JNeViS
Journal of Neurointervention and Stroke

Journal of Neurointervention and Stroke 2025;1(2):57-62
doi: 10.63937/jnevis-2025.12.13

Original Article

Profile of Acute Ischemic Stroke Patients Receiving Intravenous Thrombolysis with Recombinant Tissue Plasminogen Activator at Soeradji Tirtonegoro Hospital

Adika Mianoki[1], Fatikha Fajar Wiati[2]✉, Hanum Salsabila[2]

[1] Department of Neurology, Soeradji Tirtonegoro Hospital, Klaten, Indonesia
[2] Department of General Medicine, Soeradji Tirtonegoro Hospital, Klaten, Indonesia

Corresponding Author:
Fatikha Fajar Wiati
Department of General Medicine, Soeradji Tirtonegoro Hospital, Klaten, Indonesia
Email: fatikha.md@gmail.com

Received: August 31, 2025
Revised: November 7, 2025
Accepted: November 15, 2025
Published: Desember 2, 2025

Introduction: Acute ischemic stroke is a leading cause of mortality and disability worldwide, including in Indonesia. Intravenous thrombolysis with recombinant tissue plasminogen activator (rtPA) is recommended for eligible patients, but data from Indonesian referral hospitals remain limited. **Objective:** This study aimed to describe the demographic characteristics, treatment times, and in-hospital clinical measures of patients with acute ischemic stroke receiving intravenous rtPA at Soeradji Tirtonegoro Hospital. **Method:** A descriptive study analyzed medical records of patients treated with intravenous rtPA between April 2022 and August 2024. Collected variables included age, sex, stroke onset, onset-to-needle time (OTN), vital parameters, comorbidities, door-to-imaging (DTI), door-to-needle (DTN) times, early ischemic change (EIC), National Institutes of Health Stroke Scale (NIHSS) scores at admission, at 24 hours, and at discharge, Barthel Index at admission and discharge, early neurological improvement (ENI), early neurological deterioration (END), symptomatic intracerebral hemorrhage (sICH), in-hospital mortality, and length of stay (LOS). **Result:** Most patients were older males (62.2%; median age 62 years). Hypertension was the most common comorbidity, followed by diabetes mellitus and dyslipidemia. The median onset-to-needle time (OTN) was 240 minutes, and 80% achieved a DTI time within 25 minutes. The median DTN time was 80 minutes. Median NIHSS scores improved from 11 on admission to 6 at 24 hours and four at discharge, with ENI in 64.44% and early END in 15.56% of patients. The Barthel Index increased from 3 to 20 during hospitalization. Symptomatic intracerebral hemorrhage occurred in 6,.67%, and in-hospital mortality was 17.78 %. **Conclusion**: Intravenous rtPA thrombolysis improved neurological and functional measures among acute ischemic stroke patients. However, the prolonged door-to-needle time indicates the need for enhanced in-hospital workflows to accelerate treatment delivery.

Keywords: Acute ischemic stroke, Door-to-needle time, Intravenous thrombolysis, NIHSS, Recombinant tissue plasminogen activator

Highlights
- Most patients showed early neurological improvements after IV thrombolysis
- The door-to-needle time was longer than the recommended guidelines
- A patient profile may guide the optimization of stroke management

JNeViS

Introduction

Stroke is the leading cause of disability worldwide. According to the 2018 Indonesian Basic Health Research (RISKESDAS), the stroke prevalence in Indonesia is 10.9 per 1,000 people. Among post-stroke patients, 23.3% will develop a disability if they do not undergo regular follow-up visits to the hospital.[1] Based on the 2023 Performance Report of the Directorate General of Disease Prevention and Control, cardiovascular diseases, including stroke, are the leading cause of death in Indonesia.[2]

Globally, approximately 68% of all strokes are ischemic, whereas 32% are hemorrhagic. Ischemic stroke occurs due to vascular occlusion that disrupts the cerebral blood supply, which may result from thrombotic or embolic mechanisms, leading to neuronal death in the brain parenchyma.[3] The mainstay of treatment for acute ischemic stroke is intravenous thrombolysis with recombinant tissue plasminogen activator (rtPA), which should be administered within 4.5 hours of stroke onset. The rtPA dose recommended by AHA(American Heart Association) and ASA(American Stroke Association) is 0.9 mg/kg body weight, whereas several studies suggest that a lower dose of 0.6 mg/kg is preferable in Asian patients. Ten percent of the total dose is administered as an initial bolus, followed by the remaining 90% via continuous infusion over 60 minutes.[4]

Recent international registries have provided valuable benchmarks for the implementation of thrombolysis and its outcomes. The Safe Implementation of Treatments in Stroke–International Stroke Thrombolysis Register (SITS-ISTR) and the Thrombolysis in Ischemic Stroke Patients (TRISP) collaboration reported substantial improvements in workflow efficiency and clinical outcomes across Europe.[5,6] Meanwhile, large-scale studies from the China National Stroke Registry (CNSR) demonstrated progressive increases in intravenous thrombolysis rates and optimization of door-to-needle time between 2012 and 2022, reflecting the global trend toward better acute stroke care systems.[7]

As one of the referral hospitals in Central Java, Soeradji Tirtonegoro Hospital in Klaten has implemented intravenous thrombolysis for ischemic stroke patients since April 2022. However, data regarding the demographic and clinical profiles of ischemic stroke patients receiving rtPA thrombolysis at this hospital remain limited.

Objective

To describe the demographic characteristics, comorbidities, and in-hospital clinical measures, including door-to-imaging, door-to-needle, and onset-to-needle times of acute ischemic stroke patients receiving intravenous rtPA at Soeradji Tirtonegoro Hospital.

Method

This study employed a descriptive observational design. Data were obtained from the medical records of acute ischemic stroke patients who received intravenous rtPA thrombolysis at Soeradji Tirtonegoro Hospital between April 2022 and August 2024. A total of 47 patient records were initially identified; however, 2 were excluded due to incomplete data on key study variables, leaving 45 patients included in the final analysis. The study population comprised all acute ischemic stroke patients who underwent rtPA thrombolysis and met the inclusion and exclusion criteria. The inclusion criteria were acute ischemic stroke patients treated with intravenous rtPA within the study period, along with complete medical records. Exclusion criteria included patients with incomplete medical records regarding key variables or those who underwent additional interventions beyond thrombolysis, such as thrombectomy.

The collected variables included sex, age, stroke onset, systolic and diastolic blood pressure, random blood glucose (RBG), body weight, DTI time, DTN time, OTN time, LOS, and NIHSS scores at admission, at 24 hours, and at discharge, as well as the Barthel Index at discharge. Comorbidities recorded included hypertension (HT), diabetes mellitus (DM), and dyslipidemia. The presence of ENI and END was determined based on observed in-hospital changes in NIHSS scores. Safety was assessed based on the occurrence of sICH, END, and in-hospital mortality.

Imaging findings on non-contrast head CT (NCCT) were evaluated for EIC. According to the American Heart Association/American Stroke Association (AHA/ASA, 2019) guidelines for the early management of acute ischemic stroke, EIC is defined as “loss of gray–white matter differentiation, sulcal effacement, or focal hypodensity consistent with acute ischemia.” Based on this evaluation, patients were divided into two groups: those with EIC and those without EIC. This simplified categorization reflects the pragmatic evaluation commonly used during the hyperacute phase (<4.5 hours after onset), when infarct demarcation may still be subtle or absent.[5]

DTI was defined as the time from the patient’s arrival at the emergency department to the performance of a head CT scan. DTN was defined as the time from the patient’s arrival at the emergency department to the initiation of the rtPA bolus. LOS was defined as the duration from the first day of admission to the last day of hospitalization. The NIHSS was assessed upon admission to the emergency department, at 24 hours, and at discharge. The Barthel Index was evaluated upon admission to the ward and at discharge.

ENI was defined as a decrease of ≥4 points in the NIHSS score, or an NIHSS score of 0–1 within 24 hours after thrombolysis, indicating substantial neurological recovery during hospitalization.[6,7] END was defined as a worsening of ≥4 points in the NIHSS score within 24 hours following thrombolysis compared to baseline, in

doi: 10.63937/jnevis-2025.12.13

accordance with current international guidelines.[5] Safety assessments included the identification of sICH on follow-up head CT scans after thrombolysis, as well as documented cases of END and in-hospital mortality. Symptomatic intracerebral hemorrhage (sICH) was defined according to the European Cooperative Acute Stroke Study III (ECASS-III) criteria as any intracranial bleeding detected on head CT accompanied by a ≥4-point increase in the NIHSS score from the previous assessment, or resulting in death within 36 hours after thrombolysis.

All data tabulation and descriptive analysis were performed using Microsoft Excel. Descriptive analysis was used to summarize the data, including frequencies and percentages for categorical variables and medians with ranges for numerical variables.

This study received ethical approval from the Research Ethics Committee of Aisyiyah University Surakarta, with approval number 235/IX/AUEC/2024.

Result

Table 1. Characteristic of subjects

Variable	n	%	Median (min-max)
Sex			
Male	28	62.22	
Female	17	37.77	
Age			62 (39-84)
Onset (minutes)			150 (15-225)
Body weight (kg)			60 (45-80)
Random Blood Glucose (mg/dL)			138 (86-409)
Systolic Blood Pressure (mmHg)			167 (106-249)
Diastolic Blood Pressure (mmHg)			88 (58-153)
Comorbidities			
Hypertension	30	66.67	
Diabetes mellitus	13	28.89	
Dyslipidemia	23	51.11	
Onset-to-Needle Time (minutes)			240 (71-269)
Door-to-Imaging Time (minutes)			18 (3-96)
≤ 25 minutes	36	80	
> 25 minutes	9	20	
Door-to-Needle Time (minutes)			118 (23-240)
≤ 60 minutes	7	15.55	
> 60 minutes	38	84.44	
Early Ischemic Change (EIC)			
Present	38	84.44	
Absent	7	15.55	
NIHSS			
At admission	248	78.23	1 (4-33)
At 24 hours	85	26.81	6 (0-42)
At discharge	57	17.98	4 (0-42)
Barthel Index at Admission			3 (0-20)
0-4	28	62.22	
5-8	9	20	
9-11	5	11.11	
12-19	2	4.44	
20	1	2.22	
Barthel Index at Discharge			20 (0-20)
0-4	8	17.77	
5-8	1	2.22	
9-11	5	11.11	
12-19	8	17.77	
20	23	51.11	
Early Neurological Improvement (ENI)	29	64.44	
Safety			
Early Neurological Deterioration (END)	7	15.56	
Symptomatic Intracerebral Hemorrhage (sICH)	3	6.67	
In-hospital Mortality	8	17.78	
Length of Hospital Stay (days)			5 (1-16)

In total, 45 patients with acute ischemic stroke received intravenous rtPA thrombolysis. The majority of patients were male (62.22%), with a median age of 62 years (range 39–84 years). The most common comorbidities were hypertension (68.88%), diabetes mellitus (33.33%), and dyslipidemia (20%). The median body weight was 62 kg (range 45–88 kg); the median random blood glucose was 160 mg/dL (range 70–480 mg/dL); the median systolic blood pressure was 165 mmHg (range 100–230 mmHg); and the median diastolic blood pressure was 90 mmHg (range 50–140 mmHg).

Most patients (80%) had a DTI ≤25 minutes, with a median of 20 minutes (range 5-99 minutes). A DTN ≤25 minutes was achieved in 15.55% of patients, whereas the majority (84.44%) had DTN >60 minutes, with a median of 90 minutes (range 35-40 minutes). All patients received OTN within the recommended therapeutic window (<4.5 hours), with a median time of 240 minutes (range 71–269 minutes).

Head CT scans showed EIC in 84.44% of patients, whereas 15.55% had no visible ischemic changes (EIC absent). The initial NIHSS score had a median of 12 (range 4–35), decreasing to 8 at 24 hours (range 0–35) and 6 at discharge (range 0–35). ENI was observed in 64.44% of patients, while END occurred in 15.56%. At baseline, the Barthel Index indicated that most patients (62.22%) were categorized as totally dependent (score 0–4), with a median score of 4. At discharge, the Barthel Index increased to a median of 19 (range 0–20), with 51.11% of patients achieving complete independence (score 20).

The median length of hospital stay was 5 days (range 1–16 days). Symptomatic intracranial hemorrhage (sICH) was identified in 6.67% of patients based on post-thrombolysis head CT scans, and in-hospital mortality occurred in 17.78%.

Discussion

Acute ischemic stroke remains a significant health problem with a high disease burden worldwide, especially in Indonesia. This study highlights the profile of acute ischemic stroke patients who received rtPA thrombolysis at Soeradji Tirtonegoro Hospital in Klaten, encompassing an analysis of patient demographics, DTI, DTN, and OTN times, clinical outcomes based on changes in NIHSS and Barthel Index scores, as well as length of hospital stay.

Patient Profile and Comorbidities

This study describes the early experience with intravenous thrombolysis for acute ischemic stroke at Soeradji Tirtonegoro Hospital in Klaten. The median patient age was 62 years, with a predominance of males (62.2%), consistent with previous Indonesian and regional data indicating that ischemic stroke more frequently affects older male patients.[8] Hypertension, diabetes mellitus, and dyslipidemia were the most common comorbidities. This is in line with reports that these modifiable vascular risk factors are responsible for more than 80% of stroke burden worldwide and in Asia.[9] The SITS-ISTR and TRISP registries showed similar trends, reporting hypertension in 70–80% and diabetes in 20–30% of thrombolysed patients, respectively.[10,11] The presence of these comorbidities most likely reflects the systemic vascular injury that causes ischemic stroke and may influence the responsiveness to thrombolytic therapy.

Timelines and Workflow (OTN, DTI, and DTN)

All patients in this study arrived within the therapeutic window for rtPA administration (<4.5 hours), with a median onset-to-needle (OTN) time of 240 minutes (range 71–269 minutes). This finding indicates that prehospital delay remains substantial, as most patients arrived close to the upper limit of eligibility. The median door-to-imaging (DTI) time was 18 minutes, with 80% meeting the recommended benchmark (≤25 minutes),[5,11,12] suggesting efficient early triage processes and good CT scan availability. However, the median door-to-needle (DTN) time was 118 minutes (range 23–240 minutes), with only 15.5% of patients treated within 60 minutes. These findings reflect challenges similar to those reported in other Indonesian hospitals.[8] In contrast, registries such as SITS-ISTR and TRISP report median DTN times of 50–60 minutes, and recent Chinese multicenter data (2012–2022) demonstrate continuous improvement, achieving a median DTN of 45 minutes through workflow optimization.[10,11,14] The delay in DTN time likely reflects the early phase of implementation and highlights the need for improved coordination among emergency, radiology, and pharmacy units.[5,15]

Imaging Characteristics

The study demonstrated that most patients presented with early ischemic change (EIC) on non-contrast CT. In contrast, a smaller subset showed no detectable EIC despite having clinically confirmed acute ischemic stroke. The absence of EIC in these cases suggests the stroke occurred during the hyperacute phase. At this point, ischemic changes in the brain parenchyma are not yet visible on imaging. This finding is consistent with the current understanding that, within the first <3–4.5 hours after symptom onset, non-contrast CT often fails to delineate infarcted tissue clearly.[5,16,17]

Neurological and Functional Response (NIHSS and Barthel Index)

Neurological improvement, defined as ENI (≥4-point NIHSS reduction or NIHSS=0 or one within 24

hours), occurred in 64.4% of patients, while END (≥4-point NIHSS increase within 24 hours) occurred in 15.5%. The initial NIHSS median score of 11 significantly decreased at 24 hours and at discharge, indicating overall neurological improvement. These findings are consistent with registry data reporting that 70–80% of patients experience early improvement following timely rtPA administration.[10,11,14] Functional independence also improved, reflected by the rise in the Barthel Index at discharge, indicating enhanced performance of daily activities.[6] The high proportion of ENI may be attributed to lower baseline NIHSS scores in lacunar infarctions and adequate systemic control during hospitalization.

Safety Indicators

Safety parameters were assessed based on the incidence of symptomatic intracerebral hemorrhage (sICH), END, and in-hospital death. sICH, defined by ECASS-III criteria as any intracerebral hemorrhage with ≥4 NIHSS deterioration, occurred in 3 patients (6.67%), which aligns with SITS-ISTR data (5–7%).[5] END occurred in 7 patients (15.5%), and 8 patients (17.8%) died during hospitalization. The mortality rate remains higher than international registry benchmarks (6–10%),[10,11,14] likely due to delayed DTN and the absence of advanced reperfusion therapies such as thrombectomy.

Benchmarking and Clinical Implications

Compared to major registries, the current study's DTN and safety parameters fall within the range usually observed in early program phases. Data from SITS-ISTR, TRISP, and the Chinese National Stroke Registry consistently show that systematic workflow improvements and multidisciplinary coordination significantly lower DTN and mortality.[10,11,14] Establishing a structured "stroke code" system, implementing pre-hospital notification, and ensuring a rapid pharmacy response are key interventions proven to shorten DTN to 30–45 minutes.[18,19,20] These findings highlight that targeted improvements in hospital systems and coordination can lead to safer treatment processes and improved patient recovery.

The present study has several limitations. Its descriptive, single-center design and relatively small sample size limit both generalizability and statistical power. Furthermore, the absence of standardized Alberta Stroke Program Early CT Score (ASPECTS) assessments and vascular imaging, such as computed tomography angiography (CTA), magnetic resonance angiography (MRA), or digital subtraction angiography (DSA), precludes objective quantification of infarct extent and comprehensive evaluation of eligibility for intravenous thrombolysis. Additionally, the lack of 90-day modified Rankin Scale (mRS) follow-up limits the assessment of long-term functional outcomes and compromises comparability with international stroke registries. Future studies should therefore employ a multicenter, prospective design incorporating standardized ASPECTS scoring, vascular imaging, and long-term outcome measures such as 90-day mRS to ensure methodological consistency and enhance external validity.[5]

Conclusion

This study provides an overview of the clinical profile and in-hospital course of acute ischemic stroke patients receiving intravenous thrombolysis at Soeradji Tirtonegoro Hospital. Most patients were male, with hypertension, diabetes, and dyslipidemia as common comorbidities. Although door-to-imaging and onset-to-needle times met international standards, door-to-needle times remained prolonged, highlighting the need to optimize in-hospital workflows further.

Most patients showed early neurological improvement (ENI) and functional gains during hospitalization, while safety issues such as sICH and END occurred in a small number of cases. These findings highlight the importance of strengthening stroke pathways and multidisciplinary coordination to reduce treatment delays and improve service performance. Further multicenter or registry-based studies incorporating angiographic and long-term follow-up data are warranted to better understand and contextualize thrombolysis practice in Indonesia.

Acknowledgement

We are grateful for the data support provided by Soeradji Tirtonegoro Hospital, Klaten.

Conflict of Interest

All authors have no conflict of interest.

Ethic consideration

This study was approved by the Research Ethics Committee of Aisyiyah University Surakarta with ethical approval number 235/IX/AUEC/2024.

Funding

This research was funded by Soeradji Tirtonegoro Hospital, Klaten

Author contribution

All authors contributed to all the processes in this research. **Andika Mianoki:** Conceptualization and supervision. **Fatikha Fajar Wiati**: Data curation and writing. **Hanum Salsabila:** Writing and editing.

References

1. Kementerian Kesehatan RI. Laporan nasional RISKESDAS 2018. Jakarta: Badan Penelitian dan Pengembangan Kesehatan. 2018. 156 p. Available at: https://repository.kemkes.go.id/book/1323

2. Kementerian Kesehatan RI. Laporan kinerja direktorat jenderal pencegahan dan pengendalian penyakit. 2023. Jakarta: Direktorat Jenderal Pencegahan dan Pengendalian Penyakit. 2023. Available at: https://ppid.kemkes.go.id/wp-content/uploads/2024/10/FINAL_LAKIP-KEMENKES-2023_compressed.pdf
3. Lui F, Suheb MZK, Patti L. Ischemic stroke. In: StatPearls. Treasure Islands (FI): StatPearls Publishing. 2025. Available at: https://www.ncbi.nlm.nih.gov/books/NBK499997/
4. Wang X, You S, Sato S, Yang J, Carcel C, Zheng D, et al. Current status of intravenous tissue plasminogen activator dosage for acute ischaemic stroke: an updated systematic review. Stroke Vasc Neurol. 2018;3(1):28-33. DOI: 10.1136/svn-2017-000112
5. Powers WJ, Rabinstein AA, Ackerson T, et al. Guidelines for the early management of 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;50(12):e344-e418. DOI: 10.1161/STR.00000 00000000211
6. Agarwal S, Scher E, Lord A, Frontera J, Ishida K, Torres J, et al. Redefined measure of early neurological improvement shows treatment benefit of alteplase over placebo. Stroke. 2020;51(4):1226-30. DOI: 10.1161/STROKEAHA. 119.027476
7. Kobeissi H, Ghozy S, Bilgin C, Kadirvel R, Kallmes DF. Early neurological improvement as a predictor of outcomes after endovascular thrombectomy for stroke: A systematic review and meta-analysis. *J* Neurointerv Surg. 2023;15(6):547–51. DOI: 10.1136/neurintsurg-2022-019008
8. Retnaningsih R, Hendartono TK. Profil pasien stroke iskemik akut dengan terapi recombinant tissue plasminogen activator di RSUP Dr. Kariadi Semarang. Neurona. 2020;36(4):86. DOI: 10.523 86/neurona.v36i4.86
9. GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis. Lancet Neurol. 2021;20(10):795-820. DOI: 10.1016/S1474-4422(21)00252-0
10. Wahlgren N, Ahmed N, Eriksson N, Aichner F, Bluhmki E, Dávalos A, et al. Multivariable analysis of outcome predictors and adjustment of main outcome results to baseline data profile in randomized controlled trials: Safe Implementation of thrombolysis in Stroke-MOnitoring STudy (SITS-MOST). Stroke. 2008;39(12):3316–22. DOI: 10.1161/STROKEAHA.107.510768
11. Scheitz JF, Gensicke H, Zinkstok SM, Curtze S, Arnold M, Hametner C, et al. Cohort profile: Thrombolysis in Ischemic Stroke Patients (TRISP): A multicentre research collaboration. BMJ Open. 2018;8(9):e023265. DOI: 10.1136/bmjopen-2018-023265
12. Reznek MA, Murray E, Youngren MN, Durham NT, Michael SS. Door-to-imaging time for acute stroke patients is adversely affected by emergency department crowding. Stroke. 2017;48(1):49-54. DOI: 10.1161/STROKEAHA.116.015131
13. Sadeghi-Hokmabadi E, Taheraghdam A, Hashemilar M, Rikhtegar R, Mehrvar K, Mirnour R, et al. Simple in-hospital interventions to reduce door-to-CT time in acute stroke. J Stroke Cerebrovasc Dis. 2016;2016(1):1656212. DOI: 10.1155/2016/1656212
14. Jia W, Jiang Y, Ma R, Huang X, Gu H, Meng X, et al. 10-year temporal trends of intravenous thrombolysis in acute ischemic stroke: Analysis of the China National Stroke Registry I–III. J Stroke Cerebrovasc Dis. 2024;33(1):107431. DOI: 10.1016/j.jstrokecerebrovasdis.2023.107431
15. Iglesias-Mohedano AM, García Pastor A, Díaz Otero F, Vázquez Alen P, Martín Gómez MA, Simón Campo P, et al. A new protocol reduces median door-to-needle time to the benchmark of 30 minutes in acute stroke treatment. Neurologia (Engl Ed). 2021;36(7):487-94. DOI: 10.1016/j.nrleng.2018.03.009
16. Abdalkader M, Siegler JE, Lee JS, Yaghi S, Qiu Z, Huo X, et al. Neuroimaging of acute ischemic stroke: Multimodal imaging approach for acute endovascular therapy. J Stroke. 2023;25(1):55-71. DOI: 10.5253/jos.2022.03286
17. Nukovic JJ, Opancina V, Ciceri E, Muto M, Zdravkovic N, Altin A, et al. Neuroimaging modalities used for ischemic stroke diagnosis and monitoring. Medicina. 2023;59(11):1908. DOI: 10.3390/MEDICINA59111908
18. Man S, Xian Y, Holmes DN, Matsouaka RA, Saver JL, Smith EE, et al. Association between thrombolytic door-to-needle time and 1-year mortality and readmission in patients with acute ischemic stroke. JAMA. 2020;323(21):2170-84. DOI: 10.1001/jama.2020.5697
19. Meretoja A, Strbian D, Mustanoja S, Tatlisumak T, Lindsberg PJ, Kaste M. Reducing in-hospital delay to 20 minutes in stroke thrombolysis. Neurology. 2012;79(4):306-13. DOI: 10.1212/WNL.0b013e31825d6011
20. Lodhi OUH, Bowers J, Parameswaran A, Vandeburg J, Labin E. Pre-hospital notification to stroke team significantly improves acute ischemic stroke outcome. Neurology. 2025;104(7 Suppl 1):3215. DOI: 10.1212/ WNL.0000000000210865