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IMPACT OF AN EDUCATIONAL INTERVENTION ON KNOWLEDGE, ATTITUDE, AND PRACTICE REGARDING THROMBOLYSIS AMONG CAREGIVERS OF NEUROLOGY PATIENTS: A PROSPECTIVE PRE–POST STUDY

Pooja Tripathi[1], Keerthiraj D B[2], Pradeep Kumar Maurya[3], Ajai Kumar Singh[4], Dinkar Kulshrestha[5], Abdul Qavi[6], Vikas Prabhu[7], K. Shrikrishna[8]

[1]Assistant Professor, Department of Neurology, Dr. Ram Manohar Lohia Institute of Medical Sciences, 1, Mandi Parishad Rd, Vijaipur Colony, Vibhuti Khand, Gomti Nagar, Lucknow, Uttar Pradesh 226010, India.
[2]Assistant Professor, Department of Neurology, Dr. Ram Manohar Lohia Institute of Medical Sciences, 1, Mandi Parishad Rd, Vijaipur Colony, Vibhuti Khand, Gomti Nagar, Lucknow, Uttar Pradesh 226010, India.
[3]Professor, Department of Neurology, Dr. Ram Manohar Lohia Institute of Medical Sciences, 1, Mandi Parishad Rd, Vijaipur Colony, Vibhuti Khand, Gomti Nagar, Lucknow, Uttar Pradesh 226010, India.
[4]Professor & Head, Department of Neurology, Dr. Ram Manohar Lohia Institute of Medical Sciences, 1, Mandi Parishad Rd, Vijaipur Colony, Vibhuti Khand, Gomti Nagar, Lucknow, Uttar Pradesh 226010, India.
[5]Professor, Department of Neurology, Dr. Ram Manohar Lohia Institute of Medical Sciences, 1, Mandi Parishad Rd, Vijaipur Colony, Vibhuti Khand, Gomti Nagar, Lucknow, Uttar Pradesh 226010, India.
[6]Professor, Department of Neurology, Dr. Ram Manohar Lohia Institute of Medical Sciences, 1, Mandi Parishad Rd, Vijaipur Colony, Vibhuti Khand, Gomti Nagar, Lucknow, Uttar Pradesh 226010, India.
[7]Assistant Professor, Department of Neurology, Dr. Ram Manohar Lohia Institute of Medical Sciences, 1, Mandi Parishad Rd, Vijaipur Colony, Vibhuti Khand, Gomti Nagar, Lucknow, Uttar Pradesh 226010, India.
[8]Senior Resident, Department of Neurology, Dr. Ram Manohar Lohia Institute of Medical Sciences, 1, Mandi Parishad Rd, Vijaipur Colony, Vibhuti Khand, Gomti Nagar, Lucknow, Uttar Pradesh 226010, India.

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Corresponding Author:
Dr. Pooja Tripathi,
Assistant Professor, Department of Neurology, Dr. Ram Manohar Lohia Institute of Medical Sciences, 1, Mandi Parishad Rd, Vijaipur Colony, Vibhuti Khand, Gomti Nagar, Lucknow, Uttar Pradesh 226010, India
Email: poojat886@gmail.com

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ABSTRACT

Background: Acute ischemic stroke (AIS) is a leading cause of death and disability worldwide, and intravenous thrombolysis remains the standard evidence-based reperfusion therapy within a narrow time window. In India, prehospital and in-hospital delays substantially limit thrombolysis rates, largely due to poor public and caregiver awareness. This study evaluated the effect of a structured educational intervention on the knowledge, attitude, and practice (KAP) regarding thrombolysis among caregivers of patients attending a neurology department.

Materials and Methods: This prospective, single-center, pre–post interventional study enrolled 389 caregivers (≥18 years) of patients visiting the neurology outpatient and inpatient services at RMLIMS, Lucknow, from June to December 2025. A validated, pilot-tested questionnaire covering knowledge (stroke warning signs, therapeutic window, thrombolysis benefits/risks), attitude, and hypothetical practice was administered before and four weeks after a 30-minute structured audio-visual educational session delivered in Hindi/English. The primary outcome was change in mean KAP scores.

Results: At baseline, only 26.2% of caregivers knew the term "thrombolysis," and 18.5% correctly identified the 4.5-hour time window. Post-intervention, the overall knowledge score improved from 34.6±12.8% to 78.9±10.3% ($p<0.001$). Favorable attitude (willingness to accept thrombolysis) rose from 41.9% to 84.1%, and self-reported intention to call emergency services immediately increased from 52.7% to 91.3%. Improvements were significant across all educational and age subgroups.

Conclusion: A brief, culturally tailored educational intervention markedly improves caregivers' KAP regarding thrombolysis. Integrating such programs

into routine neurology services could reduce prehospital delays and enhance acute stroke care in resource-limited settings.
Keywords: Thrombolysis, caregivers, knowledge, attitude, practice, educational intervention, acute ischemic stroke, India.

INTRODUCTION

Stroke is the second-leading cause of death and a major contributor to long-term disability globally, with low- and middle-income countries (LMICs) bearing a disproportionate share of the burden.[1] In India, the incidence of stroke is rising, and outcomes remain poor, partly because fewer than 2% of eligible patients receive intravenous thrombolysis.[4,6] The central mantra of acute stroke care, 'time is brain' underscores the critical importance of early recognition and rapid transport to a stroke-ready facility.[16] Yet, prehospital delays are pervasive; studies from India and other LMICs report median delays from symptom onset to hospital arrival exceeding 6–10 hours, often due to lack of awareness among patients, families, and primary caregivers.[5,10,12] Thrombolysis with alteplase or tenecteplase is effective only within a narrow therapeutic window (typically ≤4.5 hours from symptom onset) and administering it requires swift decision-making, frequently involving family members who act as surrogate decision-makers.[3,8]

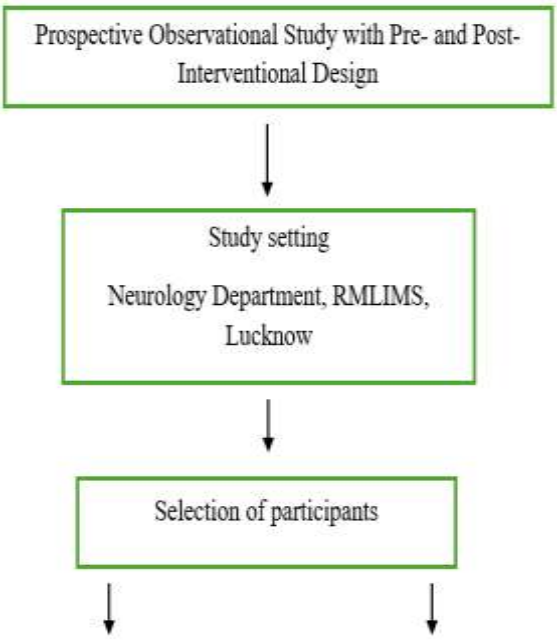
In many Indian settings, the caregiver often a close relative plays a pivotal role in recognizing stroke symptoms, arranging transport, and providing consent for acute treatment. Consequently, inadequate knowledge about stroke symptoms, the urgency of thrombolysis, and the risks versus benefits of treatment directly contributes to prehospital and in-hospital delays.[4,10,13] A survey among medical entrance examinees in Nepal revealed substantial knowledge gaps regarding thrombolysis eligibility and window period, mirroring trends observed in patient families.[7] Similarly, qualitative studies have identified fear of adverse effects, mistrust, and financial concerns as primary barriers to thrombolysis consent among families.[8]

Despite these observations, structured educational interventions targeting caregivers have been implemented infrequently in Indian neurology departments. The majority of stroke education studies focus on patients or the general public, with limited data on sustained knowledge retention among caregivers.[19] Given that caregivers are often the first responders in the community, enhancing their stroke literacy could substantially shorten onset-to-needle times. In high-income countries, mobile stroke units and community education campaigns have demonstrated that focused educational efforts can improve stroke recognition and reduce time to treatment.[14,16] However, such resource-intensive models are difficult to replicate in India, necessitating low-cost, scalable strategies within existing hospital infrastructure. Understanding the baseline KAP of caregivers is an essential first step to designing effective educational tools. Prior Indian studies have reported low awareness of stroke warning signs, and even lower familiarity with thrombolysis as a treatment option.[13] Yet, few investigations have employed a pre–post design to quantify the impact of a structured teaching session specifically on thrombolysis-related knowledge and attitudes among caregivers in a tertiary care setting. This study, therefore, aimed to assess the baseline KAP regarding thrombolysis among caregivers of patients attending the neurology services of a large public hospital in North India, deliver a standardized educational intervention, and measure its short-term impact on knowledge, attitude, and reported practice. We hypothesized that the intervention would lead to significant improvements in all KAP domains, irrespective of caregiver educational background.

MATERIALS AND METHODS

Study Design and Setting

The Department of Neurology at the Dr. Ram Manohar Lohia Institute of Medical Sciences (RMLIMS), Lucknow, a tertiary care teaching hospital in Uttar Pradesh, India, was the site of this prospective, observational, single-group pre-post interventional study. June 2025 to December 2025 was the duration of the research. Written informed consent was given by each subject. The overall study design is summarized in Figure 3.



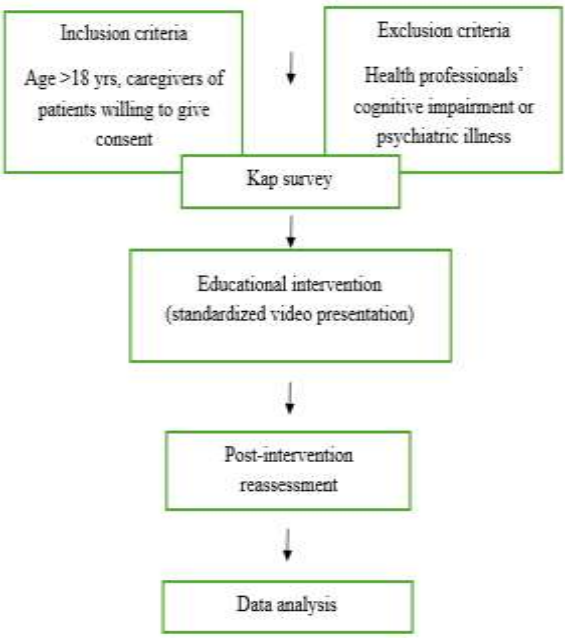


Figure 1: Depicts the prospective pre-post design, participant selection, baseline KAP survey, structured educational video intervention, and post-intervention reassessment at 4 weeks

Participants

Caregivers aged 18 years and above, accompanying adult patients (inpatients or outpatients) to the neurology department, were eligible. A caregiver was defined as a family member or close relative primarily responsible for the patient's day-to-day care and medical decision-making. Exclusion criteria included healthcare professionals (doctors, nurses, or allied health staff), individuals with severe cognitive impairment or hearing loss that precluded comprehension of the educational material, and those who declined to participate or were unable to return for the post-intervention assessment.

Sample Size

Based on an anticipated baseline knowledge score of 35%, a desired post-intervention improvement of 40 absolute percentage points (to 75%), a standard deviation of 15%, an alpha of 0.05, and power of 90%, the minimum required sample size for paired comparison was 68. To account for a potential dropout of up to 20%, and to allow robust subgroup analyses by age, sex, and education, a target of 389 participants was set. A consecutive sampling method was employed until the required sample size was achieved.

Development of KAP Questionnaire

A structured, interviewer-administered questionnaire was designed based on previously validated instruments, including the tool used by Pradhan et al. in their KAP study on stroke and thrombolysis [7]. The instrument was developed in English, translated into Hindi, and back-translated to ensure linguistic and conceptual equivalence. It contained four sections:

Section I – Sociodemographics: Age, sex, education, residence, relationship to patient, prior stroke exposure.

Section II – Knowledge: Stroke definition ("brain attack"), recognition of cardinal warning signs (face drooping, arm weakness, speech difficulty), thrombolysis term, time window (≤4.5 hours), purpose of thrombolysis, availability at the study hospital, bleeding risk, and treatability of stroke. Each correct response was scored 1, incorrect/don't know 0.

Section III – Attitude: Perceived urgency of stroke, immediate hospital visit importance, effectiveness of thrombolysis, need for more information, and trust in physician decision-making. Each item rated on a 5-point Likert scale (strongly disagree to strongly agree); favourable responses scored higher.

Section IV – Practice: Actual past encounter with stroke, immediate intended action (call ambulance/go to hospital vs. wait/home remedy), recognition of facial drooping as stroke, and knowledge of a local stroke-ready facility.

The questionnaire was pilot-tested on 30 caregivers (not included in the final sample). Content validity index was 0.89. Internal consistency of the knowledge domain was assessed using Cronbach's alpha; the overall alpha was 0.81. Following the methodology of Pradhan et al. [7], we further computed Cronbach's alpha for each knowledge item if deleted, to identify potentially redundant items (Table 1). No item deletion would have substantially raised the overall alpha.

Table 1: Item-wise reliability of the knowledge questionnaire

S.No.	Knowledge Item	Cronbach's α if item deleted
1.	Face drooping as stroke sign	0.79
2.	Arm weakness as stroke sign	0.80
3.	Speech difficulty as stroke sign	0.78
4.	All three cardinal signs together	0.82
5.	Term "thrombolysis/clot-buster"	0.81
6.	Time window ≤4.5 hours	0.83
7.	Purpose of thrombolysis (dissolves clot)	0.80
8.	Thrombolysis available at this hospital	0.79
9.	Bleeding is a possible side effect	0.82
10.	Stroke is treatable (knowledge component)	0.80
Overall Cronbach's α		**0.81**

Educational Intervention

After the baseline KAP assessment, each participant individually viewed a standardized 30-minute audio-visual presentation, delivered on a tablet device in a quiet room adjacent to the neurology clinic. The content was developed in Hindi (with key terms also in English) and covered:

- What is a stroke and why it is a medical emergency ("brain attack")
- The concept of "time is brain," emphasizing the 4.5-hour window
- How thrombolysis works and its potential benefits (clot dissolution, reduced disability)
- Common misconceptions and risks (bleeding, but very low in carefully selected patients)
- Steps to take if stroke is suspected call the national emergency number (112), note the time of onset, and go to the nearest stroke-ready hospital.

The presentation used simple animations, real-life scenarios, and testimonials from stroke survivors. A trained neurology resident was present to answer any questions afterward. The intervention was not repeated, but participants received a single-page illustrated summary to take home.

Data Collection and Follow-up

Baseline sociodemographic data and pre-intervention KAP questionnaire were collected on the day of enrollment. The same questionnaire was re-administered under supervision exactly four weeks (28 ± 3 days) later, either when the participant returned for the patient's follow-up visit or through a scheduled home visit if the patient was discharged. Both assessments were conducted by a research assistant blinded to the pre-intervention scores. Participant flow was recorded, and reasons for dropout were documented.

Outcome Measures

The primary outcome was the change in total knowledge percentage score from baseline to four weeks post-intervention. Secondary outcomes included changes in attitude and practice scores, proportions of participants achieving "adequate" knowledge (≥75% correct), and improvement stratified by age (<45 vs. ≥45 years), education (<secondary vs. ≥secondary), and residence.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range) depending on distribution normality. Categorical variables were presented as frequencies and percentages. Pre- and post-intervention scores were compared using paired t-tests for normally distributed data or Wilcoxon signed-rank test for skewed distributions. McNemar's test was used for paired dichotomous outcomes. Subgroup analyses employed independent t-tests or ANOVA for continuous change scores. All tests were two-sided, and a p-value <0.05 was considered statistically significant. Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY). The study is reported in accordance with the STROBE guidelines for observational studies.

RESULTS

Between June and December 2025, a total of 427 caregivers were screened; 38 were excluded (16 healthcare workers, 12 declined, 10 unable to follow-up). Thus, 389 participants completed both pre- and post-intervention assessments and were included in the analysis. The mean age of caregivers was 41.2 ± 12.5 years; 62.7% (n=244) were male. The majority were spouses (38.8%) or children (34.4%) of the patient. About 52.4% (n=204) had education below secondary level, and 54.8% (n=213) hailed from rural areas. Stroke-related history (a relative who had a stroke) was reported by 29.3% (n=114).

Baseline KAP

At baseline, the mean knowledge score was 4.2 ± 1.5 out of 12 (34.6% ± 12.8%). Only 26.2% (n=102) had heard the term "thrombolysis" or "clot-buster drug." The correct time window (≤4.5 hours) was identified by 18.5% (n=72). Even basic stroke warning signs were poorly recognized: facial droop (58.4%), arm weakness (66.8%), and speech difficulty (62.7%) were each identified by about two-thirds; however, only 38.6% recognized all three cardinal symptoms simultaneously. Knowledge of bleeding risk as a side effect was present in 12.1% (n=47). Mean attitude score was 14.8 ± 4.6 out of 25 (59.2% ± 18.4%); 41.9% (n=163) strongly agreed/agreed they would accept thrombolysis if advised. The mean practice score was 1.4 ± 0.8 out of 3 (46.5% ± 26.7%); just over half (52.7%) said they would immediately call an ambulance or rush to hospital, while the rest would first consult a local doctor or wait for improvement.

Post-Intervention KAP

Four weeks after the educational session, statistically and clinically significant improvements were observed across all domains (Table 1, Figure 1). Knowledge scores increased to 9.5 ± 1.2 out of 12 (78.9% ± 10.3%), a mean improvement of 44.3 percentage points (95% CI 42.1–46.5; p<0.001). Recognition of the thrombolysis window rose to 85.3% (n=332), and awareness of bleeding risk increased to 76.1% (n=296). All individual knowledge items showed significant gains (p<0.001 for each, Table 3). Attitude scores improved to 21.6 ± 3.2 out of 25 (86.4% ± 12.8%), with 84.1% expressing willingness to accept thrombolysis (Figure 2). The practice score nearly doubled to 2.7 ± 0.5 (90.5% ± 17.3%), with 91.3% now indicating they would call emergency services immediately.

Table 1: Distribution of study subjects according to age in months (n=120)

Age (months)	Cases (N=60) Frequency (%)	Controls (N=60) Frequency (%)	P value
1–6	22 (36.7%)	14 (23.3%)	
7–12	16 (26.7%)	18 (30.0%)	

13–18	13 (21.7%)	15 (25.0%)	
19–24	9 (15.0%)	13 (21.7%)	0.214
Mean±SD	11.82±6.12	13.76±6.48	

Table 2: Comparison of Global KAP Scores Before and After Intervention (n=389)

Domain	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	Mean Change (95% CI)	p-value
Knowledge (%)	34.6 ± 12.8	78.9 ± 10.3	44.3 (42.1–46.5)	<0.001
Attitude (%)	59.2 ± 18.4	86.4 ± 12.8	27.2 (25.0–29.4)	<0.001
Practice (%)	46.5 ± 26.7	90.5 ± 17.3	44.0 (41.2–46.8)	<0.001

SD: standard deviation; CI: confidence interval. p-values from paired t-test.

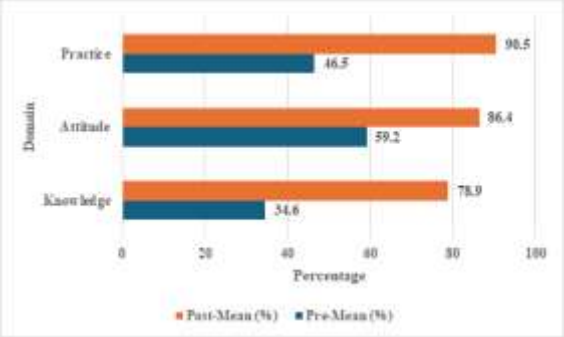


Figure 2: Bar chart comparing caregivers' mean knowledge, attitude, and practice scores (%) before and after the structured educational intervention (n=389). Error bars indicate ±1 standard deviation. The differences for all three domains were highly significant (paired t-test, ***p<0.001). Knowledge increased from 34.6% to 78.9%, attitude from 59.2% to 86.4%, and practice from 46.5% to 90.5%.

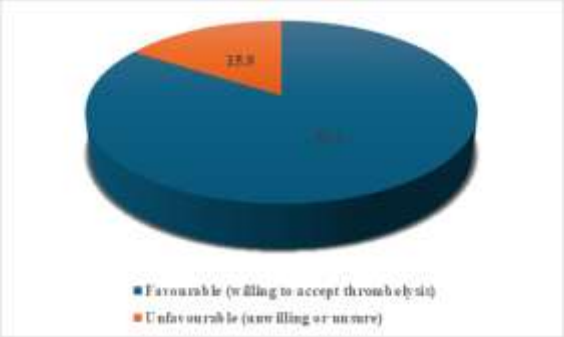


Figure 3: Pie chart showing caregivers' post-intervention willingness to accept thrombolysis for acute ischemic stroke (n=389). The green segment represents those with a favorable attitude (willing to accept thrombolysis, 84.1%), and the orange segment represents those with an unfavorable attitude (unwilling or unsure, 15.9%)

Subgroup Analysis

The improvement in knowledge scores was pronounced across all sociodemographic subgroups (Table 2). Participants with education below secondary level showed a slightly larger absolute gain in knowledge (46.3% vs. 42.1%, p=0.03 for interaction), attributable to their lower baseline. No significant differences in knowledge change were observed by age, sex, residence, relationship, or prior family stroke history.

Table 3: Changes in Knowledge Score Stratified by Sociodemographic Characteristics

Characteristic	n	Pre-score (%)	Post-score (%)	Mean Change (%)	p-value (interaction)
Age					0.76
<45 years	196	35.2 ± 13.1	79.2 ± 10.1	44.0 ± 14.2	
≥45 years	193	34.0 ± 12.5	78.5 ± 10.5	44.5 ± 13.8	
Sex					0.84
Male	244	35.0 ± 13.0	79.2 ± 10.2	44.2 ± 14.0	
Female	145	33.9 ± 12.5	78.4 ± 10.5	44.5 ± 13.9	
Education					0.03
<Secondary	204	29.5 ± 11.8	75.8 ± 10.9	46.3 ± 14.5	
≥Secondary	185	40.2 ± 11.5	82.3 ± 8.8	42.1 ± 13.1	
Residence					0.19
Urban	176	35.8 ± 13.2	80.9 ± 9.7	45.1 ± 13.9	
Rural	213	33.6 ± 12.4	77.0 ± 10.6	43.4 ± 14.1	
Prior family stroke					0.62
Yes	114	36.1 ± 12.9	79.8 ± 10.0	43.7 ± 13.8	
No	275	33.9 ± 12.7	78.4 ± 10.4	44.5 ± 14.1	

Values are mean ± SD. Interaction p-values from independent t-test or one-way ANOVA.

Table 4: Item-wise Correct Responses Before and After Intervention (n=389)

Knowledge Item	Pre n (%)	Post n (%)	p-value*
Face drooping as stroke sign	227 (58.4)	355 (91.3)	<0.001
Arm weakness as stroke sign	260 (66.8)	361 (92.8)	<0.001
Speech difficulty as stroke sign	244 (62.7)	370 (95.1)	<0.001
All three cardinal signs together	150 (38.6)	331 (85.1)	<0.001
Term "thrombolysis/clot-buster"	102 (26.2)	350 (89.9)	<0.001
Time window ≤4.5 hours	72 (18.5)	332 (85.3)	<0.001
Purpose of thrombolysis (dissolves clot)	98 (25.2)	340 (87.4)	<0.001
Thrombolysis available at this hospital	80 (20.6)	305 (78.4)	<0.001
Bleeding is a possible side effect	47 (12.1)	296 (76.1)	<0.001
Stroke is treatable (knowledge component)	140 (36.0)	364 (93.6)	<0.001

McNemar's test.

Retention and Acceptability

All 389 participants responded to the post-intervention survey, reflecting the facilitated follow-up strategy. Over 94% rated the educational video as "very useful," and 89% reported having discussed the content with at least one other family member. No adverse effects of the intervention were reported.

DISCUSSION

This prospective study demonstrates that a single, brief educational intervention dramatically improves caregivers' knowledge, attitude, and hypothetical practice regarding thrombolysis for acute ischemic stroke. At baseline, the KAP among caregivers attending a tertiary neurology department in North India was alarmingly poor: only one in four had heard of thrombolysis, fewer than one in five knew the correct time window, and barely half expressed an intention to seek emergency care. These figures are consistent with previous surveys from India and other LMICs. For instance, Das and Das reported that public awareness of stroke thrombolysis in India was significantly lower than in developed countries,[13] and Pradhan et al. found that even medical aspirants in Nepal possessed substantial knowledge gaps about thrombolysis.[7] Our baseline data reinforce that the "time is brain" concept has not yet penetrated the caregiver population that is often the crucial link in the chain of survival.[16]

The post-intervention gains exceeding 40 absolute percentage points in knowledge, attitude, and practice scores are larger than those seen in many hospital-based stroke education trials. In a multicomponent stroke education study in the United States, Johnson et al. reported that in-hospital education improved stroke knowledge but with less dramatic effect sizes, possibly because the baseline knowledge was higher.[19] Our findings suggest that when baseline awareness is extremely low, even a single, well-designed educational encounter can produce a substantial shift. The use of an audio-visual format, local language, and simple analogies likely enhanced comprehension among participants with limited formal education. Importantly, rural and less-educated caregivers benefited at least as much as their urban, more-educated counterparts, supporting the scalability of such interventions across diverse populations.

The attitude domain showed a marked increase in willingness to accept thrombolysis, from 41.9% to 84.1%. This is particularly relevant given that refusal of thrombolysis by patients or families is a recognized barrier. A study from San Diego observed that approximately 7–9% of eligible patients declined intravenous thrombolysis, with mistrust and fear of complications being prominent reasons.[11] Qualitative work by Prasad et al. identified similar themes, including fear of intracranial hemorrhage and lack of understanding of benefit, as barriers to tenecteplase use.[8] Our intervention explicitly addressed these fears by presenting balanced data on the effectiveness and safety of thrombolysis, which may have mitigated exaggerated risk perceptions. Although we measured only hypothetical acceptance, the dramatic attitudinal shift suggests that caregivers are amenable to evidence-based persuasion when information is delivered in a trusted setting. The practice domain improvements are equally encouraging. After the intervention, over 90% of caregivers reported they would immediately call emergency services or go directly to a hospital, compared to only 52.7% at baseline. Prehospital delays in India often stem from a "wait and see" approach, consultation with local practitioners, or transport to a facility not equipped for thrombolysis.[10,12] By clarifying the concept of "time is brain" and providing a clear, actionable plan note the symptom onset, call 112, go to the nearest stroke-ready center the intervention aligns with the prehospital triage strategies advocated in international guidelines.[3,14] Even a modest reduction in decision-making delay at the family level can translate into substantial improvements in onset-to-needle times when coupled with efficient emergency medical services. Prehospital stroke management protocols, including mobile stroke units where feasible, have shown that speeding response times increases thrombolysis rates.[14,16] While our study did not measure actual time metrics, the change in reported intention is a necessary precursor to behavioral change.

Our study must be interpreted in the context of its design. The single-group pre–post design, while pragmatic, is susceptible to regression to the mean, social desirability bias, and the Hawthorne effect.

The knowledge gain we observed may partially reflect test-retest familiarity rather than true learning; however, the magnitude of improvement and the fact that the questionnaire was not identical in all aspects argue against this being the sole explanation. The four-week interval, though short, is longer than many similar studies and provides some assurance of retention,[19] however, longer-term follow-up (6–12 months) is necessary to assess decay. Furthermore, we measured only stated intentions, not actual behavior in a real stroke emergency. A future phase could track whether caregivers who received the intervention exhibit shorter prehospital delays when a family member actually experiences a stroke. The study was conducted in a single tertiary care center in North India, which may limit generalizability to other regions or to primary care settings. Finally, the caregiver population self-selected by accompanying a patient to a neurology department; their KAP may differ from the general community, although the low baseline scores suggest that even this relatively engaged group lacks critical knowledge. Despite these limitations, the study has several strengths. It is one of the first from India to systematically evaluate a structured thrombolysis-focused educational intervention among caregivers using a robust pre–post methodology. The large sample size (n=389) allowed inclusion of diverse sociodemographic subgroups and provided sufficient power for secondary analyses. The intervention was low-cost, reproducible, and culturally adapted, requiring only a tablet device and a trained facilitator resources available in most Indian district hospitals. By targeting caregivers, who are both vulnerable and influential, the intervention addresses a critical gap in the stroke care continuum that is frequently overlooked by traditional public campaigns.

The clinical implications are clear. Integrating a brief educational module into the routine workflow of neurology outpatient and inpatient services could be an effective strategy to improve community stroke preparedness. Such programs could be reinforced through short-message-service reminders, pictorial handouts, and community health worker follow-up. Given the rising stroke burden in India,[1,6] low-cost, scalable solutions to reduce prehospital delays are urgently needed. Future studies should investigate whether the observed KAP improvements translate into reduced door-to-needle times and increased thrombolysis rates, ideally through a cluster-randomized trial design across multiple hospitals.

CONCLUSION

This study demonstrates that a single, structured, audio-visual educational intervention delivered in a tertiary neurology clinic can profoundly improve caregivers' knowledge, attitude, and practice regarding thrombolysis for acute ischemic stroke. Baseline awareness was extremely low, underscoring the critical gap in stroke literacy among family decision-makers. Post-intervention, recognition of the time-sensitive nature of thrombolysis and willingness to act appropriately in a stroke emergency improved dramatically, irrespective of age, sex, education, or urban-rural residence. Because caregivers are often the first responders and consent providers for acute stroke treatment, empowering them through education has the potential to reduce prehospital delays and enhance thrombolysis rates in India and similar settings. Widespread implementation of such low-cost, culturally sensitive educational modules within existing neurology services should be considered a public health priority to mitigate the growing stroke burden.

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Conflict of Interest

The authors state that they have no known conflicting financial interests or personal ties that might have influenced the work described in this study.

REFERENCES

1. GBD 2021 Stroke Risk Factor Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. Lancet Neurol. 2024 Oct;23(10):973-1003. doi: 10.1016/S1474-4422(24)00369-7. PMID: 39304265; PMCID: PMC12254192.
2. Su L, Kuchling J, Gao C, Niendorf T, Finke C, Zhang Z, Guo A, Jing J, Tian DC, Li YJ, Zhang M, Shi X, Liu X, Wang H, Liu Y, Chien C, Levy M, Duan Y, Paul F, Shi FD. Brain Characteristics in Patients With Myelin Oligodendrocyte Glycoprotein Antibody-Associated Disorder by 7.0 Tesla MRI. Ann Clin Transl Neurol. 2025 Jul;12(7):1431-1441. doi: 10.1002/acn3.70080. Epub 2025 May 22. PMID: 40404603; PMCID: PMC12257113.
3. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, Biller J, Brown M, Demaerschalk BM, Hoh B, Jauch EC, Kidwell CS, Leslie-Mazwi TM, Ovbiagele B, Scott PA, Sheth KN, Southerland AM, Summers DV, Tirschwell DL. Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke. 2019 Dec;50(12):e344-e418. doi: 10.1161/STR.0000000000000211. Epub 2019 Oct 30. Erratum in: Stroke. 2019 Dec;50(12):e440-e441. doi: 10.1161/STR.0000000000000215. PMID: 31662037.
4. Shah A, Diwan A. Stumbling Blocks to Stroke Thrombolysis: An Indian Perspective. Indian J Crit Care Med. 2023 Sep;27(9):616-619. doi: 10.5005/jp-journals-10071-24517. PMID: 37719355; PMCID: PMC10504641.
5. Evenson KR, Rosamond WD, Morris DL. Prehospital and in-hospital delays in acute stroke care. Neuroepidemiology. 2001 May;20(2):65-76. doi: 10.1159/000054763. PMID: 11359072.
6. Pandian, Jeyaraj & Kalkonde, Yogeshwar & Sebastian, Ivy & Felix, Cynthia & Urimubenshi, Gerard & Bosch, Jackie.

(2020). Stroke systems of care in low-income and middle-income countries: challenges and opportunities. The Lancet. 396. 1443-1451. 10.1016/S0140-6736(20)31374-X.
7. Pradhan RR, Jha A, Bhandari S, Ojha S, Karn R. Knowledge, attitude, and practice of stroke and thrombolysis among students preparing for undergraduate medical entrance examination in Kathmandu, Nepal. Health Sci Rep. 2021 Apr 5;4(2):e268. doi: 10.1002/hsr2.268. PMID: 33842697; PMCID: PMC8020573.
8. Prasad S, Jones EM, Gebreyohanns M, Aguilera V, Olson DM, Anderson JA, Savitz SI, Flores SC, Warach SJ, Rhodes CE, Goldberg MP, Ifejika NL. A qualitative study of barriers and facilitators to using tenecteplase to treat acute ischemic stroke. J Stroke Cerebrovasc Dis. 2024 Jan;33(1):107458. doi: 10.1016/j.jstrokecerebrovasdis.2023.107458. Epub 2023 Nov 11. PMID: 37956644.
9. Li X, He Y, Wang D, Rezaei MJ. Stroke rehabilitation: from diagnosis to therapy. Front Neurol. 2024 Aug 13;15:1402729. doi: 10.3389/fneur.2024.1402729. PMID: 39193145; PMCID: PMC11347453.
10. 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 Oct-Dec;7(4):224-230. doi: 10.4103/IJCIIS.IJCIIS_20_17. PMID: 29291175; PMCID: PMC5737064.
11. von Kleist T, Meyer D, Rapp K, Meyer BC, Modir R. Characteristics and Outcomes of Patients who Refuse Intravenous Thrombolysis for Acute Ischemic Stroke - The San Diego Experience. J Stroke Cerebrovasc Dis. 2020 Nov;29(11):105137. doi: 10.1016/j.jstrokecerebrovasdis.2020.105137. Epub 2020 Aug 4. PMID: 33066942.
12. Kaur P, Verma SJ, Singh G, Bansal R, Paul BS, Singla M, Singh S, Samuel CJ, Sharma M, Pandian JD. Stroke profile and outcome between urban and rural regions of Northwest India: Data from Ludhiana population-based stroke registry. Eur Stroke J. 2017 Dec;2(4):377-384. doi: 10.1177/2396987317724052. Epub 2017 Jul 27. Erratum in: Eur Stroke J. 2017 Dec;2(4):NP1. doi: 10.1177/2396987317728603. PMID: 31008330; PMCID: PMC6453185.
13. Das S, Das SK. Knowledge, attitude and practice of stroke in India versus other developed and developing countries. Ann Indian Acad Neurol. 2013 Oct;16(4):488-93. doi: 10.4103/0972-2327.120431. PMID: 24339565; PMCID: PMC3841586.
14. Fassbender K, Lesmeister M, Merzou F. Prehospital stroke management and mobile stroke units. Curr Opin Neurol. 2023 Apr 1;36(2):140-146. doi: 10.1097/WCO.0000000000001150. Epub 2023 Feb 15. PMID: 36794965; PMCID: PMC9994848.
15. Venketasubramanian N. Stroke Demographics, Risk Factors, Subtypes, Syndromes, Mechanisms and Inter-Ethnic Differences between Chinese, Malays and Indians in Singapore-A Hospital-Based Study. J Cardiovasc Dev Dis. 2024 Jun 12;11(6):180. doi: 10.3390/jcdd11060180. PMID: 38921680; PMCID: PMC11203577.
16. Ragoschke-Schumm A, Walter S, Haass A, Balucani C, Lesmeister M, Nasreldein A, Sarlon L, Bachhuber A, Licina T, Grunwald IQ, Fassbender K. Translation of the 'time is brain' concept into clinical practice: focus on prehospital stroke management. Int J Stroke. 2014 Apr;9(3):333-40. doi: 10.1111/ijs.12252. Epub 2014 Mar 4. PMID: 24593156; PMCID: PMC4374710.
17. Liao Q, Zhang Y, He J, Huang K. Global Prevalence of Myotonic Dystrophy: An Updated Systematic Review and Meta-Analysis. Neuroepidemiology. 2022;56(3):163-173. doi: 10.1159/000524734. Epub 2022 Apr 28. PMID: 35483324.
18. Tan KS, Pandian JD, Liu L, Toyoda K, Leung TWH, Uchiyama S, Kuroda S, Suwanwela NC, Aaron S, Chang HM, Venketasubramanian N. Stroke in Asia. Cerebrovasc Dis Extra. 2024;14(1):58-75. doi: 10.1159/000538928. Epub 2024 Apr 26. PMID: 38657577; PMCID: PMC11250668.
19. Johnson B, Handler D, Urrutia V, Alexandrov AW. Retention of Stroke Education Provided during Hospitalization: Does Provision of Required Education Increase Stroke Knowledge? Interv Neurol. 2018 Oct;7(6):471-478. doi: 10.1159/000488884. Epub 2018 Jul 26. PMID: 30410527; PMCID: PMC6216712.
20. Corbali O, Chitnis T. Pathophysiology of myelin oligodendrocyte glycoprotein antibody disease. Front Neurol. 2023 Feb 28;14:1137998. doi: 10.3389/fneur.2023.1137998. PMID: 36925938; PMCID: PMC10011114.
21. Radzikowska-Büchner E, Łopuszyńska I, Flieger W, Tobiasz M, Maciejewski R, Flieger J. An Overview of Recent Developments in the Management of Burn Injuries. Int J Mol Sci. 2023 Nov 15;24(22):16357. doi: 10.3390/ijms242216357. PMID: 38003548; PMCID: PMC10671630.
22. Elnasieh AM, Alturki AT, Alhadlaq R, Almesned M, Al-Hazm AN, Almajid H, Khalaf Alharbi TK, Alaidarous TM, Alturki AT. Health Education Resources Favored by Out-Patients Attending King Saud Medical City, Riyadh. Cureus. 2024 Aug 17;16(8):e67089. doi: 10.7759/cureus.67089. PMID: 39286698; PMCID: PMC11405005.
23. Ton MD, Phuong DV, Thom VT, Dung NT, Tho PQ, Thuan LD, Nguyen TN. Factors related to unfavorable outcome in minor ischemic stroke. J Stroke Cerebrovasc Dis. 2023 Aug;32(8):107203. doi: 10.1016/j.jstrokecerebrovasdis.2023.107203. Epub 2023 Jul 11. PMID: 37441912.
24. Hill D, Conner M, Clancy F, Moss R, Wilding S, Bristow M, O'Connor DB. Stress and eating behaviours in healthy adults: a systematic review and meta-analysis. Health Psychol Rev. 2022 Jun;16(2):280-304. doi: 10.1080/17437199.2021.1923406. Epub 2021 May 24. PMID: 33913377.