



Medication Non-Compliance as a Determinant of Stroke Severity and Mortality in Diabetic and Hypertensive Patients

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ABSTRACT

Introduction: Hypertension and diabetes mellitus are major modifiable risk factors for stroke, but the impact of medication adherence on stroke severity and short-term outcomes remains underexplored. This study evaluated the association between treatment compliance, stroke severity, and in-hospital mortality.

Methods: In this prospective observational study, 115 adult patients with radiologically confirmed stroke and documented diabetes or hypertension were enrolled. Medication adherence over the preceding three months was assessed ($\geq 80\%$ defined as compliant), and stroke severity was graded using the NIHSS.

Results: Non-compliant patients in both diabetic and hypertensive groups presented with significantly more severe strokes ($p < 0.01$). Mortality occurred exclusively in non-compliant diabetics (26.3%) and was significantly higher in non-compliant hypertensives (10.7%).

Conclusion: Medication non-compliance is strongly associated with increased stroke severity and higher in-hospital mortality, highlighting adherence as a critical and modifiable determinant of stroke outcomes.

Keywords: Stroke; Medication Non-compliance; Treatment Adherence; Hypertension; Diabetes Mellitus; NIHSS; In-hospital Mortality.

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INTRODUCTION

Effective long-term control of modifiable vascular risk factors remains the cornerstone of stroke prevention. Among these, hypertension and diabetes mellitus are the most prevalent contributors to cerebrovascular disease worldwide.¹ Although, the pathophysiological link between these conditions and stroke is well established, the impact of medication adherence on stroke severity and short-term outcomes has received comparatively less attention.

Non-adherence to antihypertensive therapy has been consistently associated with increased risk of stroke, particularly haemorrhagic events, owing to persistent vascular injury and poor blood pressure control.^{2,3} Similarly, inadequate adherence to antidiabetic medications contributes to chronic hyperglycaemia, endothelial dysfunction, and accelerated atherosclerosis, thereby increasing susceptibility to ischemic stroke.⁴ Observational studies have demonstrated that

patients with poor medication adherence experience significantly higher rates of recurrent stroke and vascular complications.^{3,5}

Beyond increasing stroke incidence, uncontrolled hypertension and diabetes may influence the severity of neurological deficits at presentation. Poorly controlled vascular risk factors predispose to larger infarcts, haemorrhagic transformation, and impaired collateral circulation. Furthermore, treatment adherence has been shown to significantly reduce vascular events in high-risk populations, reinforcing its critical role in both primary and secondary prevention.⁶

Importantly, the consequences of non-compliance are not limited to stroke. Large cohort studies and other reports have demonstrated that poor adherence to antihypertensive and antidiabetic therapy significantly increases the risk of major adverse vascular events, including myocardial infarction (MI) and autoamputations.⁷⁻¹² These findings highlight that medication non-compliance represents a

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systemic vascular risk multiplier rather than an isolated contributor to cerebrovascular disease.

Given the substantial burden of uncontrolled hypertension and diabetes in developing nations, understanding the association between medication adherence, stroke severity, and early outcomes is essential. This prospective observational study therefore aimed to evaluate the impact of treatment compliance on stroke severity and in-hospital mortality among diabetic and hypertensive patients presenting with acute cerebrovascular accidents.

MATERIALS AND METHODS

Study Design and Participants

This prospective observational study was carried out in the Department of Emergency Medicine at Maharashtra Post Graduate Institute of Medical Education and Research, MUHS, Nashik, over a duration of two years. Prior approval was obtained from the Institutional Ethics Committee (Ref. No. MPGIMER Nashik/IEC/Outward No/33/2024). Written informed consent was obtained from all participants or their legally authorized representatives before inclusion, and the approval remained valid for the entire study period.

The primary objective of this study was to evaluate the impact of medication compliance on stroke severity and in-hospital outcomes among patients with diabetes mellitus and hypertension presenting with acute cerebrovascular accidents.

A total of 115 patients meeting eligibility criteria were enrolled consecutively following confirmation of stroke diagnosis.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Male and female patients aged >18-years
- Patients with a documented diagnosis of diabetes mellitus or hypertension
- Patients presenting with acute neurological deficits and radiologically confirmed cerebrovascular accident

Exclusion Criteria

- Patients below 18-years of age
- Stroke secondary to trauma or road traffic accidents
- Patients without a confirmed history of diabetes or hypertension
- Patients intubated prior to hospital arrival
- Patients with major comorbid illnesses likely to independently influence outcomes
- Patients with suspected aspiration confirmed on CT scan or chest imaging

Data Collection and Measurements

All patients presenting with acute focal neurological deficits fulfilling Cincinnati Stroke Scale criteria (facial droop, arm drift, slurred speech) were evaluated in the emergency department. Initial management followed standard airway, breathing, and circulation

(ABC) stabilization protocols.

Upon arrival, patients underwent detailed neurological assessment including Glasgow Coma Scale scoring and pupillary evaluation. Non-contrast computed tomography (CT) of the brain was performed in all patients to confirm the diagnosis and classify stroke as ischemic or haemorrhagic.

Stroke severity was assessed at admission using the National Institutes of Health Stroke Scale (NIHSS) and categorized as:

- Minor (0–4)
- Moderate (5–15)
- Moderate to severe (16–20)
- Severe (>21)

Medication compliance was assessed through direct patient or caregiver interviews at admission. Patients were asked about adherence to prescribed antidiabetic or antihypertensive medications over the preceding three months, including frequency of missed doses. Compliance was defined as intake of $\geq 80\%$ of prescribed medications, while intake below this threshold was classified as non-compliance.

Patients were managed according to standardized institutional stroke care protocols.

Haemorrhagic stroke management included:

- Intravenous 20% mannitol (100 mL bolus), repeated every 8 hours as indicated
- Blood pressure control using antihypertensive agents to maintain systolic BP <140 mmHg
- Anticonvulsants initiated when clinically indicated

Ischemic (thromboembolic) stroke management included:

- Aspirin 150 mg stat followed by 75 mg once daily
- Clopidogrel 150 mg stat followed by 75 mg once daily
- Atorvastatin 40 mg stat followed by 20 mg daily

Patients were monitored every 15 minutes for the first 4 hours, every 30 minutes for the next 4 hours, and hourly for the subsequent 12 hours. Ongoing care including thrombolysis was provided in coordination with neurology or internal medicine teams. Demographic details, duration of hospital stay, and in-hospital outcomes (survived or deceased) were recorded.

Statistical Analysis

Data were recorded in a structured study proforma and analyzed using SPSS version 26.0.

Categorical variables were expressed as frequencies and percentages, and associations between compliance status and stroke severity or outcome were assessed using the Chi-square test.

Continuous variables were expressed as mean \pm standard deviation. Comparisons between compliant and non-compliant groups were performed using the unpaired t-test for normally distributed data and the Mann–Whitney U test for non-normal distributions.

A *p*-value <0.05 was considered statistically significant. Graphical representations were generated using Microsoft Excel 2021.

RESULTS

A total of 115 patients with radiologically confirmed cerebrovascular accidents were enrolled in the study, comprising 50 diabetic and 65 hypertensive patients. The majority of patients were aged above 60-years (53.0%), followed by those between 41–60 years (44.3%), with a mean age of 61.8 years (Table 1). Gender distribution was nearly equal (Figure 1), and most patients (71.3%) belonged to urban areas (Figure 2).

Table 1: Distribution of study groups as per age.

Age in years	N	%
<=40	3	2.6%
41-60	51	44.3%
>60	61	53.0%
Total	115	100.0%

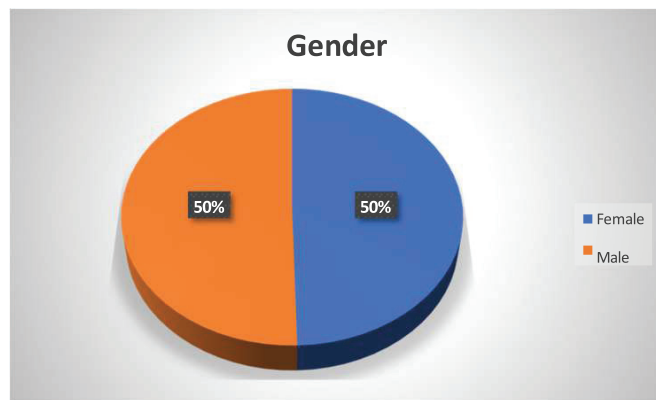


Figure 1 : Gender Distribution.

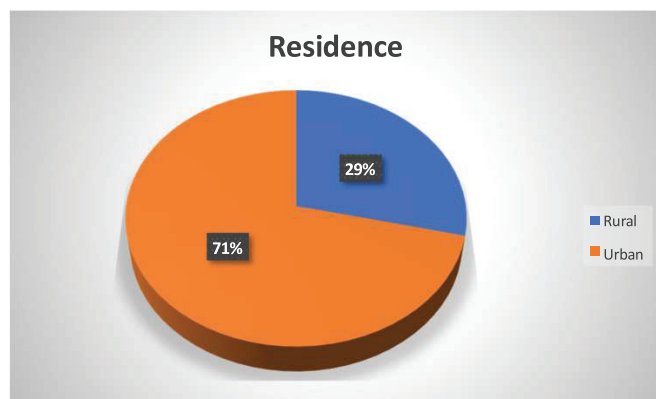


Figure 2 : Rural and urban distribution.

Among diabetic patients (n = 50), 31 (62.0%) were classified as treatment-compliant, while 19 (38.0%) were non-compliant. All compliant diabetic patients presented with minor (19.4%) or moderate

(80.6%) stroke. In contrast, non-compliant diabetics predominantly presented with moderate-to-severe (84.2%) or severe stroke (15.8%). This association between non-compliance and increased stroke severity was statistically significant (p < 0.01) (Table 2).

Similarly, among hypertensive patients (n = 65), 37 (56.9%) were compliant and 28 (43.1%) were non-compliant. All compliant hypertensive patients had either minor (29.7%), or moderate stroke (70.3%). Conversely, all non-compliant hypertensive patients presented with moderate-to-severe (82.1%), or severe stroke (17.9%). The association between treatment non-adherence and higher stroke severity was highly significant (p < 0.01) (Table 3).

Table 2: Association of severity of stroke with compliance of treatment in diabetic cases.

Severity of Stroke (DM cases)	Compliance		Total
	Compliant	Non-Compliant	
Minor	6	0	6
	19.4%	0.0%	12.0%
Moderate	25	0	25
	80.6%	0.0%	50.0%
Moderate to Severe	0	16	16
	0.0%	84.2%	32.0%
Severe	0	3	3
	0.0%	15.8%	6.0%
Total	31	19	50
	100.0%	100.0%	100.0%
p- value < 0.01			

Table 3: Association of severity of stroke with compliance of treatment in hypertensive cases.

Severity of Stroke (HT cases)	Compliance		Total
	Compliant	Non-Compliant	
Minor	11	0	11
	29.7%	0.0%	16.9%
Moderate	26	0	26
	70.3%	0.0%	40.0%
Moderate to Severe	0	23	23
	0.0%	82.1%	35.4%
Severe	0	5	5
	0.0%	17.9%	7.7%
Total	37	28	65
	100.0%	100.0%	100.0%
p- value < 0.01			

Table 4: Association of outcome of stroke with compliance of treatment in diabetic cases.

Outcome (DM Cases)	Compliance		Total
	Compliant	Non-Compliant	
Survived	31	14	45
	100.0%	73.7%	90.0%
Deceased	0	5	5
	0.0%	26.3%	10.0%
Total	31	19	50
	100.0%	100.0%	100.0%

p-value < 0.01

In diabetic patients, mortality was observed exclusively among non-compliant individuals. All compliant diabetic patients survived (100%), whereas 5 out of 19 non-compliant patients (26.3%) died during hospitalization. This difference was statistically significant ($p < 0.01$) (Table 4).

A similar trend was noted in hypertensive patients. No deaths occurred among compliant individuals, while 3 out of 28 non-compliant patients (10.7%) died. This association was statistically significant ($p = 0.03$) (Table 5).

Overall, the findings demonstrate a strong and consistent relationship between medication non-compliance and increased stroke severity as well as higher in-hospital mortality in both diabetic and hypertensive populations. These results highlight treatment adherence as a critical determinant of neurological outcome following acute cerebrovascular events.

Table 5: Association of outcome of stroke with compliance of treatment in hypertensive cases.

Outcome (HT Cases)	Compliance		Total
	Compliant	Non-Compliant	
Survived	37	25	62
	100.0%	89.3%	95.4%
Deceased	0	3	3
	0.0%	10.7%	4.6%
Total	37	28	65
	100.0%	100.0%	100.0%

p-value – 0.03

DISCUSSION

In this study, treatment compliance emerged as a critical determinant of both stroke severity and clinical outcomes among diabetic and hypertensive patients. Patients who were non-compliant with their prescribed antidiabetic or antihypertensive therapy exhibited a markedly higher proportion of moderate to severe and severe stroke, while those who maintained adequate compliance (defined as $\geq 80\%$ adherence) experienced only minor to moderate deficits.

Table 6 : Summary of findings in this study

- Among diabetics, non-compliant patients had significantly more severe stroke; all compliant patients had minor to moderate stroke ($p < 0.01$).
- Diabetic patient mortality was 26.3% among non-compliant individuals, while no deaths occurred among compliant patients ($p < 0.01$).
- Among hypertensive patients, all compliant individuals had minor to moderate stroke, while non-compliant ones had moderate to severe or severe stroke ($p < 0.01$).
- Mortality among non-compliant hypertensives was 10.7%, whereas no compliant patients died ($p = 0.03$).

This association was statistically significant in both diabetic and hypertensive cohorts ($p < 0.01$), underscoring the protective effect of consistent medication use in mitigating the neurological impact of cerebrovascular events. These findings are consistent with the Stroke Registry, which demonstrated that poor adherence to antihypertensive therapy increased stroke risk by over three-fold, and achieving blood pressure control below 130/80 mmHg significantly reduced stroke incidence by 42%.¹³ Similarly, studies reported that diabetic patients with poor glycaemic control were more likely to suffer severe stroke and adverse outcomes.^{14,15} Mortality data in the present study, further reinforces this pattern. Among diabetic patients, all compliant individuals survived, whereas 26.3% of non-compliant patients succumbed. A similar trend was noted in hypertensive patients, with no deaths in those, who were adherent to therapy compared to a 10.7% mortality rate in the non-compliant group. These statistically significant outcomes ($p < 0.01$ for diabetics, $p = 0.03$ for hypertensives) illustrate that non-compliance is not merely a background factor but a decisive contributor to stroke prognosis. These results highlight the urgent need for structured patient education, regular follow-up, and healthcare system interventions to enhance treatment adherence, particularly in high-risk populations.

In summary (Table 6), this study highlights important clinical differences in stroke type, severity, and outcomes between diabetic and hypertensive patients. Ischemic stroke was predominant, particularly among diabetics, while haemorrhagic stroke was more frequent in hypertensives. Stroke severity correlated significantly with hyperglycaemia and treatment non-compliance in both groups. Although urban patients formed the majority, rural patients showed a slightly higher severity without significant differences in mortality. Importantly, compliance with therapy significantly reduced stroke severity and improved survival, emphasizing the vital role of continuous risk factor management. Stroke severity is influenced not only by acute vascular occlusion but also by the cumulative burden of uncontrolled systemic disease. In hospital ischemic strokes have been associated with greater disability and mortality due to compounded comorbidities and physiological stress.¹⁶ The coexistence of diabetes and hypertension creates a pathophysiological milieu characterized by endothelial dysfunction, oxidative stress, and neurohormonal activation that accelerates target-organ damage, including cerebrovascular injury.¹⁷ Emergency department populations frequently

represent patients with heightened systemic vulnerability and delayed healthcare engagement, often carrying a greater burden of undiagnosed, or poorly controlled comorbidities,¹⁸ which may parallel the non-compliant group in our cohort who presented with more severe neurological deficits and higher mortality. Importantly, sustained blood pressure modulation—even modest reductions in systolic and diastolic values—has demonstrated meaningful vascular benefit and, in some cases, reduced medication requirements.¹⁹ This reinforces the principle that consistent and long-term risk-factor control is central to preventing catastrophic cerebrovascular events. Furthermore, as baseline neurological severity strongly determines rehabilitation trajectory and functional recovery,²⁰ the higher NIHSS scores observed among non-compliant patients in our study may translate into greater long-term disability. Collectively, these findings emphasize that medication adherence is not merely preventive at the level of stroke incidence, but critically influences stroke severity, survival, and subsequent recovery.

Medication non-compliance in diabetic and hypertensive patients likely accelerates the convergence of metabolic and vascular injury pathways. Chronic uncontrolled hypertension is characterized by excess vasoconstrictor signaling (Angiotensin II, Endothelin-1, aldosterone), oxidative stress generation, and reduced nitric oxide bioavailability, resulting in endothelial dysfunction and vascular stiffness.²¹ When antihypertensive therapy is inconsistently used, these maladaptive pathways remain unchecked, predisposing to both ischemic and hemorrhagic cerebrovascular events.

Beyond hemodynamic instability, emerging Indian data highlight the synergistic relationship between hyperuricemia, obesity, and hypertension.²² Serum uric acid has demonstrated strong positive correlations with BMI, waist-to-hip ratio, sagittal abdominal diameter, and both systolic and diastolic blood pressure.²³ Hyperuricemia promotes oxidative stress, inflammatory cytokine activation (IL-6, TNF- α), and endothelial dysfunction—mechanisms directly implicated in cerebral small-vessel disease and infarct expansion.

Similarly, anthropometric markers and insulin resistance indices have been strongly associated with worsening glycemic control and elevated serum uric acid in Indian diabetic populations.²⁴ Reduced adiponectin levels in T2DM patients correlate with higher HbA1c, fasting glucose, and insulin resistance, suggesting impaired anti-inflammatory and insulin-sensitizing signaling.²⁵ Furthermore, osteocalcin—a bone-derived endocrine hormone—demonstrates significant inverse associations with HbA1c and HOMA-IR,²⁶ indicating that chronic non-compliance may perpetuate endocrine-metabolic imbalance beyond glucose elevation alone.

Collectively, these findings support the concept that medication non-compliance does not merely allow transient blood pressure or glucose elevation, but sustains a pro-inflammatory, oxidative, insulin-resistant state that amplifies cerebrovascular vulnerability. This systemic metabolic-vascular dysregulation likely explains the greater stroke severity and mortality observed in non-compliant patients in our cohort.

From a clinical standpoint, these findings underscore the necessity of early identification and aggressive control of diabetes and hypertension to reduce stroke burden. Regular monitoring, patient

education on medication adherence, and structured follow-up are imperative. Integrating stroke prevention into primary care, especially in resource-limited settings, and bridging urban-rural disparities through community outreach and telemedicine may further improve outcomes and reduce the long-term neurological and socioeconomic impact of stroke.

CONCLUSION

Medication non-compliance is strongly associated with greater stroke severity and higher in-hospital mortality among both diabetic and hypertensive patients. Patients who adhered to prescribed therapy presented with milder neurological deficits and had significantly better survival outcomes. These findings emphasize that improving long-term treatment adherence is a crucial and modifiable strategy for reducing stroke-related morbidity and mortality.

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