term survival compared with those with lower BMI.[26] However, this relationship remains complex and may be influenced by nutritional status, age, disease severity, and underlying comorbidities. Although hypertension and smoking are well-established risk factors for stroke development, neither demonstrated a statistically significant independent association with unfavorable outcomes after adjustment in our analysis. This finding may reflect the influence of other clinical characteristics, duration of exposure, disease severity, and treatment-related factors that contribute to short-term outcomes following stroke.[27]

However, several limitations should be acknowledged. The cross-sectional design restricts the ability to establish temporal relationships or causal associations between risk factors and clinical outcomes. The single-center setting may limit the generalizability of findings to other healthcare facilities and populations. Furthermore, outcomes were assessed only during hospitalization; therefore, long-term functional status, disability, and post-discharge outcomes could not be evaluated. Moreover, important clinical factors, including stroke severity scores, rehabilitation status, socioeconomic determinants, and other potential predictors of outcome, were not assessed. Furthermore, because treatment decisions were based on routine clinical practice, potential

differences in therapeutic approaches could not be fully controlled. Future multicenter prospective studies with longer follow-up periods and standardized functional outcome measures are warranted to further validate these findings.

Conclusion

Age, diabetes mellitus, higher HbA1c levels, elevated LDL cholesterol, and increased serum creatinine were identified as significant predictors of unfavorable in-hospital outcomes among stroke patients admitted to a tertiary care hospital. After adjustment for potential confounding factors, age, diabetes mellitus, glycemic status, lipid levels, renal function, and BMI remained associated with stroke outcomes, whereas sex, hypertension, smoking status, and family history of stroke did not show significant independent associations. These findings highlight the importance of early identification and management of modifiable metabolic and vascular risk factors to improve short-term outcomes among hospitalized stroke patients.

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