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ORIGINAL ARTICLE

Awareness of alteplase therapy for acute ischemic stroke among postgraduate residents in public and private hospitals of Khyber Pakhtunkhwa

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ABSTRACT

Background: Acute ischemic stroke (AIS) is a predominant cause of death and prolonged disability, globally. Intravenous alteplase (tPA) is the mainstay treatment when administered within therapeutic timeframe. In low and middle-income countries like Pakistan, treatment delays frequently stem from insufficient awareness among healthcare professionals. This study evaluated the knowledge, attitudes, and behaviors of postgraduate residents at public and private hospitals of Khyber Pakhtunkhwa regarding the use of intravenous alteplase in the management of acute ischemic stroke.

Methods: A cross-sectional study was conducted from January to June 2025 among 206 postgraduate residents from various public and private-sector hospitals of Khyber Pakhtunkhwa using a validated questionnaire adapted from Al Khathaami et al. Knowledge was evaluated using three fundamental criteria (effectiveness, standard of treatment, recommendation), resulting in a Knowledge Score from 0-3. Statistical investigations included t-tests, one-way ANOVA with post-hoc evaluations, and multivariable linear regression to identify the determinants of knowledge.

Results: The average Knowledge Level Score was 2.81 ± 0.63, with 89.8% of individuals attaining the highest level. No notable differences were detected between inhabitants of public and private institutions ($p = 0.882$) or among residency years ($p = 0.234$). Multivariable regression indicated no significant determinants of knowledge ($R^2 = 0.009$, $p = 0.880$). Notwithstanding robust foundational knowledge, 10% of participants exhibited hesitance in endorsing tPA, attributing their reservations to worries over bleeding (52.9%), insufficient experience (35.0%), and medico-legal implications (3.4%). Notably, 86.4% indicated a readiness to pursue additional training, while 72.3% endorsed tele-stroke consulting methods.

Conclusion: Postgraduate residents in Khyber Pakhtunkhwa exhibit substantial basic knowledge of intravenous alteplase in acute ischemic stroke, regardless of training year or type of institution. Obstacles to implementation originate from attitudes, self-assurance, and medico-legal issues.

Keywords: Alteplase, Acute Ischemic Stroke, Postgraduate Residents, Khyber Pakhtunkhwa

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Introduction

Acute ischemic stroke (AIS) is a significant cause of mortality and disability around the world, making it a substantial global health concern (1, 2). Stroke is the second leading contributor to the global cardiovascular disease burden. Its prevalence increases with advancing age, reaching its highest levels among individuals aged 74-79 years.

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Approximately 63% of ischemic strokes occur in low and middle-income countries (3). South Asia bears this burden disproportionately; population-level incidence estimates vary widely (116-483/100,000), reflecting variability in risk factors and healthcare systems (4).

Intravenous thrombolysis with alteplase, a recombinant tissue plasminogen activator (rtPA), is the most effective treatment (5). The effectiveness of this approach has been demonstrated to be exceptionally high when administered within a restricted therapeutic window. The investigation conducted by the National Institute of Neurological Disorders and Stroke (NINDS) demonstrated that intravenous alteplase administered within three hours enhances 90-day functional outcomes (6). This trial established the initial substantial evidence for time-sensitive reperfusion and stimulated systemic alterations globally. ECASS III expanded the therapeutic window to 3-4.5 hours, broadening eligibility for treatment while noting that the absolute benefit diminishes over time and the risk of hemorrhage increases (6, 7).

Barreto synthesized evidence that prompt intervention yields the greatest benefits (8). Additionally, selection criteria, imaging, and clinical proficiency substantially affect real-world safety and efficacy. Subsequent reanalysis and critiques highlighted baseline imbalances in specific trials, underscoring the need for cautious extrapolation to heterogeneous populations (9). The administration of intravenous alteplase varies widely across regions. While it is administered promptly in developed countries, developing countries face substantial challenges, including delayed patient presentation, limited availability of experienced physicians, and inadequate healthcare infrastructure. A local study from Baluchistan found that several patients sought non-medical practitioners for initial advice, resulting in delays beyond the optimal treatment window (10).

Research indicates that in-hospital strokes frequently result in poorer outcomes and prolonged delays to reperfusion (11). In-hospital thrombolytic treatment rates for stroke are suboptimal, with the administration of tPA confounded by comorbidities, anticoagulation status, and surgical timing (12). Lu et al. compared in-hospital strokes with community-onset strokes undergoing endovascular thrombectomy, revealing disparities in workflow and results, thereby emphasizing the necessity for in-hospital stroke procedures and staff training. Implementing quality improvement methodologies in inpatient neurologic emergencies can reduce response times (13, 14).

Even though there is a considerable body of evidence confirming safety and efficiency of alteplase, its application varies around the world, highlighting the importance of expanding knowledge to ensure that stroke care is provided in effective manner. Residents frequently serve as initial in-hospital responders and may activate stroke protocols. As they are pivotal to initial evaluation and treatment decisions; their level of knowledge is a modifiable determinant of door-to-needle time and tissue plasminogen activator (tPA) utilization. However, the research from China and other contexts demonstrates diversity in the competency and

preparedness of residents to escalate care for both community-onset and in-hospital strokes (13, 15). The use of telemedicine has also been employed to enhance outcomes for patients. Mobile Stroke Units equipped with onboard CT and telestroke functionalities reduce treatment intervals. They provide professional assistance to remote hospitals, facilitating the safe administration of tPA in the absence of on-site competence (16, 17).

Keeping in view the lack of empirical data, this study was designed to evaluate the knowledge, attitudes, and behaviors of postgraduate residents at public and private hospitals in Khyber Pakhtunkhwa regarding the use of intravenous alteplase in the treatment of acute ischemic stroke.

Methods

A cross-sectional study was designed in the Community Medicine Department of Khyber Medical College, Peshawar following ethical approval from the Institutional Review Board vide letter no 657/DME/KMC. The study included postgraduate residents of public and private sector hospitals in Khyber Pakhtunkhwa, aiming to assess their understanding of intravenous alteplase in the management of acute ischemic stroke. A total of 206 residents were selected through a non-probability sampling method between January to June 2025. Eligible participants comprised residents in any year of training after the FCPS-I examination. Allied medical personnel, consultants, and non-consenting individuals were excluded from the study.

A systematic and validated questionnaire, derived from Al Khathaami et al. was utilized (18). It comprised demographic details including age, gender, year of residency, type of hospital, presence of a stroke team, and weekly exposure to stroke cases. The domain of knowledge assessment included the effectiveness of tPA, standard of care, and evidence grade. The practice and attitude domain included recommendations for tPA, obstacles, desire for training, and willingness to participate in tele-stroke. Responses to three essential knowledge items (effectiveness, standard of treatment, and recommendation) were categorized as accurate (1) or incorrect (0). The scores were aggregated to provide a Knowledge Score ranging from 0-3, with higher scores indicating greater knowledge.

Data were analyzed using SPSS version 22. Descriptive statistics were presented as means (SD) for continuous variables and frequencies (%) for categorical variables. An independent-sample t-test was used to compare the Knowledge Scores of residents at public versus private hospitals. A one-way ANOVA was used to examine variations between residency years, followed by Tukey's post-hoc analysis. Multivariable linear regression was used to evaluate determinants of Knowledge Score (age, gender, year of residency, type of institution, and stroke team). A p-value of less than 0.05 was deemed statistically significant.

Results

The average age of participants was 28.6 ± 2.7 years. Male participants comprised 69.4% (n = 143), while female participants accounted for 30.6% (n = 63). Over fifty per cent originated from state hospitals (55.8%) as opposed to private institutions (44.2%). The distribution of residents across different residency years showed that 61 (29.6%) were in PGY-1, 35 (17.0%) in PGY-2, 62 (30.1%) in PGY-3, 31 (15.0%) in PGY-4, and 17 (8.3%) in PGY-5. Only 94 (45.6%) residents indicated the presence of a specific stroke management team at their institution, while 106 (51.5%) reported no such team and 6

(2.9%) were unsure. Approximately 45.6% reported managing 1–5 stroke cases per week, 38.8% handled 6–10 cases, and 15.5% treated more than 10 cases per week.

Knowledge, perceptions, and attitudes regarding intravenous tPA among residents are shown in Table 1. Regarding self-evaluated knowledge, 41.7% reported being well-informed, 46.1% reported adequate knowledge, and 12.1% reported insufficient knowledge. The majority of residents (95.6%) considered tPA effective, and 93.7% reported it as a standard of care. Regarding the strength of evidence, 67.5% of residents considered the evidence strong, 18.9% considered it controversial, and 13.6% were uncertain. A majority (91.3%) endorsed the use of tPA in qualifying instances, 2.4% did not, and 6.3% were uncertain. Among reasons cited against the use of tPA, risk of hemorrhage was the most common concern, reported by 52.9% of residents, followed by lack of expertise, lack of benefit, and medicolegal concerns. Regarding the preferred action in the absence of expertise, 57.8% of residents favored training emergency physicians, 18.0% preferred not using tPA, 14.1% preferred training interns, and 10.2% supported establishing a telestroke service. Notably, 86.4% of residents indicated readiness for training, whereas 72.3% were amenable to administering tPA via tele-stroke consultation.

Table 1. Self-Reported Knowledge, Perceptions, and Attitudes Toward tPA Therapy

Domain / Variable	Response	n (%)
Self-rated knowledge	Poor	25 (12.1)
	Acceptable	95 (46.1)
	Well updated	86 (41.7)
Perceived effectiveness of tPA	Yes	197 (95.6)
	No	3 (1.5)
	Uncertain	6 (2.9)
tPA as standard of care	Yes	193 (93.7)
	No	3 (1.5)
	Uncertain	10 (4.9)
Perceived strength of evidence	Strong	139 (67.5)
	Controversial	39 (18.9)
	Don't know	28 (13.6)
Would recommend tPA	Yes	188 (91.3)
	No	5 (2.4)
	Uncertain	13 (6.3)
Preferred action in absence of expertise	Train interns	29 (14.1)
	Train emergency physicians	119 (57.8)
	Establish telestroke	21 (10.2)
	No tPA	37 (18.0)
Reasons against tPA	Hemorrhage	109 (52.9)
	Lack of expertise	72 (35.0)
	Lack of benefit	18 (8.7)
	Medicolegal concerns	7 (3.4)
Willingness for further training	Yes	178 (86.4)
	No	10 (4.9)
	Uncertain	18 (8.7)
Willingness to participate in tele-stroke	Yes	149 (72.3)
	No	30 (14.6)

	Uncertain	27 (13.1)

The average Knowledge Score was 2.81 ± 0.63, with the majority of inhabitants achieving the highest score of 3 (89.8%), while a small fraction scored 2 (3.9%), 1 (3.4%), or 0 (2.9%). Self-assessed knowledge levels aligned with performance, as a significant percentage of individuals indicating they were "well updated" also attained a score of 3. This is illustrated in Figure 1.

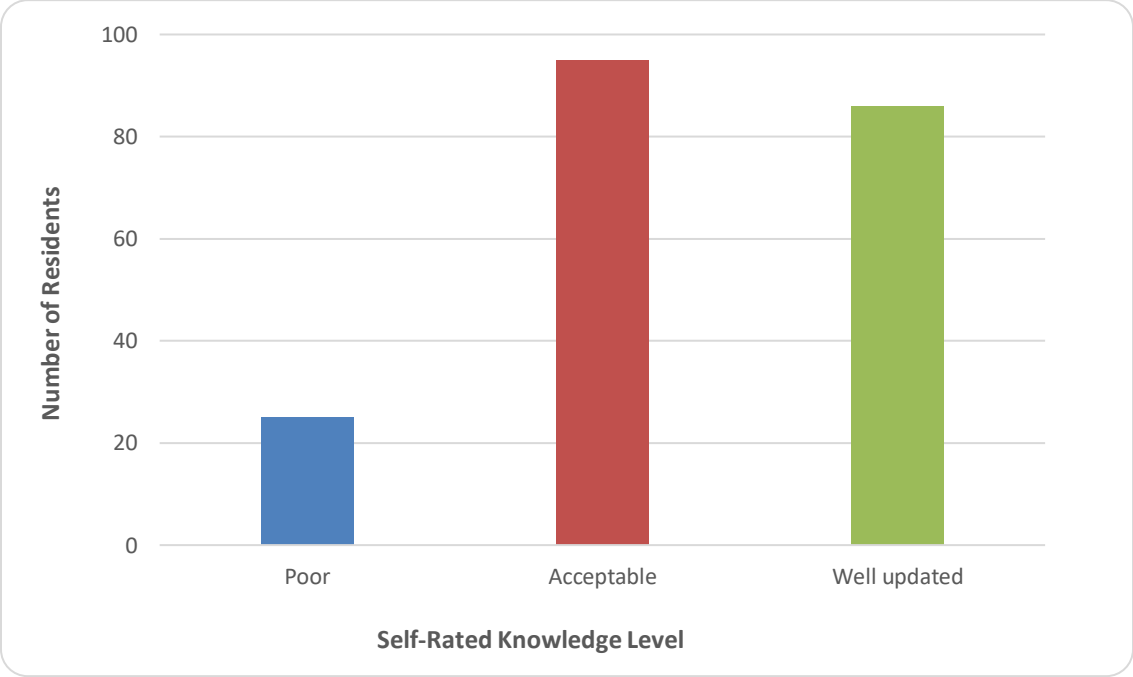

Figure 1. Self-rated Knowledge Levels about tPA Use

No statistically significant difference in Knowledge Score between residents working in public and private hospitals was observed (Public: 2.80 ± 0.62 vs. Private: 2.81 ± 0.65, p = 0.882). Similarly, there was no statistically significant difference in Knowledge Score across residency years with means ranged from 2.69 to 2.97 (p = 0.234). Multivariable regression revealed no significant predictors of Knowledge Score. Age, gender, duration of residence, type of institution, and presence of a stroke team did not correlate with elevated scores (R^2 = 0.009, p = 0.880).

Discussion

This cross-sectional study of postgraduate residents in public and private hospitals in Khyber Pakhtunkhwa reveals that the baseline knowledge of intravenous alteplase (tPA) for acute ischemic stroke is high, with a nearly 90% of participants achieved the maximum score. Nonetheless, despite this substantial factual information, attitudinal and practical impediments were apparent, including hesitance to endorse tPA due to hemorrhagic consequences, inadequate proficiency,and medicolegal apprehensions. These gaps suggest that, although the underlying information is robust, its

application to confident clinical decision-making is variable.

The near-ceiling knowledge distribution identified in this study suggests that the questionnaire effectively assessed fundamental awareness but failed to differentiate between subtle knowledge deficiencies. Aspects such as contraindications, stroke mimics, intricate patient scenarios, or dose disputes were not examined. Consequently, while the data affirm robust foundational competency, they may undervalue shortcomings in sophisticated clinical reasoning. Previous research demonstrates analogous difficulties. In Saudi Arabia, Al Khathaami et al. indicated that emergency physicians possessed substantial knowledge yet displayed reluctance in practice, primarily due to worries of haemorrhage and medicolegal implications (18). Algarni et al. subsequently highlighted discrepancies between guideline awareness and practical use among emergency residents (19). Ziaee et al. discovered that emergency medicine personnel in Iran possessed commendable knowledge, although they exhibited inconsistent attitudes, highlighting the impact of risk perception on their readiness to administer tPA (20). In Sudan, Ahmed et al. noted inconsistent preparedness among registrars, while in Cyprus, Rossis et al. emphasised that systematic training programs can improve readiness (21, 22). These findings correspond with our results indicating the issue lies not in fundamental knowledge, but in confidence and context-specific obstacles.

The lack of substantial differences between residents at public and private hospitals in our study is striking. It suggests that variations in stroke outcomes across institutions are likely not attributable to provider-level expertise but rather to systemic inadequacies, including imaging access, costs, and the efficiency of door-to-needle workflows. Similar findings have been documented in Pakistan, where Iqbal et al. reported that only 7.4% of patients arrived within the 4.5-hour window, citing cost and infrastructure delays as the primary obstacles (23). Global literature supports this interpretation. Bulmer et al. examined thrombolysis procedures in Canadian hospitals and found that systemic efficiency, rather than individual expertise, dictated door-to-needle times, especially in rural locations with constrained resources (24). They identified process optimization, specifically direct-to-CT pathways, stroke alerts, and pharmacist participation, as the primary drivers of higher treatment rates, rather than deficiencies in provider competence.

The absence of variance across residency years in our sample indicates that knowledge is either effectively conveyed early in training or that it stagnates due to insufficient organized reinforcement as residency advances. Additional research underscores the significance of ongoing, systematic instruction. Rossis et al. correlated organized training with enhanced readiness (22). Aaron et al. similarly reported that general practitioners in India exhibit inadequate awareness of tPA, highlighting the need to educate all frontline physicians who may face stroke patients, not solely experts (25). In the absence of such reinforcement, experiential exposure alone may fail to enhance decision-making competence in stroke thrombolysis.

Approximately 10% of our participants' hesitance to endorse tPA, primarily attributable to worries over bleeding, aligns with the international literature. Scott et al.

reported comparable concerns among Michigan emergency physicians, where apprehension of consequences and medicolegal responsibility constrained treatment rates despite substantial expertise (26). In the absence of comprehensive institutional stroke protocols and explicit indemnity support, such concerns are likely to endure.

This study has certain limitations including the cross-sectional design making it difficult to establish causal relationships, use of a non-probability sampling technique, and assessing knowledge using only three items which may not have comprehensively captured the perception of respondents.

Conclusion

The study reveals that postgraduate residents of Khyber Pakhtunkhwa exhibit a consistently high level of knowledge about intravenous alteplase in acute ischemic stroke, irrespective of their training year or institutional affiliation. Nonetheless, attitudinal barriers such as fear of hemorrhagic consequences, insufficient confidence, and medicolegal apprehensions continue to exist and may hinder the commencement of thrombolysis. The lack of distinctions between public and private institutions indicates that systemic, rather than pedagogical shortcomings are the principal barriers to prompt and successful stroke reperfusion.

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All the authors agree to take responsibility for every facet of the work, making sure that any concerns about its integrity or veracity are thoroughly examined and addressed.	