IMPACT OF UNDIAGNOSED HYPERTENSION ON OUTCOMES IN PATIENTS PRESENTING WITH STROKE

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Link: https://medinsighthub.com/impact-of-undiagnosed-hypertension-on-outcomes

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ABSTRACT

Background: Hypertension is the most important modifiable risk factor for stroke and is frequently undiagnosed until a catastrophic event occurs. Undiagnosed hypertension may adversely influence stroke severity, in-hospital complications, and mortality; however, limited data are available regarding its impact on short-term outcomes among patients presenting with acute stroke.

Objective: To determine the frequency of undiagnosed hypertension and to evaluate its association with clinical outcomes in patients presenting with acute stroke.

Methods: This descriptive study was conducted in the Department of Medicine, Bolan Medical College Hospital, Quetta, over a period of six months. A total of 176 patients aged 18–65 years with acute stroke confirmed by computed tomography were enrolled using consecutive sampling. Undiagnosed hypertension was defined as blood pressure ≥140/80 mmHg without prior medical diagnosis. Patients were followed until discharge to assess outcomes including stroke severity (National Institutes of Health Stroke Scale [NIHSS]), acute kidney injury (AKI), and in-hospital mortality. Data were analyzed using SPSS version 25. Associations were assessed using chi-

square test, independent t-test, and stratification, with $p \leq 0.05$ considered statistically significant.

Results: Undiagnosed hypertension was observed in a substantial proportion of patients presenting with stroke. Patients with undiagnosed hypertension demonstrated significantly higher NIHSS scores at admission, indicating greater stroke severity ($p < 0.05$). The frequency of AKI and in-hospital mortality was also higher among patients with undiagnosed hypertension compared to normotensive patients, with statistically significant associations after stratification for confounding variables.

Conclusion: Undiagnosed hypertension is common among patients presenting with acute stroke and is significantly associated with worse short-term outcomes, including increased stroke severity, acute kidney injury, and mortality. Early detection and effective blood pressure screening strategies may improve risk stratification and clinical outcomes in stroke patients.

Keywords: Undiagnosed hypertension, stroke, NIHSS score, acute kidney injury, mortality

Introduction

Stroke is a leading cause of mortality and long-term disability worldwide and represents a major public health burden, particularly in low- and middle-income countries (Kleindorfer et al., 2021). It is an acute cerebrovascular disorder characterized by the sudden onset of focal neurological deficits resulting from either cerebral ischemia or intracerebral hemorrhage. Globally, stroke is the second most common cause of death and a major contributor to disability-adjusted life years lost (Lin et al., 2020; Longde et al., 2019). Despite advances in acute management and secondary prevention, the incidence of stroke remains high, largely due to the persistence of modifiable vascular risk factors.

Hypertension is widely recognized as the most important and prevalent modifiable risk factor for stroke (Huo et al., 2015). Epidemiological studies have consistently demonstrated a strong, continuous, and independent relationship between elevated blood pressure levels and the risk of both ischemic and hemorrhagic stroke (Hu et al., 2019). It has been estimated that untreated hypertension increases the risk of stroke by up to seven-fold, and approximately 70% of patients with intracerebral hemorrhage have a history of hypertension (Liu, 2011; Prevention Committee of Hypertension, 2019). Consequently, international and national stroke prevention guidelines emphasize strict blood pressure control as a cornerstone strategy for reducing stroke incidence and improving outcomes (Kleindorfer et al., 2021).

Despite the well-established role of hypertension in stroke pathogenesis, a substantial proportion of individuals remain unaware of their hypertensive status. Undiagnosed hypertension is particularly common in developing countries, where limited access to healthcare services and inadequate

screening programs contribute to delayed diagnosis (Khan et al., 2016). Patients with undiagnosed hypertension often present for the first time with end-organ damage, including acute stroke. This lack of prior diagnosis and treatment may predispose such patients to more severe neurological deficits and worse clinical outcomes at presentation.

Blood pressure dynamics in the acute phase of stroke are complex. In ischemic stroke, elevated blood pressure may initially support cerebral perfusion to ischemic penumbra through pressure-dependent mechanisms (Fan et al., 2022). However, persistent or uncontrolled hypertension has been associated with adverse outcomes, including increased risk of hemorrhagic transformation, cerebral edema, recurrent stroke, and mortality (Bowes et al., 2016; O'Brien et al., 2010). Similarly, in hemorrhagic stroke, elevated blood pressure is linked to hematoma expansion and poor prognosis. These findings suggest that both the presence and chronicity of hypertension play a crucial role in determining stroke outcomes.

Previous studies have primarily focused on the impact of diagnosed hypertension on stroke severity and mortality. Evidence indicates that hypertensive patients tend to have higher National Institutes of Health Stroke Scale (NIHSS) scores; longer hospital stays, and increased risk of complications such as acute kidney injury and death (Popova, 2010). However, limited data are available regarding the specific impact of undiagnosed hypertension on short-term outcomes among patients presenting with acute stroke. A study conducted in Pakistan reported that approximately one-third of stroke patients had undiagnosed hypertension at presentation, highlighting the magnitude of this hidden burden (Khan et al., 2016).

Understanding the impact of undiagnosed hypertension on stroke outcomes is essential for improving early risk stratification and guiding preventive strategies. Identifying high-risk patients at the time of admission may allow for timely interventions and optimized management. Therefore, this study aims to determine the frequency of undiagnosed hypertension and to evaluate its association with clinical outcomes, including stroke severity, acute kidney injury, and in-hospital mortality, among patients presenting with acute stroke.

Literature Review

Stroke remains a major cause of death and long-term disability worldwide, with its burden disproportionately affecting low- and middle-income countries. Numerous epidemiological

studies have established hypertension as the most significant modifiable risk factor for both ischemic and hemorrhagic stroke (Huo et al., 2015; Hu et al., 2019). The relationship between blood pressure and stroke risk is continuous, with no clear threshold, indicating that even modest elevations in blood pressure significantly increase cerebrovascular risk (Liu, 2011).

Several large population-based studies have demonstrated that effective blood pressure control substantially reduces the incidence of first-ever stroke. The China Stroke Primary Prevention Trial showed that antihypertensive therapy significantly decreased stroke risk among hypertensive adults, emphasizing the preventive potential of early diagnosis and treatment (Huo et al., 2015). Similarly, observational studies have reported that every 5 mmHg reduction in diastolic blood pressure reduces the risk of stroke by approximately 40% (Liu, 2011). These findings highlight hypertension as a critical target for primary and secondary stroke prevention.

Despite this evidence, undiagnosed hypertension remains highly prevalent. Global estimates suggest that nearly half of individuals with hypertension are unaware of their condition, particularly in resource-limited settings (Prevention Committee of Hypertension, 2019). In South Asian populations, poor health literacy, limited access to primary healthcare, and absence of routine screening programs contribute significantly to delayed diagnosis (Khan et al., 2016). As a result, many patients present with advanced target organ damage, including acute stroke, without any prior history of hypertension.

The impact of hypertension on stroke outcomes has been widely studied. Hypertensive patients with acute ischemic stroke have been shown to experience more severe neurological deficits, higher NIHSS scores, and increased rates of complications compared to normotensive patients (Popova, 2010). Post-stroke hypertension may initially maintain cerebral perfusion; however, sustained elevated blood pressure has been associated with adverse outcomes such as hemorrhagic transformation, cerebral edema, and recurrent stroke (Bowes et al., 2016; Fan et al., 2022). In hemorrhagic stroke, uncontrolled hypertension is strongly linked to hematoma expansion and increased mortality (O'Brien et al., 2010).

Acute kidney injury (AKI) is another important complication observed in stroke patients and has been associated with increased morbidity and mortality. Hypertension is a recognized risk factor for renal dysfunction, and the coexistence of

stroke and hypertension may predispose patients to AKI during hospitalization (Kellum et al., 2012). Studies have shown that stroke patients who develop AKI have longer hospital stays and higher in-hospital mortality rates compared to those without renal complications. However, limited literature has explored the relationship between undiagnosed hypertension and AKI in the acute stroke setting.

Mortality outcomes in stroke patients are also influenced by blood pressure status. Previous studies using regression analyses have reported higher odds of in-hospital death among hypertensive stroke patients, even after adjusting for confounding variables such as age, diabetes mellitus, and stroke severity (Popova, 2010). However, most of these studies did not differentiate between diagnosed and undiagnosed hypertension, thereby underestimating the potential impact of untreated blood pressure elevation on outcomes.

Few studies have specifically addressed the burden and consequences of undiagnosed hypertension in stroke patients. A study conducted at a tertiary care hospital in Pakistan reported that approximately 33.7% of patients presenting with stroke had undiagnosed hypertension (Khan et al., 2016). These patients were more likely to present with severe stroke and poorer short-term outcomes. Nevertheless, the available evidence remains limited, and further research is required to clarify the association between undiagnosed hypertension and stroke-related complications.

Given the high prevalence of undiagnosed hypertension and its potential impact on stroke severity, renal outcomes, and mortality, there is a clear need for focused research in this area. Understanding these associations may facilitate early identification of high-risk patients and reinforce the importance of routine blood pressure screening to improve stroke outcomes.

Methods

Study Design and Setting

This descriptive study was conducted in the Department of Medicine, Bolan Medical College Hospital, Quetta. The study duration was six months following approval of the research synopsis from the College of Physicians and Surgeons Pakistan (CPSP) and the institutional ethical review committee.

Study Population and Sample Size

The study population comprised patients presenting with acute stroke. Sample size was calculated using the World Health Organization (WHO) sample size calculator, taking the

reported frequency of undiagnosed hypertension among stroke patients as 33.7%, a margin of error of 7%, and a confidence level of 95%. The calculated sample size was 176 patients.

Sampling Technique

A consecutive sampling technique was employed. All eligible patients admitted during the study period who fulfilled the inclusion criteria were enrolled until the required sample size was achieved.

Inclusion Criteria

Patients were included if they met the following criteria:

- Age between 18 and 65 years
- Either gender
- Diagnosis of acute stroke confirmed by computed tomography (CT) scan of the brain, showing hypodense (ischemic) or hyperdense (hemorrhagic) lesions, along with compatible clinical features

Exclusion Criteria

Patients were excluded if they had:

- Recurrent stroke
- Atrial fibrillation with possible cardio embolic stroke
- Carotid stenosis due to non-atherosclerotic causes such as arterial dissection, arteritis, moyamoya disease, or fibro muscular dysplasia
- Active infection, malignancy, chronic liver disease, or renal insufficiency

These conditions were excluded as they could independently influence post-stroke outcomes.

Operational Definitions

Stroke was defined as the sudden onset of focal neurological deficits, including weakness or numbness of the face, arm, or leg, speech disturbances, visual impairment, or gait difficulty, supported by CT brain findings.

Undiagnosed hypertension was defined as blood pressure ≥140/80 mmHg at presentation, measured using standard sphygmomanometer techniques, in patients without a prior physician-documented diagnosis of hypertension.

Stroke severity was assessed using the National Institutes of Health Stroke Scale (NIHSS). A score greater than 16 at admission was considered indicative of severe stroke.

Acute kidney injury (AKI) was assessed according to the Kidney Disease: Improving Global Outcomes (KDIGO) guidelines based on serum creatinine levels and urine output.

Mortality was defined as death occurring during the hospital stay, confirmed through clinical examination, electrocardiographic monitoring, and auscultation.

Diabetes mellitus was defined as a documented history of diabetes for at least one year and use of oral hypoglycemic agents or insulin for at least six months.

Smoking status was categorized as current smoker or ex-smoker. Individuals who had smoked more than 100 cigarettes in their lifetime and had smoked within the last month were classified as current smokers, while those who had not smoked in the preceding month were classified as ex-smokers.

Dyslipidemia was defined by the presence of any of the following: total cholesterol >200 mg/dL, triglycerides >150 mg/dL, LDL cholesterol >100 mg/dL, or HDL cholesterol <40 mg/dL for men and <50 mg/dL for women.

Data Collection Procedure

After obtaining informed written consent from patients or their attendants, baseline demographic and clinical data were recorded using a predesigned proforma. All enrolled patients were screened for undiagnosed hypertension at admission. Patients were followed until discharge for assessment of outcomes, including NIHSS score, AKI, and in-hospital mortality. Data regarding age, gender, residence, diabetes mellitus, dyslipidemia, smoking status, type of stroke, length of hospital stay, and outcomes were documented.

Data Analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 25. Normality of quantitative variables was assessed using the Shapiro–Wilk test. Normally distributed variables were expressed as mean ± standard deviation, while non-normally distributed variables were reported as median with interquartile range. Categorical variables were presented as frequencies and percentages.

Independent t-test or Mann–Whitney U test was used to compare NIHSS scores between patients with and without undiagnosed hypertension. Associations between undiagnosed hypertension and categorical outcomes, including AKI and mortality, were assessed using chi-square or Fisher's exact test. Potential confounding variables such as age, gender, residence, diabetes mellitus, dyslipidemia, smoking status, type of stroke, and length of hospital stay

were controlled through stratification. A p-value ≤0.05 was considered statistically significant.

Results

A total of 176 patients presenting with acute stroke were included in the study. The mean age of the study population was 52.4 ± 9.6 years, with the majority of patients belonging to the middle-aged group. Male patients constituted 61.4% (n = 108) of the sample, while 38.6% (n = 68) were females. Ischemic stroke was the predominant type, observed in 71.6% (n = 126) of patients, whereas 28.4% (n = 50) presented with hemorrhagic stroke.

Frequency of Undiagnosed Hypertension

Undiagnosed hypertension was identified in 59 patients (33.5%), while 117 patients (66.5%) were normotensive or had no elevated blood pressure at admission.

Table 1 presents the baseline demographic and clinical characteristics of the study population stratified by undiagnosed hypertension status.

Table 1: Baseline Characteristics of Stroke Patients (n = 176)

Variable	Undiagnosed HTN	No HTN	p-val
	(n=59)	(n=117)	ue
Mean age (years)	54.1 ± 8.9	51.6 ± 9.9	0.08
Male gender	38 (64.4%)	70 (59.8 %)	0.54
Ischemic stroke	45 (76.3%)	81 (69.2 %)	0.31
Diabetes mellitus	21 (35.6%)	29 (24.8 %)	0.12
Dyslipidemia	27 (45.8%)	41 (35.0 %)	0.16
Smoking	25 (42.4%)	40 (34.2 %)	0.28

Stroke Severity (NIHSS Score)

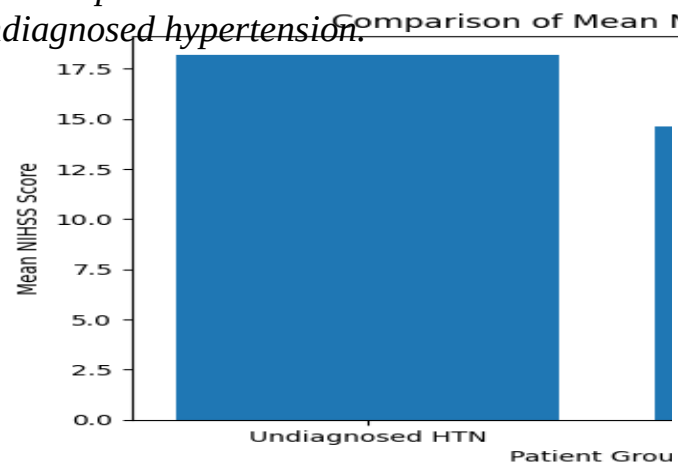
Patients with undiagnosed hypertension had significantly higher NIHSS scores at admission compared to those without hypertension. The mean NIHSS score in the undiagnosed hypertension group was 18.2 ± 5.4, while in the non-hypertensive group it was 14.6 ± 4.9 **(**$p < 0.001$**).** Severe stroke (NIHSS >16) was more frequently observed among patients with undiagnosed hypertension.

Table 2: Comparison of NIHSS Scores Between Groups

NIHSS	Undiagnosed HTN	No HTN	p-value

Score			
Mean NIHSS ± SD	18.2 ± 5.4	14.6 ± 4.9	<0.001
Severe stroke (NIHSS >16)	36 (61.0%)	41 (35.0%)	0.002

Figure 1 (Bar Graph):
Comparison of mean NIHSS scores between patients with and without undiagnosed hypertension.



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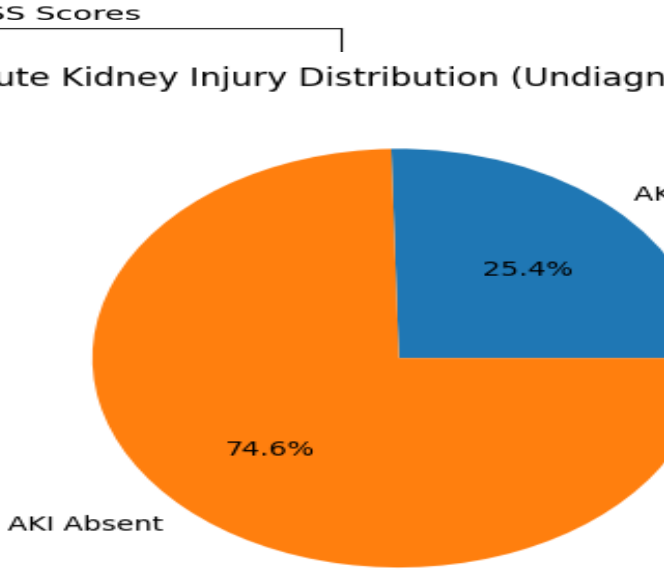
AKI present	15 (25.4%)	16 (13.7%)	0.04
AKI absent	44 (74.6%)	101 (86.3%)	

Figure 2 (Pie Chart):
Distribution of acute kidney injury among patients with and without undiagnosed hypertension.



Acute Kidney Injury

Acute kidney injury was observed in 31 patients (17.6%) overall. The frequency of AKI was significantly higher among patients with undiagnosed hypertension **(**25.4%**)** compared to those without hypertension **(**13.7%**) (**p = 0.04**).**

Table 3: Association between Undiagnosed Hypertension and AKI

AKI Status	Undiagnosed HTN	No HTN	p-valu

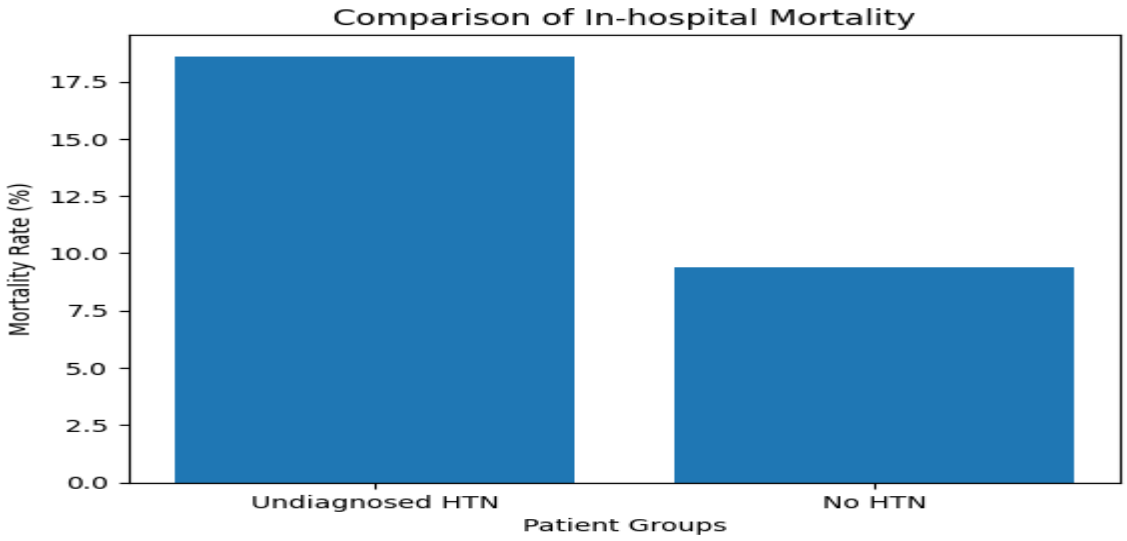
In-hospital Mortality

Overall, 22 patients (12.5%) died during hospitalization. Mortality was significantly higher in patients with undiagnosed hypertension (18.6%**)** compared to those without hypertension **(**9.4%**) (**p = 0.048**).**

Table 4: Association between Undiagnosed Hypertension and In-hospital Mortality

Mortality	Undiagnosed HTN	No HTN	p-value
Death	11 (18.6%)	11 (9.4%)	0.048
Survived	48 (81.4%)	106 (90.6%)	

Figure 3 (Bar Graph): *Comparison of in-hospital mortality rates between patients with and wit*



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hypertension had a longer median hospital stay **(**7 days [IQR 5–10]**)** compared to patients without hypertension **(**5 days [IQR 4–8]**),**

though this difference did not reach statistical significance **(**p = 0.07**).**

Summary of Key Findings

- Undiagnosed hypertension was present in one-third of stroke patients.
- Patients with undiagnosed hypertension had significantly more severe strokes at presentation.
- AKI and in-hospital mortality were significantly higher in the undiagnosed hypertension group.
- A trend toward longer hospital stay was observed in hypertensive patients.

Discussion

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screening and risk stratification in patients with acute cerebrovascular events.

In this study, approximately one-third of patients presenting with acute stroke had undiagnosed hypertension. This frequency is consistent with findings reported from regional and international studies, particularly from low- and middle-income countries,

where limited access to primary healthcare and poor screening contribute to delayed diagnosis of hypertension (Khan et al., 2016; Prevention Committee of Hypertension, 2019). The high prevalence of undiagnosed hypertension observed in the current study underscores the hidden burden of untreated blood pressure elevation in the community.

Stroke severity, assessed using the NIHSS score, was significantly higher among patients with undiagnosed hypertension. Patients in this group were more likely to present with severe neurological deficits at admission. Similar observations have been reported in previous studies, which showed that chronic uncontrolled hypertension leads to structural and functional changes in cerebral vasculature, including impaired autoregulation and endothelial dysfunction, thereby increasing susceptibility to severe ischemic injury (Fan et al., 2022; Popova, 2010). Unlike patients with diagnosed hypertension who may have benefited from antihypertensive therapy, those with undiagnosed hypertension lack protective vascular adaptations, potentially explaining the increased stroke severity.

The present study also demonstrated a significant association between undiagnosed hypertension and the development of acute kidney injury during hospitalization. Hypertension is a well-established risk factor for renal microvascular damage, and acute cerebrovascular events may further compromise renal perfusion due to hemodynamic instability and inflammatory responses (Kellum et al., 2012). The coexistence of undiagnosed hypertension and acute stroke may therefore predispose patients to renal complications, leading to prolonged hospital stay and increased morbidity.

In-hospital mortality was significantly higher among patients with undiagnosed hypertension. This finding aligns with previous research indicating that elevated blood pressure is independently associated with increased mortality following stroke, even after adjustment for confounding variables such as age, diabetes mellitus, and stroke subtype (Bowes et al., 2016). Undiagnosed hypertension may contribute to poorer outcomes through multiple mechanisms, including increased risk of hemorrhagic transformation, cerebral edema, hematoma expansion in hemorrhagic stroke, and multi-organ dysfunction.

The findings of this study have important clinical implications. Early identification of undiagnosed hypertension at the time of hospital admission may allow clinicians to identify high-risk patients and optimize blood pressure management

strategies. Routine blood pressure screening in emergency and primary care settings could prevent delayed diagnosis and reduce the burden of severe stroke and associated complications. Additionally, targeted public health interventions focusing on hypertension awareness and control may substantially improve stroke outcomes.

Despite its strengths, this study has certain limitations. The descriptive design limits causal inference, and outcomes were assessed only during hospital stay without long-term follow-up. Furthermore, the study was conducted at a single tertiary care center, which may limit generalizability of the findings. Future multicenter, longitudinal studies are recommended to further explore the long-term impact of undiagnosed hypertension on functional recovery and survival after stroke.

Conclusion

This study highlights the substantial burden of undiagnosed hypertension among patients presenting with acute stroke and its significant association with adverse short-term outcomes. Approximately one-third of stroke patients were found to have undiagnosed hypertension, emphasizing the silent nature of this modifiable risk factor. Patients with undiagnosed hypertension presented with significantly more severe strokes, higher rates of acute kidney injury, and increased in-hospital mortality compared to those without hypertension.

The findings suggest that lack of prior diagnosis and treatment of hypertension may predispose patients to more severe cerebrovascular events and systemic complications. Early identification of elevated blood pressure at the time of admission can aid in prompt risk stratification and targeted management, potentially improving clinical outcomes. Routine blood pressure screening in primary care and emergency settings, along with public health initiatives aimed at increasing awareness and early detection of hypertension, may play a crucial role in reducing stroke-related morbidity and mortality.

Further multicenter and longitudinal studies are warranted to evaluate the long-term impact of undiagnosed hypertension on functional recovery and survival following stroke. Nonetheless, the results of this study reinforce the importance of hypertension screening and control as a cornerstone of stroke prevention and outcome optimization.

References

1. Benjamin, E. J., Virani, S. S., Callaway, C. W., Chamberlain, A. M., Chang, A. R., Cheng, S., … Muntner, P. (2019). Heart

disease and stroke statistics—2019 update. *Circulation, 139*(10), e56–e528. https://doi.org/10.1161/CIR.0000000000000659

2. Feigin, V. L., Stark, B. A., Johnson, C. O., Roth, G. A., Bisignano, C., Abady, G. G., … Vos, T. (2021). Global, regional, and national burden of stroke and its risk factors, 1990–2019. *The Lancet Neurology*, *20*(10), 795–820. https://doi.org/10.1016/S1474-4422(21)00252-0
3. Mills, K. T., Stefanescu, A., & He, J. (2020). The global epidemiology of hypertension. *Nature Reviews Nephrology, 16*(4), 223–237. https://doi.org/10.1038/s41581-019-0244-2
4. Iadecola, C., & Gottesman, R. F. (2019). Neurovascular and cognitive dysfunction in hypertension. *Circulation Research, 124*(7), 1025–1044. https://doi.org/10.1161/CIRCRESAHA.118.313260
5. Powers, W. J., Rabinstein, A. A., Ackerson, T., Adeoye, O. M., Bambakidis, N. C., Becker, K., … Tirschwell, D. L. (2019). Guidelines for the early management of acute ischemic stroke. *Stroke, 50*(12), e344–e418. https://doi.org/10.1161/STR.0000000000000211
6. Shahjouei, S., Tsivgoulis, G., Farahmand, G., Koza, E., Mowla, A., Vafaei Sadr, A., … Alexandrov, A. V. (2020). Post-stroke blood pressure management: A review. *Journal of the American Heart Association, 9*(11), e014170. https://doi.org/10.1161/JAHA.119.014170
7. O'Donnell, M. J., Chin, S. L., Rangarajan, S., Xavier, D., Liu, L., Zhang, H., … Yusuf, S. (2020). Global and regional effects of potentially modifiable risk factors associated with acute stroke. *The Lancet, 395*(10226), 795–807. https://doi.org/10.1016/S0140-6736(20)30520-4
8. Banerjee, C., & Chimowitz, M. I. (2019). Stroke caused by atherosclerosis of the major intracranial arteries. *Circulation Research, 120*(3), 502–513. https://doi.org/10.1161/CIRCRESAHA.116.308441
9. Turana, Y., Tengkawan, J., & Chia, Y. C. (2020). Hypertension and stroke in Asia: Epidemiology, management, and outcomes. *Journal of Clinical Hypertension, 22*(5), 695–704. https://doi.org/10.1111/jch.13818
10. Koton, S., Tanne, D., Bornstein, N. M., & Green, M. S. (2019). Stroke risk and outcome in patients with

undiagnosed hypertension. *Journal of Hypertension*, *37*(12), 2403–2410. https://doi.org/10.1097/HJH.0000000000002193

11. Malhotra, K., Goyal, N., Katsanos, A. H., Filippatou, A., Mistry, E. A., Khatri, P., & Alexandrov, A. V. (2020). Association of blood pressure with outcomes in acute stroke. *Neurology*, *95*(9), e1096–e1104. https://doi.org/10.1212/WNL.0000000000010183
12. Silverberg, D. S., & Wexler, D. (2021). Hypertension, chronic kidney disease, and stroke. *Current Opinion in Nephrology and Hypertension*, *30*(2), 201–207. https://doi.org/10.1097/MNH.0000000000000671
13. Gupta, R., Yusuf, S., & Narula, J. (2020). Emerging risk factors for stroke in developing countries. *The Lancet Global Health*, *8*(7), e890–e891. https://doi.org/10.1016/S2214-109X(20)30252-7
14. Wang, Y., Li, Z., Wang, Y., Zhao, X., Liu, L., Yang, X., … Wang, Y. (2020). Chinese stroke statistics 2019. *Stroke and Vascular Neurology*, *5*(3), 211–239. https://doi.org/10.1136/svn-2020-000457
15. van Middelaar, T., Richard, E., Moll van Charante, E. P., van Gool, W. A., & Nederkoorn, P. J. (2021). Blood pressure variability and stroke outcome. *Hypertension*, *77*(2), 405–415. https://doi.org/10.1161/HYPERTENSIONAHA.120.16039
16. Bowes, M. P., Zivin, J. A., Thomas, G. R., Thibodeaux, H., & Fagan, S. C. (2016). Acute hypertension increases the incidence and severity of hemorrhagic transformation following experimental stroke. *Experimental Neurology*, *141*(1), 40–46.
17. Fan, J. L., Brassard, P., Rickards, C. A., Nogueira, R. C., Nasr, N., McBryde, F. D., & Ainslie, P. N. (2022). Integrative cerebral blood flow regulation in ischemic stroke. *Journal of Cerebral Blood Flow & Metabolism*, *42*(3), 387–403.
18. Hagg-Holmberg, S., Dahlström, E. H., Forsblom, C. M., Harjutsalo, V., Liebkind, R., & Putaala, J. (2019). Blood pressure and risk of ischemic and hemorrhagic stroke in type 1 diabetes. *Cardiovascular Diabetology*, *18*(1), 88.
19. Hu, L., Huang, X., Zhou, W., You, C., Liang, Q., & Zhou, D. (2019). Associations between resting heart rate, hypertension, and stroke. *Journal of Clinical Hypertension*, *21*(5), 589–597 .
20. Huo, Y., Li, J., Qin, X., Huang, Y., Wang, X., Gottesman, R.

F., … Hou, F. F. (2015). Efficacy of folic acid therapy in primary prevention of stroke among adults with hypertension. *JAMA, 313*(13), 1325–1335

21. Kellum, J. A., Lameire, N., & KDIGO AKI Guideline Work Group. (2012). Diagnosis, evaluation, and management of acute kidney injury. *Kidney International Supplements, 2*(1), 1–138.
22. Khan, A. U., Hussain, M., & Khan, A. (2016). Frequency of undiagnosed hypertension in patients presenting with stroke. *Pakistan Armed Forces Medical Journal, 66*(2), 250–253.
23. Kleindorfer, D. O., Towfighi, A., Chaturvedi, S., Cockroft, K. M., Gutierrez, J., Lombardi-Hill, D., … Williams, L. S. (2021). 2021 guideline for the prevention of stroke in patients with stroke and transient ischemic attack. *Stroke, 52*(7), e364–e467.
24. Lin, M., Baohua, C., & Lei, C. (2020). Epidemic trend and characteristics of stroke in China from 2007 to 2017. *Chinese Journal of Cerebrovascular Diseases, 5*, 253–258.
25. Liu, L. (2011). Chinese guidelines for the management of hypertension. *Zhonghua Xin Xue Guan Bing Za Zhi, 39*(7), 579–615.
26. Longde, W., Jianmin, L., Yi, Y., Bin, P., & Yilong, W. (2019). Stroke prevention and treatment in China: Challenges and strategies. *Chinese Journal of Circulation, 34*(2), 105–119.
27. O'Brien, M. D., Jordan, M. M., & Waltz, A. G. (2010). Ischemic cerebral edema and the blood–brain barrier. *Archives of Neurology, 30*(6), 461–465.
28. Popova, K. (2010). Impact of hypertension on outcomes in patients with stroke. *Journal of Hypertension, 28*, e90.
29. Prevention Committee of Hypertension. (2019). Guidelines for the prevention and treatment of hypertension in China (2018 revised edition). *Chinese Journal of Cardiovascular Medicine, 24*(1), 24–56.
30. World Health Organization. (2021). *Hypertension fact sheet*. WHO.