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# Glycated Hemoglobin Status in Patients with Stroke Admitted to Holly Family Red Crescent Medical College & Hospital

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***Abstract***
***Background:*** *Stroke remains a leading cause of mortality and long-term disability globally, with glycemic control emerging as a critical determinant of outcomes. The prevalence and patterns of glycated hemoglobin (HbA1c) abnormalities among stroke patients in Bangladesh remain inadequately characterized.* ***Objective:*** *To evaluate the glycated hemoglobin status and its distribution patterns among patients with stroke admitted to a tertiary care hospital in Bangladesh.* ***Methods:*** *This prospective cohort study was conducted at Holy Family Red Crescent Medical College & Hospital, Dhaka, Bangladesh, from July 2025 to December 2025. A total of 97 patients with clinically and radiologically confirmed stroke were enrolled using purposive sampling. HbA1c levels were measured on admission using standardized protocols. Data were analyzed using SPSS version 23.0.* ***Results:*** *Among 97 stroke patients, the mean age was 62.4±11.8 years, with male predominance (58.8%, n=57). Ischemic stroke constituted 74.2% (n=72) of cases. The mean HbA1c was 7.1±1.9%. Overall, 41.2% (n=40) had HbA1c ≥6.5%, indicating pre-existing or newly diagnosed diabetes, while 24.7% (n=24) had prediabetic range (HbA1c 5.7–6.4%). Normoglycemia (HbA1c <5.7%) was observed in 34.0% (n=33).* ***Conclusion:*** *A substantial proportion of stroke patients in this cohort exhibited elevated HbA1c levels, with over two-thirds demonstrating prediabetes or diabetes. Routine HbA1c assessment at admission may facilitate early glycemic optimization and secondary prevention strategies in stroke care.*
***Keywords:*** *Diabetes mellitus, Glycated hemoglobin, Hyperglycemia, Prediabetic state, Stroke.*

## I. INTRODUCTION

Stroke remains the second leading cause of death worldwide, accounting for 6.6 million deaths in 2020, with disability-adjusted life-years reaching 144.8 million during the same period [1]. The global burden of stroke is projected to escalate substantially, with mortality expected to increase by 50% to 9.7 million by 2050 [1]. Alarmingly, the incidence of stroke is increasing at a faster pace in low-income and middle-income countries than in high-income countries, and the burden of disability is disproportionately concentrated in these regions. South Asian populations, including Bangladesh, face a particularly elevated risk, with stroke prevalence estimated at 11.39 per 1000 population in nationwide surveys and an age-and sex-standardized mortality rate of 54.8 per 100,000 [2,3]. The prevalence of diabetes mellitus among South Asian ischemic stroke patients is notably high, with estimates suggesting a 15–27% greater prevalence compared with White British populations and a near 3.5-fold higher risk of diabetes among South Asian stroke patients [4]. These epidemiological patterns underscore the urgent need for region-specific data to inform targeted prevention and management strategies.

Diabetes mellitus is a well-established independent risk factor for both ischemic and hemorrhagic stroke [5]. A meta-analysis of 39 studies demonstrated that the prevalence of diabetes among stroke patients is approximately 28%, with higher rates observed in ischemic stroke (33%) compared with hemorrhagic stroke (26%) [6]. Type 2 diabetes alone is known to increase stroke risk 1.5- to 4-fold, and this association extends across both macrovascular and microvascular pathological pathways [7]. The rising global prevalence of diabetes, estimated to affect nearly 400 million people in 2015 with projections reaching 600 million by 2040, further amplifies the public health significance of understanding glycemic status in stroke populations [8]. Hyperglycemia is common among acute stroke patients and is consistently associated with less favorable outcomes, including infarct expansion, greater neurological deficit, and increased mortality [9].

Glycated hemoglobin (HbA1c) has emerged as a useful biochemical marker reflecting average glycemic control over the preceding 2–3 months, with the distinct advantage of not being affected by short-term transient fluctuations in blood glucose levels [10]. This stability makes HbA1c particularly valuable in the acute stroke setting, where stress hyperglycemia can confound the interpretation of admission glucose measurements [11]. A growing body of evidence supports the prognostic utility of HbA1c in stroke populations. A systematic review and meta-analysis of 22 studies demonstrated that each unit increase in HbA1c was associated with an increased risk of mortality within one-year, poor functional outcome at three months, and symptomatic intracranial hemorrhage within 24 hours of admission in patients with acute ischemic stroke [10]. In patients with HbA1c ≥ 6.5%, the risks of mortality and poor functional outcomes were further amplified. Similarly, in hemorrhagic stroke, each unit increase in HbA1c was associated with an increased risk of poor functional outcome within the first three months [10]. Elevated HbA1c levels have also been independently associated with worse functional outcomes in patients with acute anterior circulation ischemic stroke, particularly in those with large-artery atherosclerosis [12].

The association between HbA1c and stroke risk extends beyond prognostic implications to include primary prevention. A large systematic review and meta-analysis encompassing 532,779 participants found that diabetes-range HbA1c (≥6.5%) was associated with a more than two-fold increased risk of first-ever stroke compared with non-diabetes-range HbA1c (<5.7%) [7]. For every 1% increment in HbA1c, the risk of first-ever ischemic stroke increased by 49% in non-diabetes cohorts and 24% in diabetes cohorts [7]. Furthermore, prestroke glycemic control, as reflected by admission HbA1c, has been associated with subsequent risk of composite vascular events, including stroke recurrence, myocardial infarction, and vascular death, during one-year follow-up [13]. These findings collectively suggest that HbA1c assessment at the time of stroke admission may provide critical information for risk stratification and secondary prevention planning.

Despite the established role of HbA1c in predicting stroke outcomes in various populations, data from Bangladesh and the broader South Asian region remain scarce. The unique cardiometabolic profile of South Asian populations, characterized by higher prevalence of diabetes and central obesity, may influence the relationship between glycemic status and stroke outcomes in ways that differ from Western populations [4]. Previous studies from Bangladesh have primarily focused on stroke prevalence and general risk factors, with limited attention to the specific distribution of HbA1c abnormalities among stroke patients [2,3]. Given the high burden of both stroke and diabetes in Bangladesh, characterizing the glycated hemoglobin status of stroke patients admitted to tertiary care facilities is essential for guiding clinical practice and public health policy. This prospective cohort study was therefore designed to evaluate the glycated hemoglobin status and its distribution patterns among patients with stroke admitted to a tertiary care hospital in Dhaka, Bangladesh.

## II. METHODOLOGY

This prospective cohort study was conducted at the Department of Medicine, Holy Family Red Crescent Medical College & Hospital, Dhaka, Bangladesh, over six months from July 2025 to December 2025. All adult patients admitted with a clinical diagnosis of acute stroke to the inpatient medicine and neurology wards were screened for potential enrollment.

**Inclusion criteria**

Patients aged 18 years or older, with a first-ever or recurrent acute stroke confirmed by neuroimaging (computed tomography or magnetic resonance imaging), and admitted within 72 hours of symptom onset were included in the study.

**Exclusion criteria**

Patients with pre-existing severe neurological disability (modified Rankin Scale score ≥4 before the index event), coexisting acute myocardial infarction, decompensated liver cirrhosis, end-stage renal disease requiring dialysis, active malignancy, pregnancy, or those who declined to provide written informed consent were excluded.

**Study procedure**

Following written informed consent, a structured case report form was used to collect demographic data, vascular risk factors, and clinical details. A fasting venous blood sample was obtained within 24 hours of admission for HbA1c estimation using ion-exchange high-performance liquid chromatography with standardized quality control protocols. HbA1c levels were categorized according to the American Diabetes Association criteria [14]: normal (<5.7%), prediabetes (5.7–6.4%), and diabetes (≥6.5%). Neuroimaging studies were reviewed by two independent radiologists to classify stroke as ischemic or hemorrhagic. Purposive sampling was employed to enroll a total of 97 patients over the study duration.

**Data analysis**

All data were entered into a pre-designed spreadsheet and analyzed using SPSS version 23.0. Descriptive statistics were computed for baseline characteristics and HbA1c distribution. Continuous variables are presented as mean ± standard deviation, while categorical variables are expressed as frequencies and percentages. For subgroup comparisons, the Chi-square test or Fisher's exact test was used for categorical variables, and the independent t-test or Mann-Whitney U test for continuous variables, as appropriate. A two-tailed p-value <0.05 was considered statistically significant.

## III. RESULT

A total of 97 patients with acute stroke were enrolled in this prospective cohort study. The mean age of the study population was 62.4 ± 11.8 years, with a range of 28 to 89 years. Male patients constituted the majority, accounting for 58.8% (n=57) of the cohort, while female patients comprised 41.2% (n=40). Among the vascular risk factors, hypertension was the most prevalent, observed in 67.0% (n=65) of patients, followed by dyslipidemia in 46.4% (n=45), current or past smoking in 36.1% (n=35), and a known history of diabetes mellitus in 28.9% (n=28).

Regarding stroke subtype, ischemic stroke was diagnosed in 74.2% (n=72) of patients, whereas hemorrhagic stroke accounted for 25.8% (n=25) of cases. The overall mean glycated hemoglobin (HbA1c) level in the cohort was 7.1 ± 1.9%. When categorized according to the American Diabetes Association criteria, 34.0% (n=33) of patients had normal HbA1c levels (<5.7%), 24.7% (n=24) fell within the prediabetic range (5.7–6.4%), and 41.2% (n=40) exhibited diabetes-range HbA1c (≥6.5%). Among the 40 patients with diabetes-range HbA1c, 12 (30.0%) had no prior history of diabetes, indicating newly detected hyperglycemia.

Comparative analysis between stroke subtypes revealed that patients with ischemic stroke had a higher mean HbA1c level (7.3 ± 2.0%) compared with those with hemorrhagic stroke (6.5 ± 1.6%), although this difference did not reach statistical significance (p = 0.084). The distribution of HbA1c categories also varied between the two subtypes, with diabetes-range HbA1c observed in 44.4% (32/72) of ischemic stroke patients compared with 32.0% (8/25) of hemorrhagic stroke patients, while the difference in overall distribution was not statistically significant (p = 0.184).

Stratification by age demonstrated a significant association between advancing age and higher HbA1c categories. The mean age of patients with normal HbA1c was 58.2 ± 10.1 years, which increased to 62.8 ± 11.5 years in the prediabetic group and 65.9 ± 12.0 years in the diabetic-range group (p = 0.021). In terms of sex distribution, the proportions of male and female patients across the three HbA1c categories were comparable, with no statistically significant difference observed (p = 0.642). Similarly, although the prevalence of hypertension was higher among patients with elevated HbA1c levels, the association between hypertension status and HbA1c category did not reach statistical significance (p = 0.154). Notably, among patients with known diabetes mellitus, 89.3% (25/28) had HbA1c ≥6.5%, confirming suboptimal glycemic control in a substantial proportion of pre-existing diabetic patients.

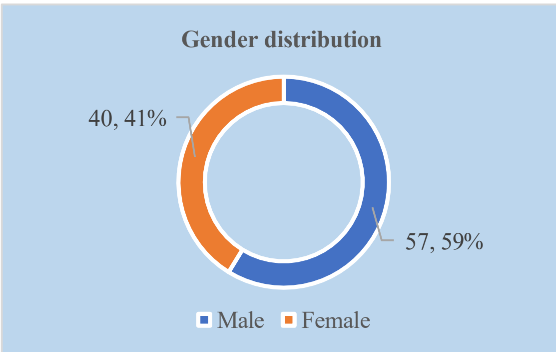


**Figure 1:** Gender distribution (N=97)

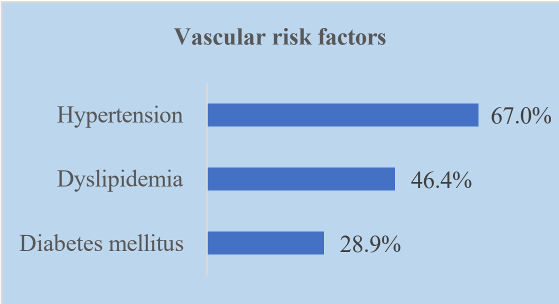


**Figure 2:** Prevalence of vascular risk factors

**Table 1:** Distribution of HbA1c categories by stroke subtype

| HbA1c Category | Ischemic (n=72) | Hemorrhagic (n=25) |
|---|---|---|
| Normal (<5.7%) | 22 (30.6) | 11 (44.0) |
| Prediabetes (5.7–6.4%) | 18 (25.0) | 6 (24.0) |
| Diabetes (≥6.5%) | 32 (44.4) | 8 (32.0) |

**Chi-square test was used for comparison; p = 0.184**

**Table 2:** Comparison of age and HbA1c by stroke subtype

| Variable | Ischemic | Hemorrhagic | p-value |
|---|---|---|---|
| Age (years), mean ± SD | 62.8 ± 11.5 | 61.2 ± 12.4 | 0.562 |
| HbA1c (%), mean ± SD | 7.3 ± 2.0 | 6.5 ± 1.6 | 0.084 |

**Independent t-test was used for continuous variables**

**Table 3:** Distribution of HbA1c categories by gender

| HbA1c Category | Male (n=57) | Female (n=40) |
|---|---|---|
| Normal (<5.7%) | 18 (31.6) | 15 (37.5) |
| Prediabetes (5.7–6.4%) | 15 (26.3) | 9 (22.5) |
| Diabetes (≥6.5%) | 24 (42.1) | 16 (40.0) |

**Chi-square test was used for comparison; p = 0.642**

**Table 4:** Distribution of HbA1c categories by hypertension status

| HbA1c Category | Hypertensive (n=65) | Normotensive (n=32) |
|---|---|---|
| Normal (<5.7%) | 18 (27.7) | 15 (46.9) |
| Prediabetes (5.7–6.4%) | 18 (27.7) | 6 (18.7) |
| Diabetes (≥6.5%) | 29 (44.6) | 11 (34.4) |

**Chi-square test was used for comparison; p = 0.154**

**Table 5:** Clinical characteristics stratified by HbA1c categories

| Variable | Normal (<5.7%) (n=33) | Prediabetes (5.7-6.4%) (n=24) | Diabetes (≥6.5%) (n=40) | p-value |
|---|---|---|---|---|
| Age (years), mean ± SD | 58.2 ± 10.1 | 62.8 ± 11.5 | 65.9 ± 12.0 | 0.021 |
| Male sex, n (%) | 18 (54.5) | 15 (62.5) | 24 (60.0) | 0.642 |
| Hypertension, n (%) | 18 (54.5) | 18 (75.0) | 29 (72.5) | 0.154 |
| Known diabetes, n (%) | 0 (0.0) | 3 (12.5) | 25 (62.5) | 0.001 |

**For age, ANOVA was used. For categorical variables, the Chi-square test was used. p-values for categorical variables correspond to the overall distribution across the three groups**

## IV. DISCUSSION

This prospective cohort study evaluated the glycated hemoglobin status and its distribution patterns among 97 patients admitted with acute stroke to a tertiary care hospital in Bangladesh. The findings reveal that a substantial majority of stroke patients—66.0%—presented with abnormal HbA1c levels, with 41.2% in the diabetes range (≥6.5%) and 24.7% in the prediabetic range (5.7–6.4%). Notably, among those with diabetes-range HbA1c, 30.0% had no prior diagnosis of diabetes, indicating previously undetected chronic hyperglycemia. These observations carry important clinical and public health implications for stroke care in Bangladesh.

The high prevalence of diabetes-range HbA1c observed in this cohort (41.2%) exceeds the global pooled estimate of approximately 28% reported among stroke populations and is notably higher than the 33% prevalence typically observed in ischemic stroke cohorts [15]. This disparity likely reflects the disproportionately high burden of diabetes in South Asian populations, where genetic predisposition, earlier age of onset, and higher rates of central obesity contribute to an elevated cardiometabolic risk profile [4]. A nationwide survey from Bangladesh documented a stroke prevalence of 11.39 per 1000 population, with diabetes emerging as one of the predominant modifiable risk factors [3]. The present study extends these epidemiological observations by quantifying the actual HbA1c distribution at the time of acute stroke admission, providing a biochemical basis for risk stratification. The finding that nearly one-quarter of the cohort (24.7%) fell within the prediabetic range (5.7–6.4%) is particularly concerning. Contemporary meta-analytical evidence indicates that even prediabetes-range HbA1c is associated with a modestly elevated stroke risk, and progression from prediabetes to overt diabetes occurs in a substantial proportion of affected individuals over five years [16]. This underscores the need for structured glycemic monitoring and lifestyle interventions in stroke survivors with prediabetes to prevent future vascular events.

The age-related gradient observed in this study—with mean ages of 58.2, 62.8, and 65.9 years across the normal, prediabetic, and diabetes-range groups, respectively—aligns with the known epidemiology of type 2 diabetes, which increases in prevalence with advancing age. However, a recent large-scale multicenter study has demonstrated that the prognostic impact of elevated HbA1c on stroke outcomes is paradoxically stronger in younger adults (<65 years) compared with older adults, possibly due to competing comorbidities in the elderly [17]. In the present cohort, the mean age of the diabetes-range group was 65.9 years, which is close to this threshold, suggesting that the glycemic burden in these patients may have a particularly pronounced influence on their post-stroke prognosis. This observation reinforces the importance of aggressive glycemic optimization in younger stroke patients with elevated HbA1c.

The comparison between stroke subtypes revealed that ischemic stroke patients had a higher mean HbA1c (7.3%) than hemorrhagic stroke patients (6.5%), although the difference did not reach statistical significance ($p = 0.084$). This pattern is consistent with the established pathophysiological paradigm that diabetes and chronic hyperglycemia preferentially contribute to large-artery atherosclerosis and small-vessel occlusion, which are predominant mechanisms in ischemic stroke. For hemorrhagic stroke, the relationship with hyperglycemia is more complex. A recent large prospective study focusing specifically on intracerebral hemorrhage found that elevated HbA1c on admission was independently associated with increased hematoma expansion and worse functional outcomes at three months, although the effect size was smaller than that observed for ischemic stroke [18]. The lack of statistical significance in the present subtype comparison is likely attributable to the relatively small sample size of the hemorrhagic subgroup (n=25), and future studies with larger hemorrhagic cohorts are warranted to clarify this association.

The clinical implications of this study are substantial. The fact that 30.0% of patients with diabetes-range HbA1c had no prior diabetes diagnosis highlights a missed opportunity for primary prevention. Routine HbA1c testing at the time of stroke admission can serve as a cost-effective screening tool to identify previously undiagnosed diabetes and prediabetes, facilitating early referral to endocrinology services and timely initiation of antidiabetic therapy [19]. Current international guidelines recommend HbA1c assessment for all patients with atherosclerotic cardiovascular disease, including stroke, as part of comprehensive secondary prevention, yet adherence to this recommendation remains suboptimal in many resource-limited settings [14]. Integrating point-of-care or laboratory-based HbA1c testing into standard stroke admission protocols in Bangladesh could substantially improve long-term glycemic control and reduce the risk of recurrent vascular events in this high-risk population.

Several limitations of this study should be carefully considered. First, the relatively small sample size (n=97) limits statistical power for subgroup analyses and precludes multivariable logistic regression to adjust for potential confounders such as body mass index, duration of pre-existing diabetes, and medication adherence. Second, the purposive sampling technique and single-center design, conducted at a tertiary facility in Dhaka, may introduce selection bias and limit the generalizability of the findings to rural populations or community-based stroke patients in Bangladesh, where healthcare access and disease burden patterns may differ substantially [20]. Third, the absence of long-term follow-up data on functional outcomes, stroke recurrence, or all-cause mortality prevents assessment of the prognostic value of HbA1c beyond the acute admission period. Fourth, while HbA1c provides a reliable estimate of average glycemia over the preceding 2–3 months, it does not capture acute stress hyperglycemia, which may also influence acute stroke outcomes. Finally, the study did not stratify ischemic strokes by etiological subtype (e.g., cardioembolic, large-artery, or small-vessel), which may have provided deeper insights into the relationship between glycemic status and specific stroke mechanisms. Despite these limitations, the present findings contribute valuable baseline data on the glycemic profile of stroke patients in Bangladesh and underscore the pressing need for routine HbA1c screening in this high-risk population.

**Limitations:**
The single-center design, purposive sampling technique, and relatively small sample size may limit the generalizability of our findings. Additionally, the lack of longitudinal follow-up data precludes evaluation of the prognostic significance of HbA1c abnormalities on long-term stroke outcomes.

## V. CONCLUSION

This prospective cohort study reveals that two-thirds of stroke patients admitted to a tertiary hospital in Bangladesh exhibit abnormal HbA1c levels, with over 40% in the diabetes range and nearly one-third of these having undiagnosed diabetes. Routine HbA1c assessment on admission offers a practical opportunity for early detection of chronic hyperglycemia. Such screening can facilitate timely glycemic optimization and strengthen secondary prevention strategies, potentially improving long-term vascular outcomes in this high-risk population.

**Recommendation:**
We recommend integrating routine HbA1c testing into standard stroke admission protocols across Bangladeshi hospitals. Large-scale, multicenter prospective studies with longitudinal follow-up are urgently needed to validate these findings and guide evidence-based glycemic management guidelines for stroke patients.

**CONFLICT OF INTEREST STATEMENT:** The authors declare no conflicts of interest. No funding was received for this study. The corresponding author had full access to all data and final responsibility for the decision to submit for publication.

**AI DECLARATION**
Artificial intelligence tools contributed marginally to manuscript preparation and development. All core scientific content was human-verified.

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