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Impact of Non-Compliance with Antihypertensive Medication on Stroke Incidence

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Abstract **Original Research Article**

Background: Hypertension is a major risk factor for stroke. Effective management of hypertension through medication adherence is crucial in preventing stroke events. However, non-compliance with antihypertensive medication remains a significant challenge, leading to adverse health consequences. ***Aim of the study:*** The aim of this study was to evaluate the impact of non-compliance with antihypertensive medication on stroke incidence. ***Methods:*** This descriptive cross-sectional study was conducted in Department of Medicine and Neurology, Dhaka Medical College Hospital, Dhaka, Bangladesh from March 2010 to August 2010. Total 120 patients who were diagnosed with stroke were selected for the study. ***Result:*** The majority of participants were aged 51-60 (35.8%) and the mean age was 54.6 years (SD 4.3). Males (57.5%) outnumbered females (42.5%), with a male-to-female ratio of 1.38:1. Age and sex distributions were significantly different ($p < .001$). Cerebral infarction was the most common stroke type (62.5%). Most participants (65.0%) were known hypertensive, with 11.7% newly diagnosed and 23.3% normotensive. Among hypertensive patients, non-compliance was high (71.8%). In hypertensive stroke patients, non-compliance was associated with higher rates of cerebral infarction (37.2% vs. 20.5%) and cerebral hemorrhage (33.3% vs. 6.4%). Subarachnoid hemorrhage and hemorrhagic transformation were rare. The overall Chi-square test was significant ($p < .001$). Recurrent stroke was more common in non-compliant patients (68.8% vs. 31.3%). The Chi-square test was significant ($p < .001$). ***Conclusion:*** Non-compliance was strongly associated with increased risk of both cerebral infarction and cerebral hemorrhage, underscoring the importance of consistent medication adherence.

Keywords: Relationship, Stroke, Compliance, and Antihypertensive Medication.

I INTRODUCTION

Hypertension, commonly known as high blood pressure, is one of the most prevalent chronic conditions worldwide, affecting approximately 1.28 billion adults aged 30-79 years, with two-thirds residing in low- and middle-income countries [1]. Characterized by persistently elevated systolic blood pressure (≥140 mmHg) or diastolic blood pressure (≥90 mmHg), hypertension is often asymptomatic, earning it the moniker "the silent killer." In South Asia, including Bangladesh, hypertension prevalence is rising steadily, posing a significant public health concern. A nationwide study conducted in Bangladesh reported a prevalence rate of 13.67% among adults, with urban residents exhibiting a higher prevalence compared to rural counterparts [2]. The risk factors for hypertension are multifactorial, encompassing both modifiable and non-modifiable elements. Non-modifiable risk factors include age, family history, and genetic predispositions, while modifiable factors comprise lifestyle choices such as diet, physical inactivity, obesity, alcohol consumption, and stress [3,4]. In Bangladesh, socio-economic factors also play a crucial role, with lower-income groups exhibiting higher rates of hypertension, attributed to factors such as limited access to healthcare, lack of awareness, and higher prevalence of risk behaviors [5]. Effective management of hypertension relies heavily on medication adherence, as continuous

and consistent use of antihypertensive medications is essential for maintaining controlled blood pressure levels. This issue is even more pronounced in low-income settings like Bangladesh, where studies have found that up to 85% of patients are non-compliant with their antihypertensive medications, citing forgetfulness, financial constraints, side effects, and lack of awareness as the primary reasons [5,6]. Non-compliance is further exacerbated by socio-economic and healthcare infrastructure-related factors, including unregulated access to healthcare providers and medications, inconsistent follow-up practices, and reliance on unqualified healthcare practitioners [2]. The implications of non-compliance are profound, not only for individual patients but also for the broader healthcare system and society. A study by Lee *et al.*, [7] found that non-compliance with antihypertensive medication was significantly associated with a higher risk of stroke, with poorly adherent patients demonstrating a 27% higher risk than their adherent counterparts. This highlights the need for effective patient education and interventions to improve adherence, as consistent medication use can significantly reduce the incidence of stroke and other cardiovascular events [8]. Stroke remains a leading cause of disability and death globally, with over 12 million new cases reported annually. Among these, ischemic strokes account for approximately 85% of cases, while hemorrhagic strokes constitute the remaining 15% [9]. Uncontrolled hypertension is the most significant risk factor for both types of strokes, as persistently high blood pressure can lead to arterial damage, increased intracranial pressure, and eventual cerebrovascular accidents. In Bangladesh, stroke incidence has been increasing, with a recent study reporting that stroke accounted for over 54.8 deaths per 100,000 population, reflecting a substantial public health burden [10]. The socio-economic and cultural context of Bangladesh presents unique challenges that impact medication adherence. Financial hardship is a significant barrier, as many patients cannot afford regular medication, leading to inconsistent treatment [11]. Many patients seek treatment only when symptoms become acute, and a large proportion rely on unqualified practitioners who may not provide appropriate guidance on medication adherence [2]. Furthermore, the lack of a robust healthcare infrastructure, particularly in rural areas, limits access to consistent and quality healthcare services, which is critical for the long-term management of chronic conditions like hypertension [12]. Given the high rates of non-compliance and the severe consequences of uncontrolled hypertension, there is an urgent need for targeted interventions to improve medication adherence among hypertensive patients in Bangladesh.

II OBJECTIVES

To evaluate the impact of non-compliance with antihypertensive medication on stroke incidence.

III METHODOLOGY & MATERIALS

This descriptive cross-sectional study was conducted in Department of Medicine and Neurology, Dhaka Medical College Hospital, Dhaka, Bangladesh from March 2010 to August 2010. Total 120 patients who were diagnosed with stroke were selected for the study. Diagnoses were established by clinical features and subsequently by CT scan of the brain. Consent of the patients and guardians were taken before collecting data. All data was collected in individual case record form. This was done by detailed history from patient or his/ her relatives; including any risk factors both modifiable and non-modifiable, detailed drug history, complete physical examination & necessary investigations. After collection of data it was coded & checked manually & then entered into computer. Data analysis was done according to the aims & objectives of the study by using SPSS (statistical Program for Social Science) software program Version 12. P-value ≤0.05 was considered significant. Patients of any age and sex who fulfilled the definition of stroke and patients who had CT scan features confirming the presence of lesion were included in this study. The exclusion criteria include patients unwilling to take part in the study, severely debilitated patients, and if CT scan of brain could not be done.

IV RESULT

The demographic characteristics of the study subjects in table I revealed that the majority of the participants fall within the age range of 51-60 years, comprising 35.8% of the sample, followed by 61-70 years at 28.3%. The age distribution highlighted that younger age groups, such as those aged 21-30 years, were represented minimally (3.3%), while those above 80 years constituted 6.7%. The mean age of the participants was 54.6 years with a standard deviation of 4.3, indicating a middle-aged to older adult population. Regarding sex distribution, males constituted a larger proportion of the sample at 57.5%, while females accounted for 42.5%, yielding a male-to-female ratio of 1.38:1. The Chi-square test showed a statistically significant distribution across age and sex, with a p-value of < .001, indicating meaningful variations within these demographic categories. Table II demonstrates the pattern of stroke observed in CT scans of the brain. Cerebral infarction was the most common type of lesion, affecting 62.5% of the study subjects. Cerebral hemorrhage ranked as the second most prevalent lesion type, accounting for 30.0% of cases, while subarachnoid hemorrhage and cerebral infarction with hemorrhagic transformation represented 5.8% and 1.7%, respectively. The distribution of stroke types showed a highly significant Chi-square test result ($p < .001$) for cerebral infarction, indicating its predominance within the study cohort. The hypertension status of the study subjects, as shown in figure 1, indicated that a significant majority, 65.0%, were known hypertensive patients. Newly diagnosed hypertensive individuals make up 11.7% of the sample, while normotensive individuals accounted

for 23.3%. Figure 2 further detailed the compliance status of hypertensive patients, showing that non-compliance with antihypertensive medication was substantially high, with 71.8% of the subjects categorized as non-compliant, while only 28.2% were compliant. Table III presents the pattern of stroke observed in known hypertensive stroke patients, highlighting differences between compliant and non-compliant groups. Among compliant patients, 20.5% experienced cerebral infarction, while a higher 37.2% of non-compliant patients had the same diagnosis. Similarly, cerebral hemorrhage was observed in 6.4% of the compliant group, but this figure rose significantly to 33.3% among non-compliant individuals. Instances of subarachnoid hemorrhage and cerebral infarction with hemorrhagic transformation were rare, with subarachnoid hemorrhage seen only in the non-compliant group (1.3%) and hemorrhagic transformation in just one compliant patient (1.3%). The overall Chi-square test result ($p < .001$) underscores a statistically significant association between non-compliance with antihypertensive medication and a higher occurrence of severe stroke types, particularly cerebral infarction and cerebral hemorrhage, within this population. Table IV explores the association between recurrent stroke and antihypertensive compliance. Recurrent stroke was more prevalent in the non-compliant group, with 68.8% experiencing a recurrent event compared to only 31.3% of the compliant patients. Among those without recurrent stroke, 27.4% were compliant, whereas 72.6% were non-compliant. This distribution, with a significant Chi-square test result ($p < .001$), highlights that non-compliance with antihypertensive medication markedly increases the risk of recurrent stroke.

Table-I: Demographic characteristics of the study subjects (N=120)

Characteristics	Frequency (N)	Percentage (%)	Chi-Square test (P value)
Age in years			
21-30	4	3.3	< .001
31-40	9	7.5	
41-50	9	7.5	
51-60	43	35.8	
61-70	34	28.3	
71-80	13	10.8	
> 80	8	6.7	
Mean± SD	54.6 ± 4.3		
Sex			
Male	69	57.5	< .001
Female	51	42.5	
Male-female ratio	1.38:1		

Table-II: Pattern of stroke observed in CT scan of brain (N=120)

Types of Lesion	Frequency (N)	Percentage (%)	Chi-Square test (P value)
Cerebral infarction	75	62.5	< .001
Cerebral haemorrhage	36	30.0	
Subarachnoid haemorrhage	7	5.8	
Cerebral infarction with haemorrhagic transformation	2	1.7	

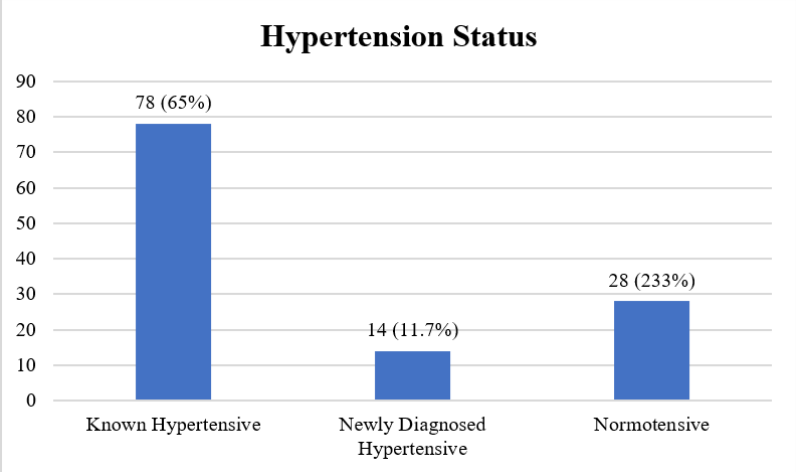

Figure 1: Association of stroke patients with hypertension (N=120)

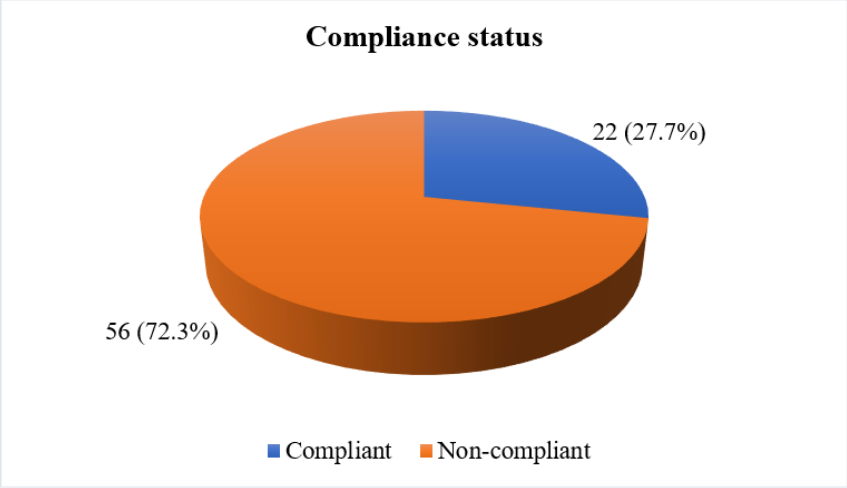

Figure 2: Compliance among previously known hypertensive stroke patients (N=78)

Table-III: Pattern of stroke observed in known hypertensive stroke patients (N=78)

Diagnosis	Compliant	Non-compliant	Chi-Square test (P value)
Cerebral infarction	16 (20.5%)	29 (37.2%)	< .001
Cerebral haemorrhage	5 (6.4%)	26 (33.3%)	
Subarachnoid haemorrhage	00 (00%)	1 (1.3%)	
Cerebral infarction with haemorrhagic transformation	1 (1.3%)	00 (00%)	
Total Frequency	**22 (28.2%)**	**56 (71.8%)**	< .001

Table-IV: Association of recurrent stroke with antihypertensive compliance (N=78)

Recurrent Stroke	Compliant Frequency	Non-compliant Frequency	Chi-Square test (P value)
Present	5 (31.3%)	11 (68.8%)	< .001
Absent	17 (27.4%)	45 (72.6%)	

V DISCUSSION

This current descriptive cross-sectional study was conducted in Department of Medicine and Neurology, Dhaka Medical College Hospital, Dhaka, Bangladesh from March 2010 to August 2010. The aim of the study was to evaluate the impact of non-compliance with antihypertensive medication on stroke incidence. Total 120 patients who were diagnosed with stroke were selected for the study. The present study evaluated the impact of antihypertensive medication compliance on stroke patterns and recurrence in a hypertensive population in Bangladesh. In this study, the majority of participants were in the age range of 51-60 years (35.8%), followed by those aged 61-70 years (28.3%). The mean age was 54.6 years, indicating a middle-aged to older adult population with a male-to-female ratio of 1.38:1. This pattern aligns with previous studies where older age groups have been identified as more susceptible to hypertension and stroke risk [11]. A study by Dhungana *et al.*, [13] in Nepal also found a similar demographic trend, with a majority of stroke patients being in middle to older age categories, further underscoring the heightened risk of cerebrovascular events in this age group. In analyzing the patterns of stroke, cerebral infarction emerged as the most prevalent type, affecting 62.5% of our study subjects, while cerebral hemorrhage affected 30.0%. This distribution is consistent with broader trends observed in stroke research, where ischemic strokes typically outnumber hemorrhagic strokes. Lüders [14] found similar prevalence rates, highlighting that cerebral infarction is often predominant in hypertensive populations, underscoring the significant burden of ischemic events in this demographic. The association between hypertension and increased cerebral infarction risk is well-documented, with ischemic strokes accounting for the majority of hypertensive strokes globally [2]. A significant finding of this study was the discrepancy in stroke patterns between compliant and non-compliant groups. Among the compliant group, 20.5% experienced cerebral infarction, whereas 37.2% of non-compliant participants had this diagnosis. Additionally, cerebral hemorrhage was present in 6.4% of compliant individuals but rose significantly to 33.3% among non-compliant patients. The Chi-square test for these distributions ($p < .001$) indicates a strong association between non-compliance and the occurrence of severe stroke types, which agrees with similar findings. In the study by Lüders [14], patients with poor adherence to antihypertensive medication were more prone to cerebral hemorrhage, consistent with the 33.3% prevalence of cerebral hemorrhage found in our non-compliant group. Similarly, Herttua *et al.*, [15] concluded that non-adherence to antihypertensive therapy resulted in nearly

28% increased risk of stroke, corroborating our findings. Our study also revealed that recurrent stroke was substantially higher among non-compliant participants (68.8%) compared to those who adhered to their antihypertensive regimen (31.3%), with a highly significant Chi-square result ($p < .001$). This result is consistent with evidence from a population-based study by Shimada [16], which showed that antihypertensive medication adherence significantly reduced the recurrence of all types of cerebrovascular events. The recurrence rates observed here further emphasize the importance of strict blood pressure management to reduce the likelihood of subsequent strokes. Badila *et al.*, [17] also reported that adherence to treatment was associated with fewer recurrent strokes, reinforcing the crucial role of antihypertensive compliance. Notably, our study's findings indicate that, among patients without recurrent strokes, the compliant group was substantially larger (27.4%) than the non-compliant group (72.6%), providing further support for the protective effect of compliance against recurrent stroke. Lee *et al.*, [7] found similar results in their cohort, where compliance was associated with a 1.27-fold reduction in stroke incidence compared to non-compliance, supporting the need for ongoing adherence to prevent recurrence. The high non-compliance rate observed in this study (71.8%) among hypertensive patients is concerning and highlights the challenges in achieving consistent adherence in chronic disease management. Reasons for non-compliance include socio-economic barriers, lack of awareness, and side effects, as documented in other studies [6,18]. Nabi *et al.*, [5] reported similar non-compliance rates, citing similar contributing factors and emphasizing the importance of patient education and accessible healthcare services to support compliance. The strong association between non-compliance and both initial and recurrent stroke incidence suggests that targeted interventions are critical to improving adherence among hypertensive patients. Education on the consequences of non-compliance, alongside the provision of affordable medications and support systems, could play an essential role in addressing this issue. Mahamood *et al.*, [19] highlighted the effectiveness of educational interventions in improving compliance, particularly in low-resource settings, indicating that such strategies could significantly impact compliance rates in Bangladesh.

Limitations of the study

In our study, there was small sample size and absence of control for comparison. Study population was selected from one center in Dhaka city, so may not represent wider population. The study was conducted at a short period of time.

VII CONCLUSION AND RECOMMENDATIONS

This study highlights the significant role of antihypertensive medication adherence in reducing the incidence and recurrence of stroke among hypertensive patients in Bangladesh. Non-compliance was strongly associated with increased risk of both cerebral infarction and cerebral hemorrhage, underscoring the importance of consistent medication adherence. Targeted interventions, including patient education and accessible treatment, are recommended for improving compliance and mitigating stroke risk in this population, ultimately enhancing long-term health outcomes for hypertensive patients.

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