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Research Article

Clinical Profile and Determinants of Stroke Severity in Patients with Acute Ischemic Stroke: A Hospital-Based Study

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Abstract

Background: Stroke severity at presentation is an important predictor of early clinical course and utilization of resources. Neurologicalal impairment in acute ischemic stroke may be associated with demographic data, vascular comorbidities, smoking, alcohol consumption, blood pressure and other available clinical parameters.

Objective: To describe the clinical characteristics of patients with acute ischemic stroke and to investigate the relationship of some demographic, comorbidity, behavioral and admission vital-sign features with neurological severity as assessed by the National Institutes of Health Stroke Scale (NIHSS).

Methods: This prospective observational hospital-based study was conducted in the Department of General Medicine, Navodaya Medical College Hospital and Research Centre, Raichur, among 100 adults with acute cerebral infarction confirmed through computed tomography, from January 1, 2021 to July 31, 2022. We collected data on demographic characteristics, history of hypertension and diabetes mellitus, smoking and alcohol consumption, admission pulse rate and blood pressure. The NIHSS was assessed on admission and at discharge. Length of stay was also recorded. Clinical characteristics and NIHSS were evaluated for associations using t-tests or analysis of variance, as appropriate.

Results: The mean age was 64.57 ± 10.06 years and 60% of participants were male. The descriptive clinical data showed the prevalence of hypertension 58%, diabetes mellitus 42%, combined hypertension and diabetes 27%, smoking 35%, alcohol consumption 39%, and combined smoking and alcohol consumption 20%. The mean hospital stay was 7.3 ± 3.71 days. Tachycardia was present in 22%, high systolic blood pressure in 56%, and high diastolic blood pressure in 51%. Mean NIHSS dropped from 15.49±7.83 at admission to 11.77±7.93 at discharge ($p=0.001$). In the study association analysis, diabetes mellitus, smoking, alcohol consumption and combined hypertension/diabetes were associated with significantly higher NIHSS scores, while hypertension alone was not statistically significant. The NIHSS increased progressively with the duration of hospitalization, from 7.74 in patients hospitalized less than 5 days to 24.40 in those hospitalized more than 16 days (ANOVA $p<0.00001$). Higher systolic and diastolic blood

pressure and tachycardia were also significantly associated with higher NIHSS scores.

CONCLUSION: Patients with acute ischemic stroke in this hospital-based cohort were predominantly older adults, with a mild male preponderance and a high prevalence of vascular risk factors. In the crude analyses, diabetes, smoking, alcohol consumption, higher blood pressure at admission and tachycardia were associated with more severe neurological symptoms. Higher NIHSS was strongly associated with longer hospital stay. These findings provide support for systematic assessment of vascular risk factors and admission physiological parameters in the evaluation of acute stroke. However, the observational design and lack of multivariable adjustment preclude conclusions on independent determinants or causality.

Keywords: acute ischemic stroke; clinical profile; stroke severity; NIHSS; hypertension; diabetes mellitus; smoking; alcohol; blood pressure; hospital stay.

Introduction

Acute ischemic stroke is one of the leading causes of death and disability worldwide. The global burden of stroke remains large, with ischemic stroke being the most common type of incident stroke. [1] Modern acute stroke care focuses on rapid neurological assessment, neuroimaging, identification of vascular risk factors and timely reperfusion treatment when appropriate. [2]

Stroke severity at presentation is clinically relevant as it determines treatment decisions, early neurological outcome, rehabilitation needs and healthcare resource use. The National Institutes of Health Stroke Scale (NIHSS) is one of the most commonly used standardized instruments for quantifying neurological impairment in acute stroke. Higher NIHSS scores are generally associated with greater neurological deficit and a poorer outcome. [3,4]

Hypertension, diabetes mellitus, tobacco use and alcohol consumption are known modifiable vascular risk factors for stroke. The INTERSTROKE study showed that a small number of potentially modifiable risk factors account for a large proportion of the population-attributable risk of stroke throughout the world, with hypertension being particularly important. [5] Hypertension also is associated with increased risk of stroke across populations including Asian populations. [6]

A further established vascular risk factor is smoking. Meta-analyses showed that current and ever smokers had an increased risk of stroke, with the magnitude of risk varying according to smoking intensity, duration and stroke subtype. [7,8] Similarly, diabetes mellitus has also been linked to increased vascular risk and adverse outcomes after stroke. [9]

Special care must be taken in the management of blood pressure in acute ischemic stroke. High blood pressure is often seen after stroke, but both too much hypertension and too much reduction in blood pressure may adversely affect cerebral perfusion and outcome . Current guidelines therefore recommend individualized blood-pressure management based on reperfusion eligibility, stroke severity and associated clinical circumstances rather than indiscriminate early reduction. [2,10]

Another clinically relevant outcome is hospital length of stay, which reflects the relationship between neurological severity, complications, comorbidity and functional recovery. Admission NIHSS has previously been shown to be an important predictor of length of hospitalization after ischemic stroke. [11]

These are important factors but clinical characteristics associated with neurologic

severity may vary across populations and health care settings. Characterization of routinely available admission variables thus may provide useful descriptive information for clinical risk stratification.

Objective

To describe the demographic and clinical profile of patients with acute ischemic stroke and evaluate the association of selected comorbidities, behavioral risk factors, admission vital signs and duration of hospitalization with stroke severity measured by NIHSS.

Materials and Methods

Study design and setting

It was a prospective observational hospital-based study conducted in the Department of General Medicine, Navodaya Medical College Hospital and Research Centre, Raichur, Karnataka.

The design was described as a "prospective cross-sectional study" in the original study. The study is described according to the actual process of clinical data collection for publication without suggesting long-term prospective follow-up.

Length of study

The study period was January 1, 2021 – July 31, 2022.

Number of samples

The minimum sample size was calculated as 66 using a cross-sectional sample-size formula based on a prevalence of 21.9%, a 95% confidence level and an absolute allowable error of 10 percentage points. The final study included 100 participants.

Thus, the analysis in this manuscript keeps the true enrolled sample of 100.

Sampling

The source study contains inconsistent descriptions of the sampling approach. The abstract describes universal sampling while the sample-size section states simple random sampling. Since the available documentation does not provide a definitive resolution to this discrepancy, the present manuscript does not assign a specific sampling label.

Selection criteria

Criteria for inclusion

• Adults >18 years old.

• CT findings of an acute cerebral infarct.

Exclusion Criteria

Patients with traumatic stroke, transient ischemic attack, cerebral venous thrombosis, intracerebral hemorrhage, space-occupying lesion, cerebellar/brainstem infarction, cardioembolic stroke or coagulation disorders were excluded.

Data collection

Demographic and clinical variables were recorded on admission. The variables recorded were:

• age; sex,

• hypertension;

• diabetes;

• diabetes combined with high blood pressure;

• tobacco use;

• consuming alcohol;

• the combined use of tobacco and alcohol;

• eating pattern;

• heart rate;

• systolic blood pressure;

• BP diastolic;

• length of hospital stay; and

• NIHSS.

The study also collected lab variables which include glucose, HbA1c, lipid profile and serum creatinine. Since these variables are the primary focus of Manuscripts 1 and 2 they are not reexamined as primary exposures in this manuscript.

Stroke severity assessment

Neurologicalal severity was evaluated at admission and discharge using the NIHSS. The NIHSS is a standardized neurological impairment measure, with higher scores indicating a greater neurological deficit. [3]

The main severity measure for this manuscript was NIHSS at admission. The secondary descriptive outcome was change in NIHSS from admission to discharge.

Classification of vital signs

The study classified admission vital signs into:

• pulse rate <100 beats/min vs >100 beats/min;

• systolic blood pressure <140 vs >140 mmHg;

• diastolic blood pressure <90 vs >90 mmHg.

The thresholds were slightly different in the original descriptive table (>101 and >141 mm Hg) and the corresponding association table (>100 and >140 mm Hg). The latter thresholds are reported in the association analyses to keep the analytical categories as used in the NIHSS comparisons.

Statistical analysis

Continuous variables are expressed as mean ± standard deviation and categorical variables as frequencies and percentages.

Similar to the study analysis, t-tests were used to compare the two clinical categories of NIHSS, and analysis of variance was used to compare the multiple hospital-stay categories.

Statistical significance was defined as $p < 0.05$.

Results

Demographic profile

The study included 100 participants. The mean age was **64.57 ± 10.06 years**. Only 7% were younger than 50 years, while 63% were aged 51–70 years. Males accounted for 60% and females for 40%.

Table 1. Demographic characteristics

Characteristic	n (%)
Total participants	100 (100)
Male	60 (60)
Female	40 (40)
<40 years	1 (1)
41–50 years	6 (6)
51–60 years	24 (24)

61–70 years	39 (39)
71–80 years	20 (20)
>81 years	10 (10)
Mean age	**64.57 ± 10.06 years**

Clinical Characteristics and Vascular Risk Factors

The descriptive clinical table reported hypertension in 58%, diabetes mellitus in 42%, combined hypertension and diabetes in 27%, smoking in 35%, alcohol consumption in 39%, and combined smoking and alcohol consumption in 20%.

Table 2. Comorbidities and behavioral risk factors

Clinical characteristic	**n (%)**
Hypertension	58 (58)
Diabetes mellitus	42 (42)
Hypertension + diabetes	27 (27)
Smoking	35 (35)
Alcohol consumption	39 (39)
Smoking + alcohol consumption	20 (20)

Important data-integrity note: The subsequent NIHSS association table contains different denominators for hypertension and diabetes (56 and 65, respectively). These values are reported separately below as part of the original association analysis and are not substituted into the descriptive table.

5. Dietary Pattern

Forty-seven percent of participants reported a vegetarian diet and 53% a mixed diet.

Table 3. Dietary pattern

Diet	**n (%)**
Vegetarian	47 (47)
Mixed	53 (53)
Total	**100 (100)**

Because dietary pattern was not analyzed against NIHSS in the study, it is presented descriptively only.

Admission Vital Signs

The mean pulse rate was **90.27 ± 9.48 beats/min**, mean systolic blood pressure was **146.96 ± 13.72 mmHg**, and mean diastolic blood pressure was **93.66 ± 12.17 mmHg**.

Twenty-two percent of participants had pulse rates above 100 beats/min. Elevated systolic blood pressure was reported in 56%, while elevated diastolic blood pressure was reported in 51%.

Table 4. Admission vital signs

Parameter	Category	n (%)	Mean ± SD
Pulse rate	<100 bpm	78 (78)	90.27 ± 9.48
	>100 bpm	22 (22)	
Systolic BP	<140 mmHg	44 (44)	146.96 ± 13.72
	>140 mmHg	56 (56)	
Diastolic BP	<90 mmHg	49 (49)	93.66 ± 12.17
	>90 mmHg	51 (51)	

Hospital Stay

The mean duration of hospitalization was **7.3 ± 3.71 days**. Thirty-eight participants (38%) stayed for <5 days, 42 (42%) for 6–10 days, 16 (16%) for 11–15 days and 4 (4%) for >16 days. Thus, 80% remained hospitalized for ≤10 days.

Table 5. Duration of hospitalization

Duration	n (%)
<5 days	38 (38)
6–10 days	42 (42)
11–15 days	16 (16)
>16 days	4 (4)
Total	**100 (100)**
Mean ± SD	**7.3 ± 3.71 days**

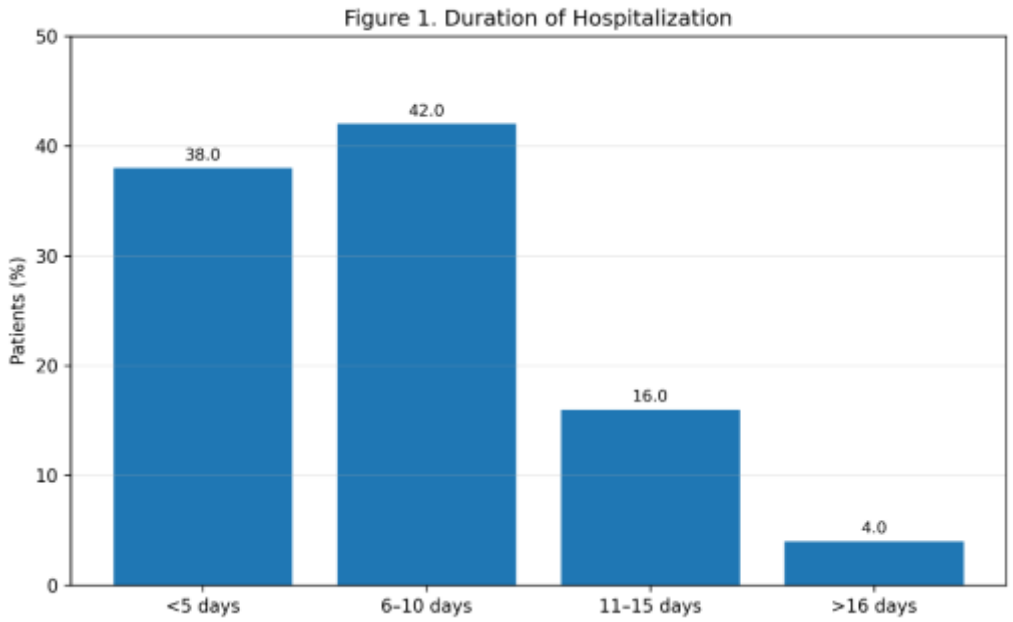

Figure 1. Distribution of patients according to duration of hospitalization.

Neurologicalal Severity

Mean NIHSS was **15.49 ± 7.83 at admission** and **11.77 ± 7.93 at discharge**. The reduction was statistically significant (t=−3.338, p=0.001).

Table 6. NIHSS at admission and discharge

Assessment	**Mean NIHSS**	**SD**
Admission	15.49	7.83
Discharge	11.77	7.93
Statistical test	t=−3.338	**p=0.001**

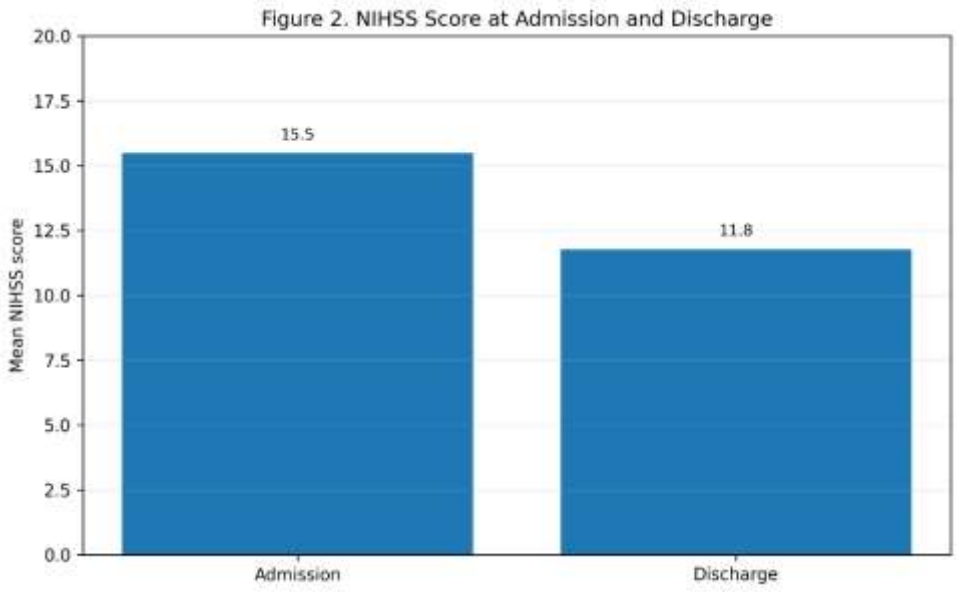

Figure 2. Mean NIHSS score at admission and discharge.

Association Between Hospital Stay and NIHSS

Mean NIHSS increased progressively with increasing duration of hospitalization:

- <5 days: **7.74 ± 3.19**
- 6–10 days: **17.79 ± 4.36**
- 11–15 days: **24.13 ± 4.94**
- 16 days: **24.40 ± 13.65**

The association was statistically significant (**F=58.3177, p<0.00001**).

Table 7. Association between duration of hospitalization and NIHSS

Hospital stay	**n**	**Mean NIHSS**	**SD**
<5 days	38	7.74	3.19
6–10 days	42	17.79	4.36
11–15 days	16	24.13	4.94
>16 days	4	24.40	13.65
ANOVA		**F=58.3177**	**p<0.00001**

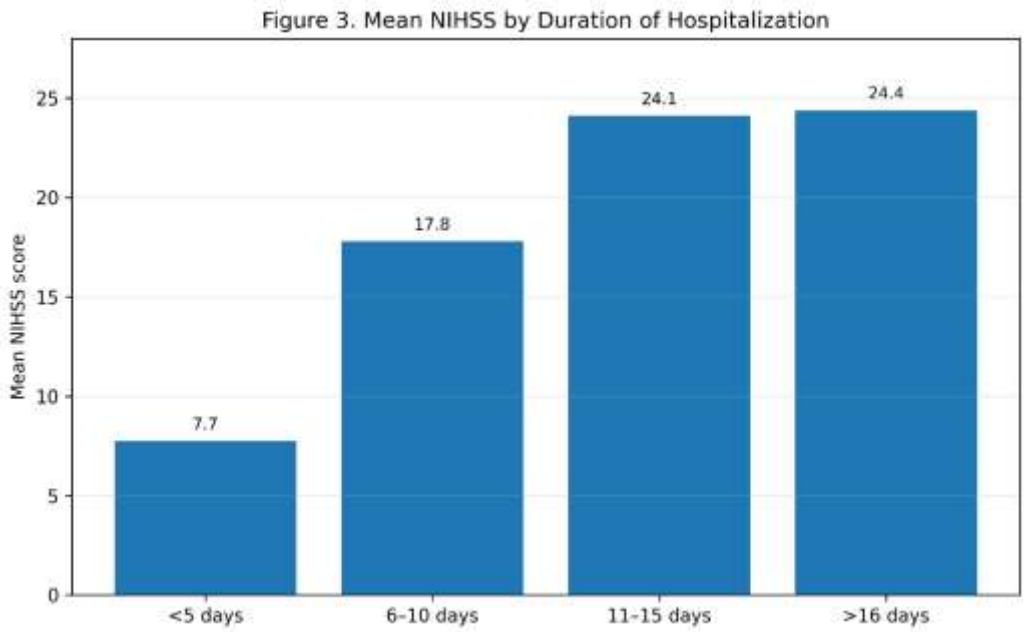

Figure 3. Mean NIHSS according to duration of hospitalization.

Comorbidities, Behavioral Factors and NIHSS

The study association analysis reported higher mean NIHSS among participants with hypertension, diabetes mellitus, combined hypertension and diabetes, smoking, alcohol consumption and combined smoking and alcohol consumption.

However, only hypertension did not reach statistical significance.

Table 8. Association between comorbidities/behavioral factors and NIHSS

Factor	Category	n	Mean NIHSS	SD	p value
Hypertension	Present	56	16.02	1.07	0.2168
	Absent	44	14.76	1.48	
Diabetes mellitus	Present	65	17.74	1.40	0.0071
	Absent	35	13.86	1.01	
HTN + diabetes	Present	27	18.41	2.49	0.0214
	Absent	27	13.78	2.49	
Smoking	Present	35	17.91	1.69	0.0115
	Absent	65	14.18	0.91	

Alcohol	Present	39	17.85	1.51	0.0079
	Absent	61	13.98	0.97	
Smoking + alcohol	Present	20	20.30	3.00	0.0012
	Absent	46	13.74	1.30	

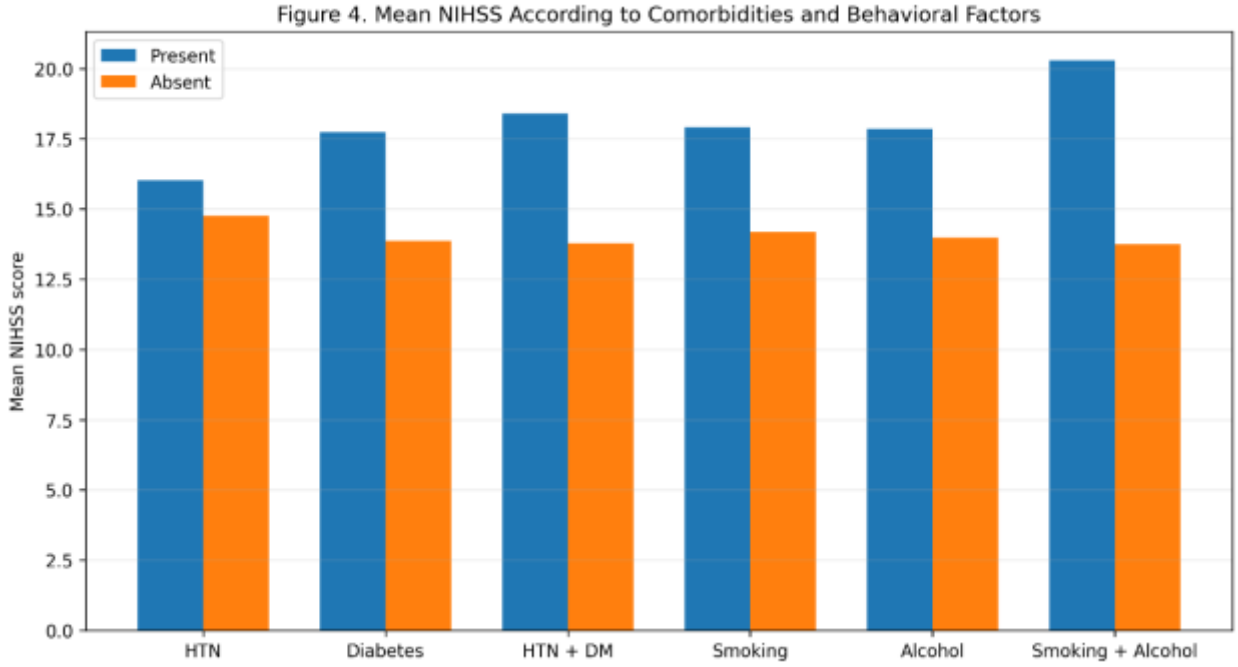

Figure 4. Mean NIHSS according to selected comorbidities and behavioral risk factors.

Admission Vital Signs and NIHSS

Mean NIHSS was significantly higher among participants with pulse rate >100 beats/min, systolic blood pressure >140 mmHg and diastolic blood pressure >90 mmHg.

Table 9. Association between admission vital signs and NIHSS

Vital sign	Category	n	Mean NIHSS	SD	p value
Pulse rate	<100 bpm	78	14.77	0.61	0.0008
	>100 bpm	22	23.75	7.06	
SBP	<140 mmHg	44	13.64	0.88	0.0007
	>140 mmHg	56	18.78	1.56	
DBP	<90 mmHg	49	13.71	0.87	0.0008

	>90 mmHg	51	18.80	1.61	

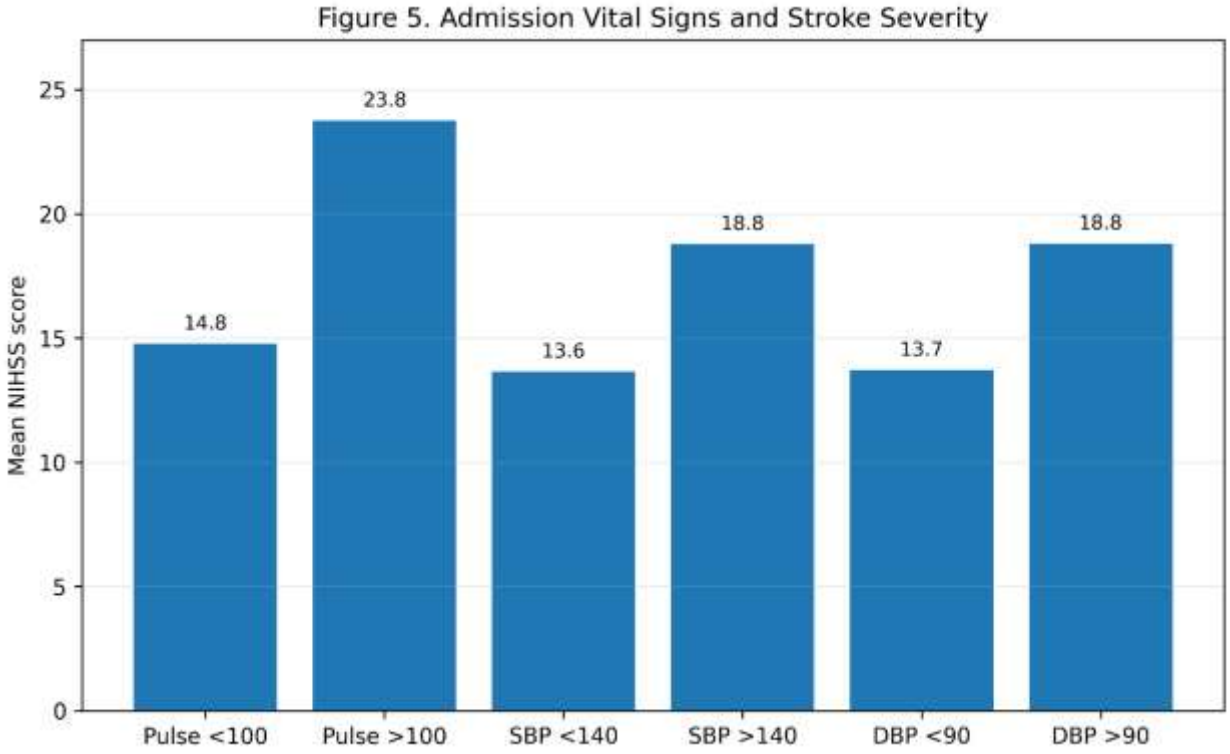

Figure 5. Mean NIHSS according to admission pulse rate and blood-pressure categories.

Discussion

The present study describes the clinical profile of 100 patients with acute ischemic stroke and evaluates some of the admission characteristics in relation to neurological severity. The cohort consisted primarily of older adults with a mean age of 64.57 years and a slight male predominance. Common clinical characteristics were hypertension, diabetes, smoking, and alcohol consumption.

The age distribution observed in this study is in line with the established relationship between age and stroke incidence. Most participants were over 50 years of age, with 63% being between 51 and 70 years of age. Age is the most important nonmodifiable risk factor for stroke, as it reflects the cumulative effects of vascular risk factors and age-related vascular changes. Current global stroke analyses still identify age as a major contributor to the total burden of stroke. [1]

There was a male predominance, with men making up 60% of the cohort. Sex differences in stroke incidence have varied by age and population, but men have historically had higher rates of stroke in several age groups, whereas women have a substantial burden of stroke at older ages. [12] The present study was not designed to investigate sex-specific incidence or outcomes, so the observed male predominance is descriptive.

Hypertension was the most frequent comorbidity, present in 58% of the participants in the descriptive clinical table. This is consistent with the established role of high blood pressure as a major modifiable vascular risk factor. In the INTERSTROKE study, hypertension was one of

the major contributors to the population-attributable risk of stroke. [5] A recent systematic review confirmed a strong association between hypertension and stroke risk in populations including Asian populations. [6] In the present study, however, the association between the history of hypertension and NIHSS was not statistically significant in the study analysis. Mean NIHSS was 16.02 among those categorized as hypertensive compared with 14.76 among those without hypertension (p=0.2168). This highlights an important distinction between the risk of developing a stroke and the severity of neurological deficit once a stroke has occurred . Hypertension is closely associated with the occurrence of stroke, but the relationship between hypertension and acute NIHSS may be influenced by stroke subtype, chronic adaptation, treatment status, collateral circulation and other clinical variables.

In the study analysis, diabetes mellitus was associated with a significantly higher NIHSS score. Mean NIHSS among participants with diabetes was 17.74 compared to 13.86 among those without diabetes (p=0.0071). Diabetes is a well-known vascular risk factor and has also been associated with adverse outcome after stroke. A meta-analysis of 66 studies estimated the prevalence of diabetes in ischemic stroke inpatients to be about one third, with many studies reporting associations between diabetes or acute hyperglycemia and worse neurological or functional outcomes. [9]

Study analysis also found that the combination of hypertension and diabetes was associated with higher NIHSS. The mean NIHSS was 18.41 in participants with both conditions versus 13.78 in the respective comparison group (p=0.0214). This finding is biologically plausible since the presence of multiple vascular risk factors may be indicative of a higher cumulative burden of vascular injury. However, the analysis was unadjusted and the result should not be interpreted as evidence of an independent synergistic effect.

Thirty-five percent of participants reported smoking. In the study analysis , the average NIHSS was significantly higher in smokers than in nonsmokers (17.91 vs 14.18 ; p=0 . 0115) . Smoking is known to be associated with risk of vascular disease and stroke . A meta-analysis of 14 studies with more than 300,000 participants reported a pooled odds ratio of 1.61 for stroke in smokers compared to nonsmokers. [7] Increased stroke morbidity and mortality have also been demonstrated in current smokers in a larger dose-response meta-analysis . [8] The present study also found a significant association between alcohol consumption and NIHSS. Mean NIHSS was 17.85 in participants reporting alcohol consumption compared to 13.98 in participants not reporting alcohol consumption (p=0.0079). But the study has insufficient information as to the amount, duration, pattern or type of alcohol consumption. Therefore, the current finding should be seen as an association with the recorded exposure category only and not as evidence for a dose-dependent relation.

Regarding the behavioral exposure groups, participants who reported smoking and alcohol consumption had the highest mean NIHSS (20.30 vs 13.74; p=0.0012). This may be a reflection of a higher cumulative vascular risk profile. However, the term “synergistic effect” should be avoided, because the study did not use multivariable regression or formally test an interaction term. The difference observed is better described as an association between combined exposure and higher NIHSS.

Admission physiologic parameters were also correlated with stroke severity. The mean NIHSS was 23.75 in participants with pulse rates >100 beats/min and 14.77 in those with lower pulse rates (p=0.0008). Causes of tachycardia include physiological stress, autonomic activation, infection, dehydration, cardiac disease, or other systemic factors associated with severe acute

stroke. These mechanisms were not explored in this study, and therefore tachycardia should be viewed as a marker associated with severity, instead of a proven causal factor.

Higher admission blood pressure was also associated with higher NIHSS. Mean NIHSS was higher in participants with systolic blood pressure >140 mmHg (18.78) compared to those with lower systolic blood pressure (13.64). A similar trend was observed for diastolic blood pressure with mean NIHSS of 18.80 in participants with DBP >90 mmHg as compared to 13.71 in those with lower DBP.

High blood pressure is common in acute ischemic stroke. Current recommendations highlight that blood pressure management should be individualized based on reperfusion therapy and other clinical scenarios. In patients not receiving reperfusion therapy and without other indications for urgent treatment, routine aggressive blood-pressure lowering during the early phase may not improve functional outcomes. [2,10] Therefore the association observed in this study should not be interpreted as evidence that immediate reduction of blood pressure to a certain target would improve neurological outcome.

Duration of hospitalization was particularly strongly associated with NIHSS. The mean NIHSS was 7.74 for participants hospitalized < 5 days and around 24 for participants hospitalized 11 or more days. There was a statistically highly significant overall association ($p<0.00001$). In previous studies, NIHSS on admission has also been identified as an important determinant of length of hospital stay. In a prospective study of 330 patients with first-ever ischemic stroke, the NIHSS on admission was one of the major determinants of length of stay. [11] But, the association between NIHSS and length of stay is not necessarily one-way causality. More severe stroke may cause longer hospital stay as a consequence of more functional dependence, complications and needs for rehabilitation. Prolonged hospitalization may also indicate complications that lead to persistent neurological deficits. The direction of causality cannot be determined, since both variables were observed in the present study.

The mean NIHSS was decreased from 15.49 on admission to 11.77 at discharge, which was a significant neurological improvement during hospitalization ($p=0.001$). This suggests a global early neurological improvement in this cohort. However, it should not be attributed to any single risk factor or treatment as the study was not designed to compare treatment interventions.

Overall the findings emphasize the need for early structured assessment of clinical risk factors and physiological parameters in acute ischemic stroke. Current guidelines for acute stroke highlight the significance of rapid neurological assessment, imaging, reperfusion eligibility and management of physiological abnormalities as parts of comprehensive early stroke care. [2] The lack of a multivariable analysis in this study, however, means that the observed associations should be interpreted as hypostudy-generating rather than as independent predictors.

Strengths and Limitations

Strengths

1. The study included one hundred patients with CT-proven acute ischemic stroke.
2. A large number of easily obtainable clinical features were studied.
3. Neurologicalal severity was assessed by NIHSS.
4. NIHSS documented at admission and discharge.
5. The length of hospitalization was recorded and correlated with the severity of neurological disease.
6. The study uses hospital-based data from Indian clinical settings.

Limitations:

1. This was a single center study with a relatively small sample size.
2. The observational design does not permit causal inference.

3. The analysis was not adjusted and did not involve multivariable regression.
4. Confounding by age, sex, stroke subtype, treatment, baseline functional status and other comorbidities could not be assessed adequately.
5. Smoking and alcohol exposure were recorded categorically with no adequate information on dose, duration or cumulative exposure.
6. Stroke etiology was not classified by a standardized system such as TOAST.
7. Long-term functional outcome, especially 90-day modified Rankin Scale, was not assessed.
8. Denominators of descriptive and analytical denominators for hypertension and diabetes in source study mismatch
9. The description of the sampling method in the source study is not consistent.
10. The observed association between hospital stay and NIHSS does not establish whether more severe neurological impairment caused longer hospitalization or whether complications during hospitalization contributed to neurological impairment.
11. The generalizability of the study results is limited because the original protocol excluded cardioembolic and posterior circulation infarctions.

Conclusion

This hospital-based study showed that acute ischemic stroke was predominantly a disease of older adults with a slight male preponderance and a substantial burden of vascular and behavioral risk factors. Smoking and drinking were common too. High blood pressure and diabetes were common.

In this unadjusted analysis, higher NIHSS scores were associated with diabetes mellitus, combined hypertension and diabetes, and smoking and alcohol consumption. Tachycardia and increased systolic and diastolic blood pressure were also associated with increased neurological severity. Higher NIHSS was significantly associated with longer hospital stay. These findings emphasize the importance of thorough clinical evaluation at the time of presentation.

Funding

None.

Conflict of interest

Nil

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