WORKFLOW METRICS AND FUNCTIONAL OUTCOMES IN AN MRI-FIRST PATHWAY FOR REVASCULARIZED ACUTE ISCHEMIC STROKE

Abu Bakar, I.S[1,2*], Muda, A.S[1,3*], Ehsan, N[2], Perisamy, R.S[5], Kamis, M.F.A[1], Tharek, A[1,3], Ahmad Sabri, M.I[1,6], Mahfar, N[4]

[1] Radiology Department, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia
[2] Radiology Department, Hospital Sultanah Aminah Johor Bahru, Malaysia
[3] Pusat Klinikal Neurovascular & Strok, HSAAS, Universiti Putra Malaysia
[4] Radiology Department, KPJ Damansara Specialist Hospital, Selangor, Malaysia
[5] Radiology Department, International Islamic University Malaysia, Kuantan, Malaysia
[6] Lönge Medikal Sdn Bhd, Serdang Selangor, Malaysia

***Corresponding author:**
Izzna Shafinaz Abu Bakar, Radiology Department, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang Selangor, Malaysia.
Email: sizznaz@gmail.com

DOI: https://doi.org/10.32896/cvns.v8n2.1-13
Received: 08.06.2026
Revised: 26.06.2026
Accepted: 28.06.2026
Published: 30.06.2026

ABSTRACT

Background: MRI-first pathways prioritize tissue-based selection in acute ischemic stroke (AIS). This study evaluated workflow metrics and functional outcomes in revascularized AIS patients managed through an MRI-first protocol. **Methods:** We conducted a retrospective cohort study of 59 consecutive revascularized AIS patients managed with the Putra Acute Stroke Protocol at a comprehensive stroke center. Primary workflow metrics were door-to-imaging (DTI) and door-to-decision (DTD) times. The primary outcome was 90-day functional independence, defined as modified Rankin Scale (mRS) 0-2. Multivariable logistic regression was used to identify factors associated with a favourable outcome. **Results:** The MRI-first pathway identified 20.1% stroke mimics and 14.1% transient ischemic attacks before revascularization decisions. Among revascularized patients, median DTI was 45 minutes (IQR 35-69) and median DTD was 67 minutes (IQR 50-98), with a median imaging-to-decision interval of 22 minutes. In multivariable analysis, baseline NIHSS (aOR 0.887; 95% CI 0.800-0.984, p=0.023) and DTD time (aOR 1.022; 95% CI 1.000-1.044, p=0.048) were associated with a favourable 90-day outcome. **Conclusion:** In this selected cohort of revascularized patients managed through an MRI-first pathway, workflow performance was acceptable for a comprehensive stroke center, and favourable 90-day functional outcomes were achieved in two-thirds of patients. The observed positive association between longer door-to-decision time and favourable outcome should be interpreted cautiously, as it may reflect selection bias and residual confounding inherent to the retrospective design. Larger prospective multicenter studies are needed to confirm these findings.

Key words: acute ischemic stroke; magnetic resonance imaging; workflow metrics; door-to-imaging; door-to-decision; thrombolysis; thrombectomy

INTRODUCTION

Acute ischemic stroke requires rapid reperfusion, but treatment decisions increasingly depend not only on time from onset but also on tissue status and vascular imaging [1]. Although CT remains the dominant first-line modality in hyperacute stroke [2], MRI can provide more detailed characterization of infarct core, salvageable tissue, and stroke mimics, which may support more selective use of reperfusion therapy [3,4].

MRI-first pathways remain atypical despite their diagnostic advantages because they require scanner availability, trained personnel, coordinated image interpretation and reliable multidisciplinary decision-making [4]. In facilities capable of adopting these pathways such as a comprehensive stroke center, workflow performance is an essential implementation consideration as diagnostic benefits must be balanced by the risk of in-hospital delay [5]. Door-to-imaging (DTI) and door-to-decision (DTD) times are therefore relevant operational metrics for evaluating MRI-first stroke systems [6]. Among these, DTD time is particularly important as it captures the interval from hospital arrival to treatment determination, encompassing diagnostic interpretation and clinical judgment. This metric reflects the coordinated efforts of radiographers, radiologists, and neurologists and represents a modifiable target for quality improvement initiatives [7].

Most prior studies have largely examined CT-based pathways and benchmarks metrics such as door-to-needle (DTN) and door-to-puncture (DTP) with several publications reports DTN within 60 minutes [8,9] establishing feasibility benchmarks for hyperacute stroke care. However, comprehensive workflow metrics specific to MRI-first pathways, including DTI and imaging-to-decision intervals, remain incompletely characterized. This study evaluated workflow metrics and their association with 90-day functional outcome in revascularized acute ischemic stroke patients managed through an established MRI-first pathway.

METHODOLOGY

Study Design and Setting

This retrospective observational study was conducted at Hospital Sultan Abdul Aziz Shah (HSAAS), Universiti Putra Malaysia, a comprehensive stroke center operating within Malaysia's hub-and-spoke model. The study evaluated patients managed through the Regional Emergency Stroke Quick Response (RESQ) unit, which employs an MRI-first pathway utilizing the Putra Acute Stroke Protocol for acute ischemic stroke (AIS) evaluation [7].

Study Population

The source population were collected from consecutive AIS patients admitted between January and September 2025. Adults aged 18 years or older were eligible for inclusion in the analytic cohort if they had confirmed acute ischemic stroke, underwent MRI-first evaluation, and received reperfusion therapy. Patients were excluded if key workflow timestamps were missing, 90-day modified Rankin Scale data were unavailable, or the final diagnosis was not ischemic stroke.

MRI-First Imaging Protocol

The Putra Acute Stroke Protocol is an accelerated eight-minute MRI sequence integrating Diffusion-Weighted Imaging (DWI), Fluid-Attenuated Inversion Recovery (FLAIR), and Magnetic Resonance Angiography (MRA) to provide rapid diagnostic assessment for immediate treatment decisions [8]. Images were transmitted in real-time to the Padimedical cloud-based PACS platform, enabling immediate neuroradiological interpretation and facilitating timely multidisciplinary treatment consensus.

Variables and Outcomes
Workflow variables included onset-to-door (OTD), door-to-imaging (DTI), door-to-decision (DTD), door-to-treatment (DTT), and onset-to-treatment (OTT) intervals. For descriptive purposes, we also derived an imaging-to-decision interval, defined as the time from MRI acquisition start to the documented treatment decision obtained by subtracting DTI from DTD. This interval encompassed the approximately eight-minute Putra Acute Stroke Protocol acquisition, near-instantaneous transfer to the PACS system, and real-time joint review by the pre-alerted stroke neurologist and on-call radiologist but excluded subsequent formal report dictation.

Baseline characteristics included age, sex, vascular risk factors, large vessel occlusion status, treatment type, and admission NIHSS score. The primary outcome was 90-day functional independence, defined as modified Rankin Scale 0-2. Secondary descriptive outcomes included discharge NIHSS score, 24-hour neurological improvement, where applicable, and successful reperfusion in endovascular cases.

Statistical Analysis
Descriptive statistics were presented as median and interquartile range (IQR) for continuous variables due to non-normal distribution and as frequencies and percentages for categorical variables. Univariate analyses compared baseline characteristics and workflow metrics between favourable (mRS 0-2) and unfavourable (mRS >2) outcome groups using Mann-Whitney U tests for continuous data and Chi-square or Fisher's exact tests for categorical data. Bivariate associations between temporal metrics and clinical scales (mRS and NIHSS) were evaluated using Spearman's rank correlation (ρ) to account for the ordinal nature of the scales and the positive skew of workflow intervals [10]. Multivariable logistic regression models were constructed to identify factors associated with favourable 90-day outcome, with separate models used for highly correlated workflow measures. Statistical significance was defined as a two-sided p-value below 0.05.

Ethical Considerations The study protocol was reviewed and approved by the Ethics Committee for Research Involving Human Subjects of Universiti Putra Malaysia (JKEUPM; Ref: JKEUPM-2025-373). A waiver of informed consent was granted because of the retrospective design and use of de-identified registry data.

RESULTS

Patient Selection and Diagnostic Yield
Figure 1 shows the patient selection flow diagram. Among 673 patients initially assessed for suspected acute ischemic stroke, 598 underwent evaluation through the MRI-first pathway. Of these, 361 were diagnosed with ischemic stroke, 120 were classified as stroke mimics, and 84 as transient ischemic attacks. Revascularization therapy was performed in 101 patients, and 59 remained in the final analytic cohort after exclusion of patients with loss to follow-up or transfer, incomplete workflow data,or missing 90-day outcomes.

Baseline Characteristics and Outcomes
The final cohort included 59 revascularized patients, of whom 39 achieved favourable 90-day functional outcome and 20 did not (Table 1). Patients with favourable outcomes had lower admission NIHSS scores than those with unfavourable outcomes, while age, sex and large vessel occlusion status were broadly similar between groups (Table 1). Endovascular therapy alone was the most frequent reperfusion strategy, followed by IVT alone and combined IVT plus EVT (Table 2).

Workflow Performance
For the overall analytic cohort, median DTI time was 45 minutes (IQR 35-69) and median DTD time was 67 minutes (IQR 50-

98). The median imaging-to-decision interval (DTD minus DTI), representing the time from MRI initiation to documented treatment decision, was 22 minutes. Across treatment groups, DTD times differed with longer intervals in patients treated with EVT alone than in those receiving IVT alone or combined therapy (Table 2).

Clinical Outcomes and associations

Favourable 90-day outcome was observed in 66.1% of patients. Patients with favourable outcomes had substantially lower discharge NIHSS scores than those with unfavourable outcomes (Table 3). Baseline NIHSS showed a modest positive correlation with 90-day mRS, whereas discharge NIHSS correlated more strongly with 90-day mRS; DTI and DTD were also highly correlated with each other (Table 3).

Multivariable analysis

In the multivariable logistic regression presented in Table 4, lower admission NIHSS remained independently associated with a favourable 90-day outcome (aOR 0.887, 95% CI 0.800-0.984; p=0.023). Door-to-decision time also showed a borderline positive association with a favourable outcome (aOR 1.022, 95% CI 1.000-1.044; p=0.048). Models including DTD and DTI demonstrated significant overall fit, whereas the OTT model did not, suggesting that in-hospital workflow intervals were more informative than total onset-to-treatment time in this cohort. The relationship between DTD and 90-day outcome is illustrated in Figure 2, where DTD was not meaningfully associated with mRS in the favourable outcome group and showed only a weak association in the unfavourable group.

DISCUSSION

This study suggests that an MRI-first stroke pathway can be implemented with reproducible workflow times in a comprehensive stroke center while retaining the diagnostic advantage of identifying stroke mimics and transient ischemic attacks before reperfusion decisions. The most robust outcome signal was the expected inverse association between baseline NIHSS and favourable 90-day recovery [11,12,20]. Although door-to-imaging (DTI) time in our cohort was longer than in CT-first protocols, favourable 90-day outcomes were maintained, which aligns with evidence that MRI-first pathways can delay imaging acquisition without measurable impact on clinical outcomes in patients undergoing endovascular therapy [7].

Our MRI-first pathway achieved a median imaging-to-decision time of 22 minutes which is consistent with MRI-based workflow benchmarks reported in contemporary acute stroke series [13,14]. This workflow relies on stroke alert activation at emergency department triage and early mobilisation of the multidisciplinary team, enabling image interpretation at the scanner console immediately after sequence completion and maintaining timely treatment decisions despite a longer DTI than in CT-based pathways.

The association between longer door-to-decision time and favourable outcome should be interpreted cautiously. Because this was a retrospective study of a small, selected cohort of treated patients, the finding may reflect residual confounding, selective treatment of more biologically favourable cases, pathway complexity, or survivorship bias rather than any benefit from delay itself. Accordingly, the data support only an exploratory hypothesis that favourable tissue-selected patients may still achieve good outcomes despite some prolongation of in-hospital decision time in an MRI-first pathway [15,16].

In our MRI-first pathway, 20.1% of suspected hyperacute strokes were ultimately classified as stroke mimics and 14.1% as TIAs, reflecting the well-described high prevalence of

non-vascular conditions in acute 'code stroke' cohorts. The literature indicates that the most frequent mimics are seizures or postictal deficits, migraine with aura, functional (psychogenic) presentations, metabolic or toxic encephalopathies (for example hypoglycaemia), and intracranial tumours or demyelinating lesions [17,18,19]. On our Putra Acute Stroke Protocol, DWI and FLAIR are particularly useful to suggest these alternative diagnoses by demonstrating atypical lesion distribution (for example mesial temporal or pulvinar signal change in seizures, bilateral deep white matter involvement in metabolic causes, or mass-like lesions with surrounding oedema in tumours/demyelination) while MRA helps exclude an arterial occlusion compatible with the presenting deficit. Although we did not prospectively code the aetiological subtypes of all stroke mimics in this cohort, our findings are consistent with these commonly reported categories, supporting the role of a focused MRI protocol in safely identifying stroke mimics and avoiding unnecessary reperfusion therapy.

The study also illustrates the broader value of MRI-first triage in selected systems [4]. By identifying substantial numbers of stroke mimics and transient ischemic attacks before treatment, the pathway may reduce unnecessary exposure to reperfusion therapy and improve diagnostic specificity. Even so, these advantages should be weighed against resource requirements, scanner availability, and the need for tightly coordinated multidisciplinary workflows [11,12].

Limitations

This study has several limitations. It was retrospective, single-center, and involved a relatively small analytic sample, which limits generalizability and increases the risk of overfitting [16]. The large reduction from the initial screened cohort to the final analytic cohort also raises the possibility of selection bias and attrition bias. The counterintuitive association between longer door-to-decision time and better outcome may reflect residual confounding from unmeasured factors such as infarct core volume, collateral status, thrombus burden, or stroke location. In addition, complete-case analysis may have introduced bias if missing data were not random. These findings should therefore be interpreted as hypothesis-generating and require prospective external validation.

CONCLUSION

In this single-center cohort of revascularized acute ischemic stroke patients, an MRI-first pathway achieved moderate in-hospital workflow times while providing diagnostic filtering of stroke mimics and transient ischemic attacks before treatment decisions. Lower baseline NIHSS was independently associated with favourable 90-day functional outcome, whereas the observed association between longer door-to-decision time and favourable outcome should be interpreted cautiously and validated in larger prospective multicenter studies. These findings suggest that MRI-first tissue-based triage may support more selective treatment decisions in carefully chosen stroke systems, but its broader clinical value requires further confirmation.

ACKNOWLEDGEMENT

We thank the Stroke Nurses of the Regional Emergency Stroke Quick Response Center, Hospital Sultan Abdul Aziz Shah and the patients whose data contributed to this study. Padimedical System was used for cloud-based PACS access to DICOM images. Google Gemini was used for language refinement during manuscript preparation and the authors reviewed, edited and approved the final text and take full responsibility for its content.

REFERENCES:

1. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al. 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;50(12):e344–e418. doi:10.1161/STR.0000000000000211.
2. Thomalla G, Simonsen CZ, Boutitie F, Andersen G, Berthezene Y, Cheng B, et al. MRI-guided thrombolysis for stroke with unknown time of onset. N Engl J Med. 2018;379(7):611–622. doi:10.1056/NEJMoa1804355.
3. Albers GW, Marks MP, Kemp S, Christensen S, Tsai JP, Ortega-Gutierrez S, et al. Thrombectomy for stroke at 6 to 16 hours with selection by perfusion imaging. N Engl J Med. 2018;378(8):708–718. doi:10.1056/NEJMoa1713973.
4. Rapillo CM, Dunet V, Pistocchi S, Salerno A, Darioli V, Bartolini B, et al. Moving from CT to MRI paradigm in acute ischemic stroke: feasibility, effects on stroke diagnosis and long-term outcomes. Stroke. 2024;55(5):1329–1338. doi:10.1161/STROKEAHA.123.045154.
5. Wardlaw JM, Chabriat H, de Leeuw FE, Debette S, Dichgans M, Doubal F, et al. European Stroke Organisation (ESO) guideline on cerebral small vessel disease, part 2, lacunar ischaemic stroke. Eur Stroke J. 2024;9(1):5–68. doi:10.1177/23969873231219416.
6. Bonura A, Musotto G, Rossi SS, Santoro F, Pillitteri P, Sferruzzi M, et al. Cerebri: a web-app to reduce door-to-treatment decision time and improve guideline adherence in acute ischemic stroke. Stroke. 2026;57(2):371–380. doi:10.1161/STROKEAHA.125.052997.
7. Muda AS, Khafiz MFA, Yaakob MNM, Rahim EA, Mahmood MK, Noh MSFM. Putra acute stroke protocol. CVNS. 2021;3(4):23–25. doi:10.32896/cvns.v3n4.12-14.
8. Shams Vahdati S, Ala A, Sadeghi-Hokmabadi E, Ghasemi H. Evaluation of door-to-needle stroke patients with thrombolytic activation code in Imam Reza educational center in Tabriz. Int J Aging. 2024;2:e16. doi:10.34172/ija.2024.e16.
9. Kumar S. Door-to-needle time in acute ischemic stroke: impact of imaging pathway on thrombolysis workflow—a single-center audit. Kauverian Med J. 2026;3(5):1–4.
10. Bathla G, Ajmera P, Mehta PM, Benson JC, Derdeyn CP, Lanzino G, et al. Statistical considerations in stroke imaging research: moving beyond the mean. AJNR Am J Neuroradiol. 2023;44(7):750–758. doi:10.3174/ajnr.A7872.
11. Al-Salahat A, Pirahanchi Y, Dhasakeerthi T, Nayar D, Almasri S, Verma K, et al. Current state and advancements of imaging in acute ischemic stroke: a practical review. Neurol Sci. 2026;47(1):29. doi:10.1007/s10072-025-08685-8.
12. Wintermark M, Sanelli PC, Albers GW, Bello JA, Derdeyn CP, Hetts SW, et al. Imaging recommendations for acute stroke and transient ischemic attack patients: a joint statement by the American Society of Neuroradiology, the American College of Radiology and the Society of NeuroInterventional Surgery. J Am Coll Radiol. 2013;10(11):828–832. doi:10.1016/j.jacr.2013.06.019.
13. Menon BK, Campbell BCV, Levi C, Goyal M. Role of imaging in current acute ischemic stroke workflow for endovascular therapy. Stroke. 2015;46(6):1453–1461.

doi:10.1161/STROKEAHA.115.009160.
14. Sakamoto Y, Suzuki K, Abe A, Aoki J, Kanamaru T, Takayama Y, et al. Reducing door-to-reperfusion time in acute stroke endovascular therapy using magnetic resonance imaging as a screening modality. J Neurointerv Surg. 2020;12(11):1080–1084. doi:10.1136/neurintsurg-2019-015625.
15. Cuschieri S. The STROBE guidelines. Saudi J Anaesth. 2019;13(Suppl 1):S31–S34. doi:10.4103/sja.SJA_543_18.
16. Bivard A, Huang X, McElduff P, Levi CR, Campbell BCV, Cheripelli BK, et al. Impact of computed tomography perfusion imaging on the response to tenecteplase in ischemic stroke: analysis of 2 randomized controlled trials. Circulation. 2017;135(5):440–448. doi:10.1161/CIRCULATIONAHA.116.022582.
17. Miller D, et al. Reducing the mimic-rate: the impact of ultra-fast MRI on emergency department stroke alerts. Clin Radiol. 2023. doi:10.1177/17562864241303251.
18. Lansberg MG, et al. Power and sample size considerations in specialized neurovascular registries. Stroke. 2012.
19. Buck BH, Akhtar N, Alrohimi A, Khan K, Shuaib A. Stroke mimics: incidence, aetiology, clinical features and treatment. Ann Med. 2021;53(1):420–436. doi:10.1080/07853890.2021.1890205.
20. Eichel R, Ben Hur T, Gomori JM, Cohen JE, Leker RR. Use of DWI-only MR protocol for screening stroke mimics. J Neurol Sci. 2013;328(1–2):37–40. doi:10.1016/j.jns.2013.02.012.

TABLE LEGENDS:

Table 1. Baseline Characteristics and Workflow Intervals of Revascularized Acute Ischemic Stroke Patients by 90-Day Functional Outcome

Variables	90-day Functional Outcome		Total Cohort n = 59	P value
	Favourable (mRS 0-2) n = 39	Unfavourable (mRS 3-6) n = 20		
Demographic				
Age (mean (SD)), years	65 (±13)	64 (±11)	64 (±11)	0.917
Gender n (%)				0.412
Female	21 (53.8)	13 (65.0)	34 (57.6)	
Male	18 (46.2)	7 (35.0)	25 (42.4)	
Baseline Stroke Characteristics				
Baseline NIHSS (median (IQR))	8 (5-14)	15 (9-23)	12 (6-16)	0.008
Large Vessel Occlusion n (%)	24 (71.8)	16 (80.0)	40 (67.8)	0.151
Treatment Types n (%)				0.262
Intravenous Thrombolysis (IVT)	14 (35.9)	3 (15.0)	17 (28.8)	
Endovascular Thrombectomy (EVT)	18 (46.2)	13 (65.0)	31 (52.5)	
Both (IVT + EVT)	7 (17.9)	4 (20.0)	11 (18.6)	
Workflow Intervals (median (IQR)), min				
Onset-to-door (OTD)	210 (110-405)	283 (161.3-363.8)	240 (132-390)	0.442
Door-to-imaging (DTI)	45 (35-82)	45 (31.3-60.8)	45 (35-69)	0.570
Door-to-decision (DTD)	68 (55-107)	64 (45.3-93.8)	67 (50-98)	0.220
Door-to-treatment (DTN/DTP)	123 (77-202)	140 (63.8-177.0)	129 (75-179)	0.701
Onset-to-treatment (OTT)	313 (250-609)	422 (293.8-554.0)	375 (255-559)	0.625
Outcomes				
NIHSS at Discharge (median (IQR))	3 (1-9)	17 (9-21)	6 (2-16)	<0.001
Significant NIHSS Improvement, n (%)	27 (69.2)	9 (45.0)	36 (61)	0.071

Data are presented as mean & standard deviation (SD) for normally distributed continuous variables, and as median (interquartile range [IQR]) for non-normally distributed continuous variables. Categorical variables are presented as a number (%).
P-values represent comparisons between the Favourable (mRS 0-2) and Unfavourable (mRS 3-6) functional outcome groups. Continuous variables were compared using the Mann-Whitney U test. Categorical variables were compared using the Chi-square test or, where appropriate, due to small, expected cell counts, Fisher's Exact Test or the Likelihood Ratio Chi-square test. A p-value < 0.05 was considered statistically significant.

Table 2. Treatment-Specific Process and Outcome Metrics

Variables	Treatment		
	IV-tPA Only n = 17	**EVT Only n = 31**	**Combined n = 11**
Workflow Metrics (median (IQR)), min			
Onset-to-door (OTD)	150 (105-227)	340 (245-530)	196 (100-230)
Door-to-imaging (DTI)	39 (22-51)	52 (42-90)	35 (27-69)
Door-to-decision (DTD)	65 (38-89)	82 (63-127)	55 (49-90)
Door-to-needle (DTN)	79 (56-115)	NA	60 (60-119)
Door-to-puncture (DTP)	NA	171 (140-245)	165 (145-204)
Onset-to-treatment (OTT)	270 (194-303)	531 (405-720)	255 (175-315)
Treatment-Specific Outcomes			
NIHSS at 24h (Median (IQR))	3 (1-5)	NA	6 (4-18)
Significant NIHSS Improvement (≥4 points at 24hours), n (%)	15 (88.2)	NA	8 (72.7)
Successful Reperfusion (TICI 2b-3), n (%)	NA	25 (80.6)	8 (72.7)

Data are presented as median (interquartile range [IQR]) for continuous variables and as number (%) for categorical variables.
Significant NIHSS Improvement is defined as a reduction of 4 points from admission to 24 hours post-treatment. Successful Reperfusion (TICI 2b-3) indicates complete or near-complete recanalization as per the Modified Thrombolysis in Cerebral Infarction scale.

Table 3. Spearman's Rank Correlation Matrix for Workflow Intervals, Baseline NIHSS, and Clinical Outcomes

Variables	1	2	3	4	5	6	7	8
1. Onset-to-door (OTD)	1.00	0.29 *	0.13	0.29 *	0.91 *	0.09	0.23	0.10
2. Door-to-imaging (DTI)	0.29	1.00	0.80 **	0.61 **	0.49 **	0.02	0.40	-0.05
3. Door-to-decision (DTD)	0.13	0.80 **	1.00	0.54 **	0.32 **	-0.01	-0.02	-0.16
4. Door-to-treatment (DTT)	0.29 *	0.61 **	0.54 **	1.00	0.59 **	0.11	0.23	-0.11
5. Onset-to-treatment (OTT)	0.91 **	0.49 **	0.32 *	0.59 **	1.00	0.12	0.27 *	0.05
6. Baseline NIHSS	0.09	0.02	-0.01	0.11	0.12	1.00	0.46 **	0.31 *
7. NIHSS at Discharge	0.23	0.01	-0.02	0.23	0.27 *	0.46 **	1.00	0.53 **
8. mRS at 90-days	0.10	-0.05	-0.16	-0.11	0.05	0.31 *	0.53 *	1.00

*The correlation is statistically significant at the 0.05 level
**The correlation is statistically significant at the 0.01 level
Correlation coefficients (ρ) are presented. Values of (ρ) are based on a two-tailed test.

Table 4. Multivariable Logistic Regression Analysis of Factors Associated with Favourable 90-Day Functional Outcome (mRS 0-2)

Variables	Model 1: DTD		Model 2: DTI		Model 3: OTT	
	Odds Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value
Workflow Metrics						
Door-to-decision (per 1-min increase)	1.022 (1.000 - 1.048)	0.048				
Door-to-imaging (per 1-min increase)			1.022 (0.996 - 1.049)	0.099		
Onset-to-door (per 1-min increase)					1.001 (0.998 - 1.005)	0.458
Core Confounders						
Age (per 1-year increase)	1.004 (0.953 - 1.059)	0.872	1.012 (0.960 - 1.066)	0.668	1.010 (0.958 - 1.064)	0.721
NIHSS at Admission (per 1-point increase)	0.887 (0.800 - 0.984)	0.023	0.891 (0.806 - 0.986)	0.026	0.895 (0.814 - 0.984)	0.022
LVO Status (Present vs. Absent)	1.400 (0.055 - 35.862)	0.839	1.373 (0.051 - 36.890)	0.850	1.543 (0.060 - 39.846)	0.794
Treatment Type						
EVT Only (vs. IVT Only)	0.211 (0.005 - 8.154)	0.404	0.254 (0.006 - 9.936)	0.464	0.290 (0.007 - 11.358)	0.508
Combined (vs. IVT Only)	0.532 (0.022 - 12.939)	0.698	0.555 (0.022 - 14.179)	0.722	0.579 (0.023 - 14.337)	0.739

***Note*:** aOR, adjusted odds ratio; CI, confidence interval. All models were adjusted for age, baseline NIHSS, LVO status, and treatment type. Model calibration was confirmed by Hosmer-Lemeshow tests (all $p > 0.05$) and multicollinearity was negligible (all VIF < 1.5).

FIGURE LEGEND:

FIGURE 1

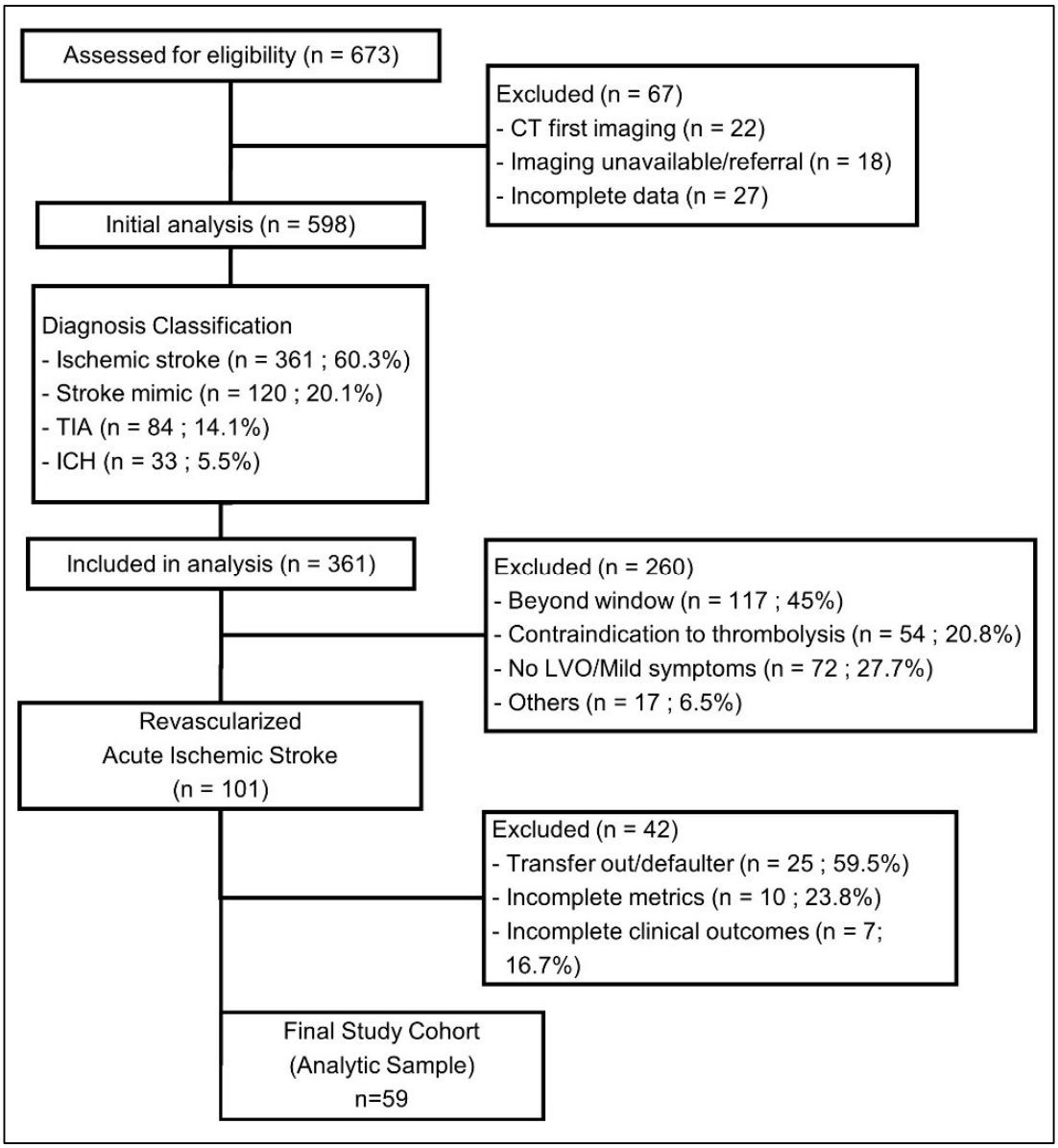

Figure 1. **Flow Diagram of Patient Selection for the Study.** TIA indicates transient ischemic attack; ICH, intracranial hemorrhage; LVO, large vessel occlusion.

FIGURE 2

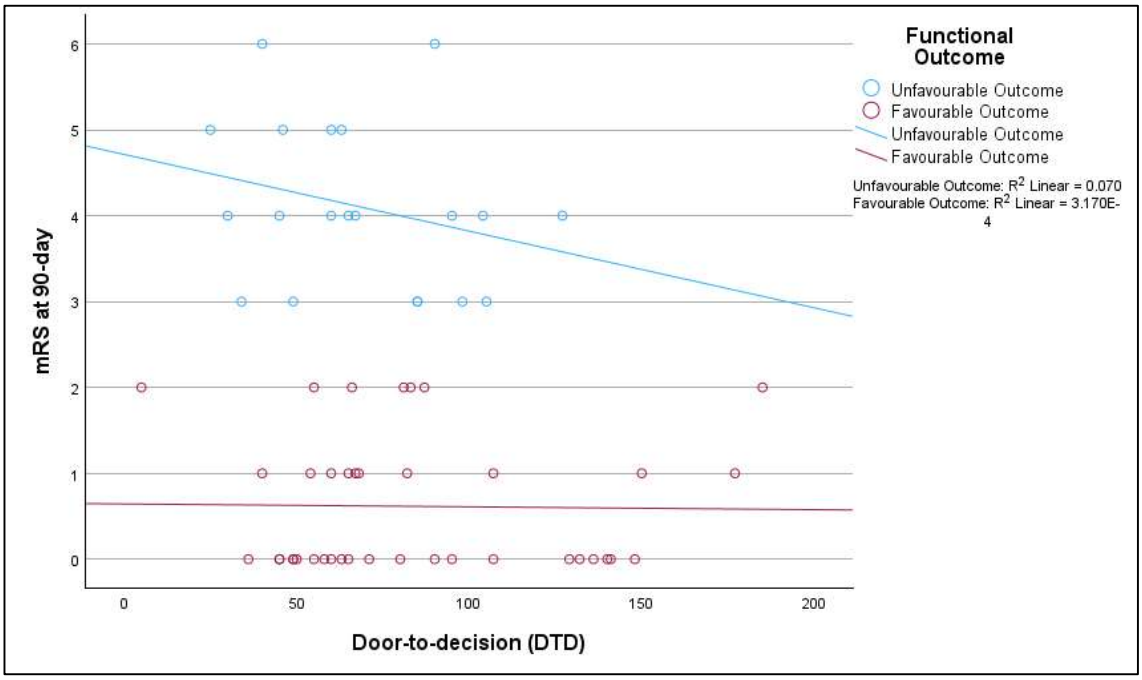

Figure 2. Scatter plot of 90-day modified Rankin Scale (mRS) scores against Door-to-Decision (DTD) time. Linear regression lines are stratified by outcome group (Red: Favourable, mRS 0–2; Blue: Unfavourable, mRS 3–6). The stability of the favourable outcome group across the temporal spectrum highlights the safety of the deliberate diagnostic window afforded by the MRI-first pathway.