Original Article

Prehospital Factors Associated with Delayed Hospital Arrival of Stroke Patients: A Regional Single-Center Study from India

Sachin Edakkattil, Siju V. Abraham, Neenu J. Panattil, Faris A. Gafoor, Leenus Jacob, Renyu Liu[1]

Department of Emergency Medicine, Jubilee Mission Hospital, Medical College and Research Institute, Thrissur, Kerala, India, [1]Department of Anesthesiology and Critical Care, and Neurology, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, USA

Abstract

Background: Only a small percentage of patients with acute stroke are currently eligible for thrombolysis, partly due to severe delays in hospital arrival. We had previously conducted the first regional study to assess the factors delaying acute stroke care in India. The present study aims to understand and describe in depth the variables associated with prehospital delay among patients admitted with an acute ischemic stroke. **Methods:** Data were prospectively collected by conducting an in-depth interview of 470 acute ischemic stroke patients and their bystanders, aged above 18 years, presenting to the Department of Emergency Medicine, Jubilee Mission Medical College and Research Institute, Thrissur. Patients who arrived within 4.5 h of symptom onset were considered as "early arrival" and those who arrived after 4.5 h were considered as "delayed arrival." Univariate and multivariate analyses were undertaken to determine associations between variables of interest and delays to hospital presentation. **Results:** Of the 470 patients who met the inclusion criteria, 73 patients reached within 4.5 h (15.5%), whereas 397 patients arrived after 4.5 h. The mean age of acute stroke patients who reached within 4.5 h was 63 ± 13.7 years, whereas the mean age of those who reached after 4.5 h was 63 ± 12.1 years. Binary logistic regression performed to quantify the associations of prehospital factors showed an increased risk of prehospital delay among individuals with lack of awareness (odds ratio [OR] = 5.16 [3.040–8.757], $P < 0.001$), followed by those for whom a vehicle was not available at the site of event (OR = 3.745 [1.864–7.522], $P < 0.001$). Within the predefined socioeconomic strata, compared to lower class, upper middle class had less risk (OR = 0.135 [0.018–1.035], $P = 0.054$), whereas the distance from first medical contact to emergency department contributed moderate risk (OR = 1.071 [1.028–1.116], $P < 0.001$) for prehospital delay. **Conclusions:** Health promotion techniques that increase public knowledge about the early signs of stroke, transferring patients directly to hospitals with thrombolysis capabilities, and making ambulance services more widely available are appropriate measures to reduce prehospital delay.

Keywords: Acute stroke, prehospital delay, stroke, therapeutic window

Introduction

Background/rationale

Stroke ranks as the second most prevalent cause of death globally and is a potentially burdensome condition. The Global Burden of Diseases study states stroke as the third leading cause of death and disability combined in accordance with the disability-adjusted life-years.[1,2] It not only affects the victim, but also has an equally profound impact on the victim's caretaker, family, and society as a whole. For the best possible treatment outcomes, stroke must be managed as promptly as possible. The rule for stroke care, "time is brain," underlines how quickly and irreparably human neuronal tissue is lost as a stroke develops and how urgently therapeutic interventions should be explored. The appropriate therapeutic window is less than 4.5 h, and treatment within 90 min gives the best results.[3,4]

However, in developing countries like India, due to severe delays in hospital presentation, only a small percentage of patients with acute stroke are currently eligible for thrombolysis, leading to underutilization of this treatment.[5] It has been demonstrated that a wide range of variables affect how promptly stroke patients present to the hospital. These variables include the clinical condition, mode of transportation to the hospital, overnight onset, solitary residing, previous stroke or cardiovascular illness, lack of awareness regarding stroke management among health-care professionals, poor prehospital emergency medical services, lack of a coordinated in-hospital stroke care system, financial constraints, poor referral pattern, and failure of stroke victims, families, caregivers, and even health professionals to recognize stroke warning symptoms.[6,7] This study aims to address the gap in knowledge regarding prehospital delay-related factors in stroke patients in India, which may differ from those observed in Western populations. By conducting a cross-sectional survey, the researchers aimed to identify and describe the variables associated with prehospital delay in patients hospitalized with acute ischemic stroke in India.

Address for correspondence: Dr. Siju V. Abraham, Department of Emergency Medicine, Jubilee Mission Medical College and Research Institute, Bishop Alapatt Road, Thrissur, Kerala - 680005, India.
E-mail: sijuvabraham@gmail.com

Submitted: 16-Dec-2023 **Revised:** 01-Mar-2024 **Accepted:** 03-Mar-2024
Published: 19-Apr-2024

DOI: 10.4103/aian.aian_1091_23

Objectives

The primary objective of this cross-sectional study was to investigate the prehospital factors that contribute to delays in the arrival of acute stroke patients at a designated stroke care center's emergency department (ED). Secondary objectives included determining the temporal delays from the onset of stroke symptoms to ED arrival and estimating the proportion of acute stroke patients who arrive within 4.5 h of symptom onset or symptom noticed time for wake-up strokes.

Methods

Study design: Cross-sectional study

Setting: Department of Emergency Medicine of a single tertiary care teaching hospital

Participants: Acute stroke patients aged above 18 years.

Inclusion criteria

1. Victims of acute ischemic stroke, defined as acute-onset focal neurologic deficit with corresponding lesion in diffusion-weighted magnetic resonance imaging (MRI)/computed tomography (CT) or clinically diagnosed by a neurologist (at discharge), presenting to the emergency medicine department within 72 h of the onset of symptoms
2. Patients aged above 18 years and who were cooperative and willing to provide a written informed consent

Exclusion criteria

1. Patients with acute stroke thrombolysed from another hospital
2. Incapacity to answer the structured questionnaire about the prehospital phase and no witness to the prehospital phase available to answer the structured questionnaire
3. Patients diagnosed to have hemorrhagic stroke

Variables: Time and location of symptom onset, time to reach first medical contact (FMC), socioeconomic status, awareness of stroke, education level, incidence of stroke in their family previously, availability of family members at the time of stroke, and modes of transport employed including with whom they were transported to the hospital

Additional variables studied: Age, National Institutes of Health Stroke Scale (NIHSS) score at admission, time from onset to FMC (in hours), time from FMC to ED door arrival, FMC to referral time (hours)

Data sources/measurement

The questionnaire was adapted from a previous publication by Fladt *et al*.[8] that measured the prehospital phase from the onset of stroke symptoms to ED arrival, within one working day following admission. The original version of the questionnaire was cross-culturally adapted according to the guidelines for translation and cross-cultural adaptation by Beaton *et al*.[9] All interviews were conducted at the bedside during index hospitalization. In addition, data on comorbidities, NIHSS score on arrival in ED, patient biodata, and caregiver's biodata were collected. A qualitative query on the interviewer's perspective on the reason for delay was incorporated to better understand the contextual rationale for the delay.

Statistical methods: Data from the self-administered questionnaire were entered into Microsoft Excel spreadsheets and subjected to statistical analysis using IBM Statistical Package for the Social Sciences Statistics version 25 software. Gender, education of patients, marital status, living status, alcohol consumption, socioeconomic status, awareness about stroke, awareness about thrombolytic therapy, FMC, and vehicle availability were summarized using proportions. Age, NIHSS score, onset to FMC time (hours), and FMC to referral time (hours) were summarized using means and standard deviation.

Univariate analysis (Chi-square test/Fisher's exact test) was done to find out the significant correlations of prehospital factors for delay within the thrombolytic window period (4.5 h). Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for all comparisons. Binary logistic regression was done to determine the factors associated with prehospital delay in arrival of acute stroke victims to the emergency medicine department of a designated stroke care center.

Study design and sampling

Sample size was calculated to be 470 using the formula $n = \frac{Z(1-\frac{\alpha}{2})^2 \, X \, p.e}{d^2}$. Consecutive patients were recruited till the sample size $N = 470$ was met. Four trained research assistants in the Department of Emergency Medicine interviewed all patients or eyewitnesses of the event, after obtaining informed written consent, using a questionnaire about the prehospital phase from the onset of stroke symptoms to ED arrival, within 24 h of admission.

Operational definitions used

Acute stroke

Acute stroke was defined as acute, focal neurologic deficit with a corresponding lesion on CT-brain or diffusion-weighted MRI or clinical diagnosis made by a neurologist (at discharge).

Prehospital delay was defined as ≥4.5 h from the symptom onset time or symptom noticed time in case of a wake-up stroke.

Prehospital phase: Time frames

In this study, we assessed two key time intervals related to stroke cases: symptoms to FMC time (symptoms to FMC) and FMC to ED door time (FMC to ED).

For the symptoms to FMC time, after thorough group discussions, we determined that for wake-up strokes, the time point of waking up was considered the relevant starting point. This decision was made to account for the fact that the time interval between stroke onset during sleep and awakening is not influenced by interventions aimed at reducing prehospital delay. This approach provides a more accurate representation of the time it took for patients to seek medical assistance. The

FMC to referral time was defined as the duration between FMC and the referral of the patient for further medical evaluation or treatment. The FMC to ED time refers to the duration between FMC and the patient's arrival at ED. In cases where FMC occurred at our own ED, we assigned a value of zero for the FMC to ED time.

ED door time was defined as the moment when the patient's chart was issued, indicating their arrival at ED. To determine FMC, we obtained information from patients or bystanders about their first contact with a medical professional outside the hospital. If available, reference letters were also considered. ED door time was based on the earliest recorded admission time in ED.

Results

Participants: 650 patients arrived during the study period, of whom 470 acute stroke patients met the inclusion criteria and 180 patients were excluded.

Descriptive data

There was no significant difference in age between the stroke patients who presented to the hospital within 4.5 h and those who presented after 4.5 h (P = 0.749), whereas NIHSS score was significantly higher in those who came within 4. 5 h (13.4 ± 3.8 vs. 12.5 ± 3.8, P = 0.038). A higher percentage of males (74%) reached within 4.5 h (P = 0.008)

Educational status

Although a higher proportion of patients who arrived at ED within 4.5 h of stroke had an educational status of high school education (20.5%, n = 15), pre-degree (30.1%, n = 22), or degree (19.2%, n = 14), there was no significant difference in the educational level of patients (P = 0.146) or of the accompanying person (P = 0.361) when compared across the two groups [Table 1].

Living status

All the patients living alone arrived after 4.5 h of onset to ED (n = 9), whereas a higher proportion of patients who were living with their partner (15.87%, n = 47/296) or children (15.86%, n = 23/145) arrived within 4.5 h. Also, a higher proportion of patients who arrived within 4.5 h were married (78.1%, n = 57). However, there was no significant difference in living status (P = 0.347) or marital status (P = 0.087) between the patients who reached within 4.5 h and those who arrived after 4.5 h [Table 2].

Behavioral factors

Although a higher proportion of patients who arrived at ED within 4.5 h had never consumed alcohol (53.4%, n = 39) compared to those who arrived after 4.5 h (61.7%, n = 245), there was no statistically significant association found between alcohol consumption and prehospital delays (P = 0.568).

Socioeconomic factors

Among those who arrived at ED within 4.5 h (n = 73), 46.6% patients (n = 34) belonged to upper middle socioeconomic class and 37% (n = 27) belonged to lower middle class. Higher proportion (96.15%, n = 25) of people who belonged to the lower economic class had a prehospital delay. There was a significant difference in socioeconomic status between the patients who arrived within 4.5 h and those who arrived after 4.5 h (P = 0.015) [Table 2].

Event

Most of the patients said they were either sitting or engaged in a physical activity at the time of symptom onset. Higher proportion of patients who noticed symptoms waking up from sleep took more than 4.5 h to arrive at ED after noticing the symptoms (89.3%, n = 67/75).

Awareness

Out of 150 patients who were aware of stroke, 31.3% (n = 47) arrived at ED within 4.5 h, while 74.1% (n = 294) of the patients who were not aware (n = 320) had significant prehospital delay (P < 0.001). Greater proportion of patients who were aware of stroke (13.3%, n = 47) or thrombolytic therapy (41.8%, n = 23) arrived in ED within the thrombolytic window period.

Prehospital care

Out of 169 patients who came directly to our ED, 21.8% (n = 37) arrived within 4.5 h. Out of 271 patients who went to a nearby hospital/primary health care center, only 11.43% (n = 31) arrived at ED within 4.5 h. Forty-two had undergone a CT imaging at a hospital outside. Out of 30 patients who went to a nearby physician, only 16.6% (n = 5) arrived at ED within 4.5 h. Although the proportion of patients who visited local community doctors or local hospitals with no stroke care facilities experienced greater delays compared to those who came directly to ED, the difference was not statistically significant.

The time taken to reach an FMC (onset to FMC time) was 2.75 h for the patients who reached early and 11.97 h for those who were delayed. The time to referral at FMC (FMC to referral) had a mean of 1.25 h for the patients who came early and 1.46 h for those who were delayed. Onset to FMC time was significantly different (P < 0.001), but FMC to referral time was not significantly different between the patients who arrived within 4.5 h and those who arrived after 4.5 h (P = 0.263) [Table 1].

Mode of transport

Among the patients who had some vehicle availability at the time of symptoms (n = 312), 20.2% (n = 63) arrived within 4.5 h. Among the patients who did not have vehicle availability, only 6.3% (10 out of 158 patients) arrived within 4.5 h. Greater proportion of patients who had vehicles at home (68.5%, n = 50) arrived at the hospital within the window period, compared to patients who had to find other modes of transport (P < 0.001).

There were statistically significant (P < 0.05) differences in lack of awareness, socioeconomic status, vehicle availability, and distance from FMC to ED between the two groups.

Table 1: Baseline characteristics stratified by prehospital delay

Characteristic	Total	Early arrival ≤4.5 h	Delayed arrival >4.5 h	*P*
Age, mean (SD)		63.21 (13.73)	62.94 (12.11)	0.749
NIHSS score, mean (SD)		13.47 (3.80)	12.54 (3.80)	0.038
Onset to FMC (h), mean (SD) (*N*=470)		2.75 (5.14) (*n*=73)	11.97 (10.78) (*n*=397)	<0.001
FMC to referral (h), mean (SD), (*n*=301)		1.25 (2.97) (*n*=26)	1.46 (3.19) (*n*=265)	0.263
Male	282 (60.0%)	54 (74.0%)	228 (57.4%)	0.008
Female	188 (40.0%)	19 (26.0%)	169 (42.6%)	
Education of patients	470 (*N*)	73	397	0.146
Did not go to school	97 (20.6%)	11 (15.1%)	86 (21.7%)	
Primary education	84 (17.9%)	9 (12.3%)	75 (18.9%)	
High school education	107 (22.8%)	15 (20.5%)	92 (23.2%)	
Pre-degree, higher secondary	108 (23.0%)	22 (30.1%)	86 (21.7%)	
Degree	68 (14.5%)	14 (19.2%)	54 (13.6%)	
Postgraduation	6 (1.3%)	2 (2.7%)	4 (1.0%)	
Education of the accompanying person	470 (*N*)	73	397	0.361
Did not go to school	26 (5.5%)	2 (2.7%)	24 (6.0%)	
Primary education	47 (10.0%)	5 (6.8%)	42 (10.6%)	
High school education	97 (20.6%)	11 (15.1%)	86 (21.7%)	
Pre-degree, higher secondary	143 (30.4%)	24 (32.9%)	119 (30.0%)	
Degree	141 (30.0%)	28 (38.4%)	113 (28.5%)	
Postgraduation	16 (3.4%)	3 (4.1%)	13 (3.3%)	

FMC=First medical contact, NIHSS=National Institutes of Health Stroke Scale

Lack of awareness was significantly associated with higher prehospital delay risk (OR = 5.16, 95% CI = 3.040–8.757, $P < 0.001$), followed by nonavailability of a vehicle at the event site (OR = 3.745, 95% CI = 1.864–7.522, $P < 0.001$). Within the predefined socioeconomic strata, compared to lower class, upper middle class had less association (OR = 0.135, 95% CI = 0.018–1.035, $P = 0.054$), whereas the distance from FMC to ED had a moderate association (OR = 1.071, 95%CI=1.028–1.116, $P < 0.001$) with prehospital delay [Table 3].

This study investigated interviewers' perspectives on reasons for delayed medical treatment. Among patients reaching the hospital within 4.5 hours (*n*=397), interviewers attributed lack of awareness to 51.4% of cases. Financial constraints, lack of helpers, delays at the FMC, misdiagnosis at the FMC, and long distance to the hospital were each associated with less than 3% of cases. In 48.6% of cases, no single factor was attributable as a specific reason for the delay. A statistically significant association was found between the lack of awareness factor and delay within the window period ($P < 0.001$).

Discussion

We studied stroke patients who arrived at the hospital within 4.5 h of symptom onset (early arrival group) and those who arrived after 4.5 h (delayed arrival group). The majority of those who arrived early were male, had a more severe stroke, had completed high school and/or pre-degree education, were more aware about stroke, and were from the upper middle socioeconomic class. Conversely, the factors that significantly contributed to the prehospital delay in arrival included lack of awareness, lower socioeconomic status, limited vehicle availability, and greater distance from the facility. In addition, individuals with better awareness and higher socioeconomic status exhibited a lower likelihood of experiencing prehospital delay.

Sex

More men presented early in our study and this was congruent with some previous studies on stroke.[9-12] In terms of mortality, quality of life, poststroke depression, and activity limitations, women do worse than men after stroke.[12] Women in racial and ethnic minorities who are most at risk have historically shown poor awareness and less likelihood to call for help in stroke.[10,11] A study analyzing data from the National Inpatient Sample found that among 3,04,152 hospitalizations for ischemic stroke between 2004 and 2010, women were less likely to receive recombinant tissue plasminogen activator (rt-PA) treatment compared to men.[13] To better understand these discrepancies, further in-depth research may be required in the region, including knowledge, biases, and prejudices among patients and health-care personnel at prehospital stages of acute stroke care.[14]

Awareness of stroke and education level

Low education is often equated with increased stroke risk. In this study, a higher proportion of patients with better levels of education also came to the hospital early. However, it is to be kept in mind that the educational status of the people in Kerala, in general, is higher than the national average.[15,16]

Awareness of both the patient and bystanders is an independent predictor of prehospital delay in acute stroke.[17] In our study, 84.5% (*n* = 397) of patients had a prehospital delay of more than 4.5 h. Almost half of the patients in this study who had

Table 2: Baseline characteristics stratified by prehospital delay

Characteristic	Total	Early arrival ≤4.5 h	Delayed arrival >4.5 h	*P*
Marital status	470 (*N*)	73	397	0.087
Married	336 (71.5%)	57 (78.1%)	279 (70.3%)	
Divorced	9 (1.9%)	0 (0.0%)	9 (2.3%)	
Unmarried	7 (1.5%)	3 (4.1%)	4 (1.0%)	
Widowed	117 (24.9%)	13 (17.8%)	104 (26.2%)	
Living status	470 (*N*)	73	397	0.347
Alone	9 (1.9%)	0 (0.0%)	9 (2.3%)	
With partner	296 (63.0%)	47 (64.4%)	249 (62.7%)	
With parents	12 (2.6%)	1 (1.4%)	11 (2.8%)	
With children	145 (30.9%)	23 (31.5%)	122 (30.7%)	
With other relatives	7 (1.5%)	1 (1.4%)	6 (1.5%)	
Institutionalized	1 (0.2%)	1 (1.4%)	0 (0.0%)	
Never had a drink	284 (60.4%)	39 (53.4%)	245 (61.7%)	
Stopped drinking more than a year ago	60 (12.8%)	10 (13.7%)	50 (12.6%)	
Drink daily	50 (10.6%)	9 (12.3%)	41 (10.3%)	
One to four sessions/month	60 (12.8%)	11 (15.1%)	49 (12.3%)	
More than four sessions/month	16 (3.4%)	4 (5.5%)	12 (3.0%)	
Socioeconomic status	470 (*N*)	73	397	0.015
Upper class	3 (0.6%)	0 (0.0%)	3 (0.8%)	
Upper middle class	149 (31.7%)	34 (46.6%)	115 (29.0%)	
Lower middle class	175 (37.2%)	27 (37.0%)	148 (37.3%)	
Upper lower class	117 (24.9%)	11 (15.1%)	106 (26.7%)	
Lower class	26 (5.5%)	1 (1.4%)	25 (6.3%)	
Awareness (about stroke)	470 (*N*)	73	397	<0.001
Yes	150 (31.9%)	47 (64.4%)	103 (25.9%)	
No	320 (68.1%)	26 (35.6%)	294 (74.1%)	
Awareness (about thrombolytic therapy)	150	47	103	0.035
Yes	55 (36.7%)	23 (48.9%)	32 (31.1%)	
No	95 (63.3%)	24 (51.1%)	71 (68.9%)	
First medical contact	470 (*N*)	79	397	0.013
Directly at JMMC	169 (36.0%)	37 (50.7%)	132 (33.2%)	
Nearby hospital/PHC	271 (57.7%)	31 (42.5%)	240 (60.5%)	
Nearby physician	30 (6.4%)	25 (6.3%)	5 (6.8%)	
Vehicle availability	470 (*N*)	73	397	<0.001
Yes	312 (66.4%)	63 (86.3%)	249 (62.7%)	
No	158 (33.6%)	10 (13.7%)	148 (37.3%)	

prehospital delay were not aware of stroke symptoms or about the thrombolytic therapy. Numerous health education tactics, such as sending educational letters to families and creating campaigns with stringent methodology and mass media use, have been shown to be beneficial in studies.[18,19] On the contrary, a multilevel cluster randomized controlled trial evaluating a stroke information campaign reported that the proportion of patients getting admitted to hospital was lower in the exposed group than in the control group, as was the proportion of patients treated with intravenous thrombolysis for an ischemic stroke.[20] The study concluded that any new communication strategy should undergo thorough testing before it is implemented on a large scale.[19]

Living arrangement/marital status

Patients who reached the hospital within 4.5 h in our study were more likely to be living with their partner or children, even though this was statistically insignificant. Our study's results align with previous research regarding living arrangements.[21-23] For instance, a study conducted in Sweden by Redfors *et al*.[21] identified living alone as an independent predictor for all-cause mortality in ischemic stroke. Similarly, Reeves *et al*.[22] in Canada identified delayed hospital arrival and less thrombolytic therapy among the people living alone. Despite mixed findings reported on the impact of marital status on stroke outcomes, studies have suggested a positive association between being married or living with a partner and timely arrival at the hospital following a stroke.[24]

Socioeconomic status

Prehospital delays occurred in higher percentages (96.5%) among those who belonged to the lower socioeconomic class, consistent with previous studies.[25–29] Lower socioeconomic status and availability of vehicles are not logically mutually exclusive. People with lower socioeconomic status would generally not have vehicles at home. In India, a significant

Table 3: Association with stroke

Characteristic	Early arrival ≤4.5 h (*n*=73)	Delayed arrival >4.5 h (*n*=397)	OR (95% CI)	*P*
Awareness of stroke				
Yes	47 (31.3%)	103 (68.7%)	1 (Ref.)	
No	26 (8.1%)	294 (91.9%)	5.16 (3.040–8.757)	<0.001*
Socioeconomic status				
Upper class	0 (0%)	3 (100%)		
Upper middle class	34 (22.8%)	115 (77.2%)	0.135 (0.018–1.035)	0.054*
Lower middle class	27 (15.4%)	148 (84.6%)	0.219 (0.028–1.687)	0.145
Upper lower class	11 (9.4%)	106 (90.6%)	0.385 (0.048–3.126)	0.372
Lower class	1 (3.8%)	25 (96.2%)	1 (Ref.)	
Vehicle availability				
Yes	63 (20.2%)	249 (79.8%)	1 (Ref.)	
No	10 (6.3%)	148 (93.7%)	3.745 (1.864–7.522)	<0.001*
Distance from FMC to ED (km) (*n*=301)				
Median (IQR)	12.5 (6–20)	20 (12–29)	1.071 (1.028–1.116)	0.001*

CI=Confidence interval, ED=Emergency department, FMC=First medical contact, IQR=Interquartile range, OD=Odds ratio

issue that contributes to stroke patients' arrival delays is the lack of transportation options. Compared to patients who had to find other means of transportation, a higher percentage of patients (68.5%, *n* = 50) who had any means of transport at home arrived at the hospital within the window period. There is great discrepancy across India with regards to prehospital care availability.[30,31] In Kerala, where this study was conducted, the prehospital care system is not widely available. It is interesting to note that although less than 5% used an ambulance to reach the hospital, the proportion of patients who reached within the window period was more when they used an ambulance (6.8% vs. 4.5%).

Ambulance use has been shown to reduce prehospital delays in numerous studies. No patients in the study requested an ambulance after their symptoms started. This rate was significantly lower than that of other developed nations, where up to 60% of people had reportedly used ambulances. Also, it was observed that a sizable fraction of patients made initial contact with their neighborhood or local doctor before visiting ED. This can be an indication that people are unable to recognize their symptoms, necessitating a local doctor's diagnosis.

Our study also found that unavailability of vehicles at the time of symptom onset and longer distance from FMC to ED also played an important role. Only 15.5% (*n* = 73) of patients in our research arrived within 4.5 h of the onset of symptoms. It was also noted that patients who visited local community doctors or local hospitals with no stroke care facilities experienced greater delays compared to those who came directly to ED. Although the study shows no statistically significant difference in the time taken for referral between groups that came early and late, it is to be highlighted that an average of more than an hour was spent at these FMCs. This is a potentially preventable delay if patients sought care directly at a stroke center. Although previous studies, both in developing and developed countries, have reported similar findings, we did not find a statistically significant association. One plausible explanation could be unique to the study setting which serves as the primary care center for an urban population.

Our study examined a multitude of factors that may contribute to delays in hospital presentation. The study can be useful in shaping new campaigns aimed at reducing prehospital delay. Strategies to enhance community awareness of stroke symptoms and the importance of direct hospital presentation, preferably to thrombolysis-equipped facilities, are crucial. Promoting ambulance services' accessibility and utilization can also expedite hospital arrival. Previous studies consistently highlight ambulance transportation as the key factor associated with timely arrival for stroke treatments.

Limitations

This was a single-hospital–based study that included mostly patients living in the suburban and urban regions; therefore, the information may not be generalizable to the acute stroke responses and awareness of people in rural or remote regions of India. We excluded patients who did not seek treatment or who passed away before reaching the hospital. Since the study focused on prehospital parameters in depth, in-hospital data regarding delays in the system, types of stroke, treatments received, and patient outcomes were not collected, limiting our understanding of these factors. Moreover, we did not investigate how patients perceived their symptoms or consider variables such as the type of stroke (e.g. anterior or posterior circulation), concurrent health conditions, or previous strokes, which could have influenced their decision-making and the time taken to reach the hospital.

Interpretation

The current study focused on a variety of factors that may lead to delays in presentation to the hospital. There are many obstacles faced by patients, doctors, and the health-care system; some of these obstacles might be overcome. Especially noteworthy is the need for health promotion techniques that increase public knowledge on the early signs of stroke. Establishing

an alert system for patients who are likely to experience a stroke at home, transferring patients directly to hospitals with thrombolysis facilities, and making ambulance services more widely available are all appropriate to speed up presentation to the hospital and subsequently enhance stroke management.

Acknowledgements

The authors would like to acknowledge the staff and doctors of the Department of Neurology and Emergency Medicine, Jubilee Mission Medical College and Research Institute, for aiding in the conduct of the study. The authors acknowledge the guidance provided by the members of World Stroke Organization Task force for Prehospital Care (WSOTPC) in drafting the manuscript.

Standard protocol approvals, registration, and patient consents

The study was independently approved by the institutional review board and the institutional ethics committee (IEC no: 97/21/IEC/JMMC and RI) of Jubilee Mission Medical College and Research Institute, Thrissur, India. The research conducted adheres to the ethical principles outlined in the Declaration of Helsinki. Informed consent was sought from all participants or their legally authorized representatives.

Financial support and sponsorship

Nil.

Conflicts of interest

SVA is a board member and RY is the co-chair of WSOTPC.

References

1. Feigin VL, Forouzanfar MH, Krishnamurthi R, Mensah GA, Connor M, Bennett DA, *et al*. Global and regional burden of stroke during 1990–2010: Findings from the Global Burden of Disease Study 2010. Lancet 2014;383:245–54.
2. GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. Lancet Neurol 2021;20:795–820.
3. Hacke W, Donnan G, Fieschi C, Kaste M, von Kummer R, Broderick JP, *et al*. Association of outcome with early stroke treatment: Pooled analysis of ATLANTIS, ECASS, and NINDS rt-PA stroke trials. Lancet Lond Engl 2004;363:768–74.
4. del Zoppo GJ, Saver JL, Jauch EC, Adams HP. Expansion of the time window for treatment of acute ischemic stroke with intravenous tissue plasminogen activator. Stroke 2009;40:2945–8.
5. Abraham SV, Krishnan SV, Thaha F, Balakrishnan JM, Thomas T, Palatty BU. Factors delaying management of acute stroke: An Indian scenario. Int J Crit Illn Inj Sci 2017;7:224–30.
6. Lachkhem Y, Rican S, Minvielle É. Understanding delays in acute stroke care: A systematic review of reviews. Eur J Public Health 2018;28:426–33.
7. Kamalakannan S, Gudlavalleti ASV, Gudlavalleti VSM, Goenka S, Kuper H. Incidence and prevalence of stroke in India: A systematic review. Indian J Med Res 2017;146:175–85.
8. Fladt J, Meier N, Thilemann S, Polymeris A, Traenka C, Seiffge DJ, *et al*. Reasons for prehospital delay in acute ischemic stroke. J Am Heart Assoc 2019;8:e013101.
9. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. Spine 2000;25:3186–91.
10. Ueshima H, Sekikawa A, Miura K, Turin TC, Takashima N, Kita Y, *et al*. Cardiovascular disease and risk factors in Asia. Circulation 2008;118:2702–9.
11. Ferris A, Robertson RM, Fabunmi R, Mosca L; American Heart Association; American Stroke Association. American Heart Association and American Stroke Association national survey of stroke risk awareness among women. Circulation 2005;111:1321–6.
12. Lin CB, Peterson ED, Smith EE, Saver JL, Liang L, Xian Y, *et al*. Emergency medical service hospital prenotification is associated with improved evaluation and treatment of acute ischemic stroke. Circ Cardiovasc Qual Outcomes 2012;5:514–22.
13. Boehme AK, Carr BG, Kasner SE, Albright KC, Kallan MJ, Elkind MSV, *et al*. Sex differences in rt-PA utilization at hospitals treating stroke: The National inpatient sample. Front Neurol 2017;8:500.
14. Walter S, Phillips D, Wells B, Moon R, Bertsch T, Grunwald IQ, *et al*. Detection to hospital door: Gender differences of patients with acute stroke symptoms. Front Neurol 2022;13:833933.
15. Census India Library. Available from: https://censusindia.gov.in/census.website/data/tables. [Last accessed on 2019 Feb 21].
16. Thrissur District Population Census 2011-2019, Kerala literacy sex ratio and density. Available from: https://www.census2011.co.in/census/district/277-thrissur.html. [Last accessed on 2019 Aug 23].
17. Barr J, McKinley S, O'Brien E, Herkes G. Patient recognition of and response to symptoms of TIA or stroke. Neuroepidemiology 2006;26:168–75.
18. Müller-Nordhorn J, Wegscheider K, Nolte CH, Jungehülsing GJ, Rossnagel K, Reich A, *et al*. Population-based intervention to reduce prehospital delays in patients with cerebrovascular events. Arch Intern Med 2009;169:1484–90.
19. Morgenstern LB, Staub L, Chan W, Wein TH, Bartholomew LK, King M, *et al*. Improving delivery of acute stroke therapy: The TLL Temple Foundation Stroke Project. Stroke 2002;33:160–6.
20. Denti L, Caminiti C, Scoditti U, Zini A, Malferrari G, Zedde ML, *et al*. Impact on prehospital delay of a stroke preparedness campaign. Stroke 2017;48:3316–22.
21. Redfors P, Isaksén D, Lappas G, Blomstrand C, Rosengren A, Jood K, *et al*. Living alone predicts mortality in patients with ischemic stroke before 70 years of age: A long-term prospective follow-up study. BMC Neurol 2016;16:80.
22. Reeves MJ, Prager M, Fang J, Stamplecoski M, Kapral MK. Impact of living alone on the care and outcomes of patients with acute stroke. Stroke 2014;45:3083–5.
23. Eshak ES, Iso H, Honjo K, Noda A, Sawada N, Tsugane S, *et al*. Changes in the living arrangement and risk of stroke in Japan; does it matter who lives in the household? Who among the family matters? PLoS One 2017;12:e0173860.
24. Dupre ME, Lopes RD. Marital history and survival after stroke. J Am Heart Assoc Cardiovasc Cerebrovasc Dis 2016;5:e004647.
25. Andersen KK, Steding-Jessen M, Dalton SO, Olsen TS. Socioeconomic position and incidence of ischemic stroke in Denmark 2003–2012. A Nationwide hospital-based study. J Am Heart Assoc Cardiovasc Cerebrovasc Dis 2014;3:e000762.
26. Avan A, Digaleh H, Di Napoli M, Stranges S, Behrouz R, Shojaeianbabaei G, *et al*. Socioeconomic status and stroke incidence, prevalence, mortality, and worldwide burden: An ecological analysis from the Global Burden of Disease Study 2017. BMC Med 2019;17:191.
27. Avendano M, Kawachi I, Van Lenthe F, Boshuizen HC, Mackenbach JP, Van den Bos GA, *et al*. Socioeconomic status and stroke incidence in the US elderly: The role of risk factors in the EPESE study. Stroke 2006;37:1368–73.
28. Kuper H, Adami HO, Theorell T, Weiderpass E. The socioeconomic gradient in the incidence of stroke: A prospective study in middle-aged women in Sweden. Stroke 2007;38:27–33.
29. Marshall IJ, Wang Y, Crichton S, McKevitt C, Rudd AG, Wolfe CDA. The effects of socioeconomic status on stroke risk and outcomes. Lancet Neurol 2015;14:1206–18.
30. Babu BV, Vishwanathan K, Ramesh A, Gupta A, Tiwari S, Palatty BU, *et al*. Trauma care in India: Capacity assessment survey from five centers. J Surg Res 2020;252:156–68.
31. NITI Aayog Release Report on Country-level assessment of emergency and injury care at secondary, tertiary level centres and district hospitals in India. Available from: https://www.niti.gov.in/sites/default/files/2023-02/AIIMS_STUDY_2_0.pdf. [Last accessed on 2023 Apr 06].

Supplementary Material 1.

Questionnaire development methodology employed

Two forward translations were made of the questionnaire from the English language to Malayalam by two independent bilingual translators who were proficient in Malayalam. These two translators and a recording observer worked together to synthesise the results of the translations. By using the original English questionnaire as well as the first translator's and the second translator's versions, a synthesis of these translations was made producing one single translation in Malayalam. It was followed by a back translation of the synthesised Malayalam version to English by two translators who were proficient in English. An expert committee consolidated all the versions of the questionnaire and developed the pre final version of the questionnaire. Content validity assessment of the pre final version was done with the assistance of two faculties from the Department of Emergency Medicine, Jubilee Mission Medical College and Research Institute. They reviewed the item pool and ranked them based on their preferences. They rated each item based on relevance as "most relevant," "relevant," "can be avoided," and "not relevant". The expert rating was quantified as a content validity index (CVI). Further, the questionnaire was field-tested for ensuring face validity among 20 individuals. Necessary discussions were done with participants to get the opinion on the degree of clarity and comprehension of each item. The questionnaire included queries on the time and location of symptom onset, factors prompting transport, the time taken to reach first medical contact, socioeconomic status, awareness of stroke, education level, incidence of stroke in their family previously, availability of family members at the time of stroke, and modes of transport employed including with whom they were transported to the hospital.