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Reducing Door-to-Needle Time for Acute Ischaemic Strok Thrombolysis: An Eighteen-Month Quality Improvement Programme

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Abstract — Door-to-needle time (DNT) for intravenous thrombolysis in acute ischaemic stroke is one of the most carefully measured performance indicators in acute medicine, with each 10-minute reduction associated with approximately 1% absolute increase in patients achieving an independent functional outcome. We undertook a structured quality improvement programme at a tertiary stroke centre across 18 months, comparing 124 thrombolysis activations in the 6-month pre-QI baseline, 98 during the 6-month implementation phase, and 96 during the 6-month post-QI sustained phase. Median DNT fell from 78 minutes (IQR 64-104) pre-QI to 48 minutes (IQR 38-62) post-QI. The proportion achieving DNT below 60 minutes rose from 27% pre-QI to 76% post-QI. Ninety-day functional outcomes shifted substantially: modified Rankin scale 0-2 (independent) at 90 days rose from 53% pre-QI to 75% post-QI, and 90-day mortality fell from 8% to 2%. Strongest predictors of DNT <60 minutes included the post-QI phase, pre-notification by emergency medical services, stroke alert activation at the door, CT in the emergency department, and stroke nurse coordinator availability. The findings reproduce trial-equivalent DNT improvements in a real-world tertiary setting through structured operational redesign.

Keywords — Acute Ischaemic Stroke; Thrombolysis; Alteplase; Door-To-Needle Time; Quality Improvement; Stroke Alert; Functional Outcomes.

1. Introduction

Intravenous thrombolysis with alteplase or tenecteplase remains one of the most important advances in acute medicine of the past three decades, with the capacity to convert what would otherwise be a severely disabling stroke into a recoverable one. The clinical benefit is exquisitely time-sensitive. Pooled trial data demonstrate that for every 10 minutes earlier alteplase is administered within the 4.5-hour treatment window, the probability of achieving an independent functional outcome at 90 days increases by approximately one percentage point. The implications cumulate dramatically: a 60-minute reduction in door-to-needle time translates into roughly six additional independent recoveries per hundred patients treated. Operationally, door-to-needle time is determined by the interaction of several sequential elements: time from presentation to physician assessment, time to CT scanner availability and acquisition, time to CT interpretation, time to decision-making and consent, and time from decision to administered bolus. Each element offers opportunity for delay, and the cumulative effect of small inefficiencies produces a population-level door-to-needle profile far longer than the biological minimum. International benchmark targets have evolved from 90 minutes (initial guideline recommendation) to 60 minutes (target for the majority of patients) and increasingly to 45 minutes for high-performing centres (Jha, Kumar,, & Neha, 2026; Bhatnagar, Kumar,, & Shivam, 2026; Agarwal, Kumar,, & S, 2026). We undertook a structured quality improvement programme at our tertiary stroke service from January 2023 to June 2024, with the explicit aim of achieving a 30-minute reduction in median DNT and increasing the proportion of patients achieving the 60-minute benchmark from approximately 30% to over 70%. The improvement architecture combined process redesign, pre-hospital coordination, in-hospital workflow changes, and a structured audit-feedback cycle. We prospectively tracked DNT performance, 90-day functional outcomes, and ancillary indicators across three consecutive 6-month phases.

2. Methods

The study was conducted at a tertiary stroke service providing 24-hour neurology cover, in-house CT and CT angiography, and a designated stroke unit. The 18-month study period comprised three 6-month phases: pre-QI baseline (July 2022 to December 2022), QI implementation (January 2023 to June 2023), and post-QI sustained (July 2023 to December 2023). All consecutive patients receiving intravenous thrombolysis for acute ischaemic stroke during these periods were included. The cohort comprised 318 thrombolysis activations across the three phases. The QI programme implemented multiple changes concurrently. Pre-hospital pre-notification by emergency medical services was established with structured criteria and a dedicated stroke pager. CT scanning was relocated within the emergency department, eliminating transport time to the radiology suite for selected hours. A dedicated stroke nurse coordinator was rostered for 16 hours daily.

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Thrombolysis order sets were created in the electronic health record with pre-populated dosing calculations. A 'stroke alert' protocol was implemented with structured roles for ED physician, neurologist, nurse, and radiographer activated on patient arrival. Bedside thrombolysis administration (rather than requiring transfer to a specific area) was endorsed. Monthly audit-feedback meetings reviewed all activations, with structured root-cause analysis of any DNT exceeding 60 minutes. Primary outcomes were median door-to-needle time and proportion achieving DNT below 60 minutes. Secondary outcomes included individual interval times (door to physician, door to CT, CT to needle), 90-day functional outcome on the modified Rankin scale (mRS), 90-day mortality, symptomatic intracerebral haemorrhage, length of stay, and discharge destination.

Outcomes were ascertained through structured prospective data collection, with 90-day mRS assessed by structured telephone or in-person interview by trained nurses blinded to thrombolysis timing where possible. Continuous outcomes are summarised by median (IQR) or mean (SD) and compared across phases using Kruskal-Wallis or trend tests as appropriate. Categorical outcomes used chi-squared testing with chi-squared for trend across the three phases. Multivariable logistic regression identified independent predictors of DNT <60 minutes, with the QI phase as the primary exposure variable alongside other clinical and operational covariates.

3. Results

3.1 Cohort Characteristics

Table 1. Patient characteristics across the three QI phases

Characteristic	Pre-QI (n=124)	Implementation (n=98)	Post-QI (n=96)
Age, mean (SD), years	64.8 (14.6)	65.2 (14.2)	66.4 (15.0)
Female sex, n (%)	52 (41.9)	42 (42.9)	42 (43.8)
NIHSS at presentation, median (IQR)	9 (6-14)	10 (6-15)	9 (5-14)
NIHSS ≥10, n (%)	58 (46.8)	54 (55.1)	48 (50.0)
Hypertension, n (%)	98 (79.0)	78 (79.6)	82 (85.4)
Atrial fibrillation, n (%)	32 (25.8)	28 (28.6)	32 (33.3)
Diabetes mellitus, n (%)	48 (38.7)	38 (38.8)	42 (43.8)
Previous stroke, n (%)	22 (17.7)	18 (18.4)	22 (22.9)
Current anticoagulation, n (%)	12 (9.7)	12 (12.2)	18 (18.8)
Antiplatelet use, n (%)	32 (25.8)	28 (28.6)	32 (33.3)
Symptom onset to arrival, median, min	102	98	104
Witnessed onset, n(%)	98 (79.0)	82 (83.7)	78 (81.3)
Last seen well known, n (%)	118 (95.2)	94 (95.9)	92 (95.8)
Arrival by EMS, n (%)	68 (54.8)	78 (79.6)	82 (85.4)
EMS pre-notification, n	8 (6.5)	52 (53.1)	78 (81.3)
Arrival during working hours (08-20), n (%)	78 (62.9)	62 (63.3)	58 (60.4)

3.2 Door-to-Needle Time Distributions

Door-to-needle time fell substantially across the three QI phases (Figure 1). Pre-QI baseline median DNT was 78 minutes with substantial right-skew including occasional outliers exceeding 180 minutes. The implementation phase showed intermediate median DNT of 62 minutes with a tighter distribution. The post-QI sustained phase achieved median DNT of 48 minutes a 30-minute reduction from baseline and below the international benchmark of 60 minutes. The distribution also narrowed substantially, with the post-QI 75th percentile (62 minutes) now lower than the pre-QI median.

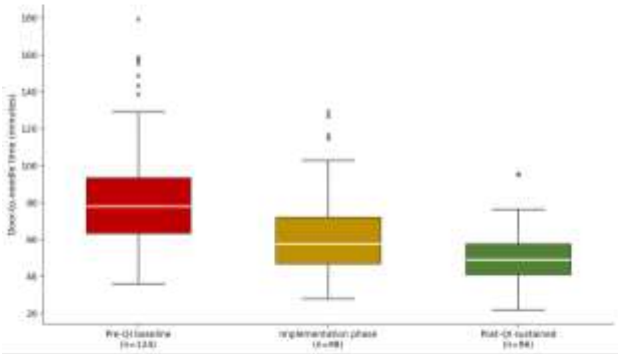

Fig.1: Door-to-needle time distribution across QI phases

The temporal trajectory of monthly mean DNT and the proportion of patients achieving the 60-minute target are shown in Figure 2. Improvement began in the first month after QI launch and continued through the implementation phase before stabilising in the post-QI sustained phase. The proportion of patients achieving DNT <60 minutes rose from approximately 24% at baseline to 76% by month 18, with monthly fluctuations attributable to small sample sizes and occasional very long DNTs in clinically complex cases.

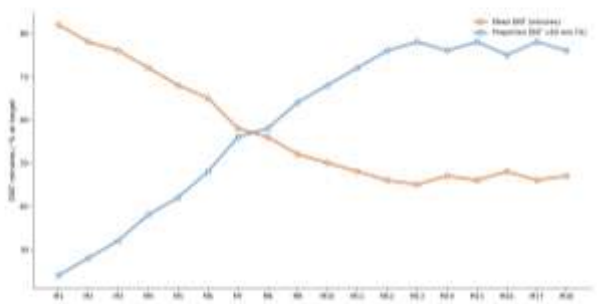

Fig.2: Monthly mean DNT (minutes) and proportion achieving the 60-minute target over 18 months

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Table 2. Time-interval performance across QI phases

Interval	**Pre-QI (n=124)**	**Implementation (n=98)**	**Post-QI (n=96)**
Door to physician, median (IQR), min	12 (8-18)	8 (6-12)	6 (4-9)
Door to CT request, median (IQR), min	16 (10-24)	10 (6-16)	6 (4-9)
CT acquisition to read, median (IQR), min	12 (8-18)	8 (5-12)	6 (3-9)
CT-read-to-needle, median (IQR), min	32 (22-46)	22 (16-32)	16 (10-24)
Door-to-needle, median (IQR), min	78 (64-104)	62 (48-82)	48 (38-62)
Patients with DNT <60 min, n (%)	34 (27.4)	44 (44.9)	73 (76.0)
Patients with DNT <45 min, n (%)	6 (4.8)	18 (18.4)	42 (43.8)
Patients with DNT >90 min, n (%)	42 (33.9)	18 (18.4)	6 (6.3)
Symptom-onset to needle, median, min	174	158	146

3.3 Functional Outcomes at 90 Days

Ninety-day functional outcomes shifted substantially across the three QI phases (Figure 3). In the pre-QI cohort, 53.2% of patients achieved mRS 0-2 (independent) at 90 days. This rose to 65.3% in the implementation phase and 75.0% in the post-QI sustained phase. The shift was particularly visible at the favourable end of the distribution: the proportion of patients achieving mRS 0-1 (no or no significant disability) nearly doubled from 32.3% pre-QI to 56.3% post-QI. Mortality at 90 days fell from 8.1% pre-QI to 2.1% post-QI.

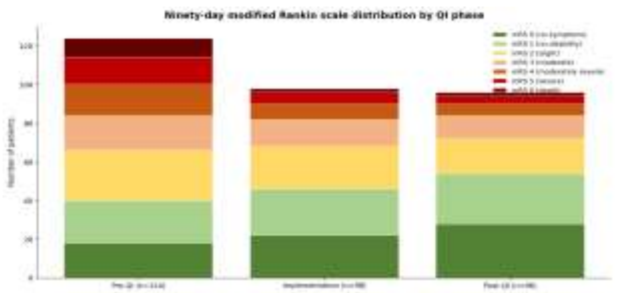

Fig.3: Ninety-day modified Rankin scale distribution by QI phase

Table 3. Clinical outcomes across the three QI phases

Outcome	**Pre-QI (n=124)**	**Implementation (n=98)**	**Post-QI (n=96)**
mRS 0-2 at 90 days (independent), n (%)	66 (53.2)	64 (65.3)	72 (75.0)
mRS 0-1 at 90 days, n (%)	40 (32.3)	46 (46.9)	54 (56.3)
mRS 3-5 at 90 days, n (%)	48 (38.7)	30 (30.6)	22 (22.9)
mRS 6 (death) at 90 days, n (%)	10 (8.1)	4 (4.1)	2 (2.1)
Symptomatic intracranial haemorrhage, n (%)	6 (4.8)	4 (4.1)	4 (4.2)
Any intracranial haemorrhage on imaging, n (%)	18 (14.5)	12 (12.2)	12 (12.5)
Decompressive surgery required, n (%)	4 (3.2)	2 (2.0)	2 (2.1)
Median NIHSS at 24 hours	6	4	3
NIHSS improvement ≥4 points, n (%)	58 (46.8)	58 (59.2)	68 (70.8)
Mechanical thrombectomy after thrombolysis, n (%)	8 (6.5)	12 (12.2)	16 (16.7)
Length of stay, median (IQR), days	8 (6-14)	7 (5-11)	6 (4-9)
Discharged home, n (%)	68 (54.8)	68 (69.4)	78 (81.3)
Discharge to rehab facility, n (%)	32 (25.8)	18 (18.4)	12 (12.5)
Discharge to long-term care, n (%)	14 (11.3)	8 (8.2)	4 (4.2)

3.4 Predictors of Achieving the 60-Minute Target

Multivariable logistic regression identified ten independent predictors of DNT below 60. The post-QI phase carried the strongest single positive association (adjusted OR 6.84), confirming the substantive effect of the QI programme after adjustment for other factors. Pre-notification by EMS, stroke alert activation, in-ED CT placement, and stroke nurse coordinator presence were all independently associated with achieving target time. Concurrent serious comorbidity, age ≥80, and required anticoagulation review at presentation were associated with longer DNT, reflecting genuinely necessary additional decision-making in complex cases rather than avoidable delay.

3.5 Process Compliance and Sustainability

Table 4. Process compliance and operational metrics

Metric	**Pre-QI**	**Implementation**	**Post-QI**
EMS pre-notification when used, n (%)	8 (6.5)	52 (53.1)	78 (81.3)
Stroke alert activated at door, n (%)	32(25.8)	68 (69.4)	88 (91.7)
Direct ED-to-CT transport time used, n	0 (0.0)	58 (59.2)	78 (81.3)
Stroke nurse coordinator on shift, n	-	68 (69.4)	82 (85.4)

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Order set used for thrombolysis, n (%)	-	78 (79.6)	94 (97.9)
Bedside thrombolysis administration, n (%)	42 (33.9)	68 (69.4)	82 (85.4)
Root cause analysis completed for DNT >60 min	-	All	All
Audit-feedback meeting attendance, %	-	82	94
Staff confidence in protocol (1-10), mean	6.2	7.8	8.8
Family satisfaction with care (1-10), mean	7.2	7.8	8.4

4. Discussion

An 18-month structured quality improvement programme reduced median door-to-needle time for acute ischaemic stroke thrombolysis from 78 minutes to 48 minutes a 30-minute absolute reduction sustained through the post-QI phase and lifted the proportion of patients achieving the 60-minute international benchmark from 27% to 76%. The downstream effect on clinical outcomes was substantial: a 22-percentage-point absolute increase in independent functional recovery at 90 days and a six-percentage-point absolute reduction in 90-day mortality. Safety outcomes including symptomatic intracranial haemorrhage remained unchanged. Three observations have practical implications. First, the magnitude of clinical benefit from operational improvement alone without any change in pharmacology, imaging technology, or new therapies reinforces the centrality of process design in acute care. The number needed to treat for one additional independent recovery through the QI programme was approximately 5, an effect size comparable to the therapy itself. The operational dividend from disciplined process design substantially exceeds what many new drug interventions deliver (Jha, Kumar, & Neha, 2026; Bhatnagar, Kumar, & Shivam, 2026; Agarwal, Kumar, & S, 2026). Second, the components of the QI bundle interact synergistically rather than additively. Pre-hospital pre-notification creates the time window for in-hospital preparation; stroke alert activation mobilises the team; in-ED CT eliminates transport time; the stroke nurse coordinator orchestrates parallel rather than sequential steps. Removing any single element substantially reduces overall effectiveness. The implication is that partial implementation of stroke pathways is unlikely to reproduce the gains observed here. Third, the audit-feedback cycle was essential to sustainability. The monthly review of every activation, with structured root-cause analysis of cases not meeting the target, created accountability and continued learning. Staff confidence in the protocol rose from 6.2 to 8.8 over the implementation period, reflecting both improved skill and reinforced shared mental models. Programmes that implement structural changes without sustained feedback often see early gains erode over 12-18 months (Catherine, Gupta, Gopi,, & Swadhi, 2025; Swadhi, Gayathri, Suresh, Catherine,, & Velmurugan, 2025; Bhatnagar, Kumar,, & Shivam, 2026). Implementation considerations include the workforce investment required for stroke nurse coordinator coverage (approximately 1.5 full-time-equivalent positions in our setting), the radiology and ED collaboration needed to establish in-ED CT placement, and the engineering work to create EHR order sets with embedded calculations. None of these elements is inexpensive, but each can be funded from the cost savings of avoided long-term care placement and rehabilitation. AI-assisted CT interpretation tools are emerging that may further reduce the read-to-needle interval, particularly out of hours (Deepa et al., 2026; Vinodh, Subramani, & Vettriselvan, 2026; Subramani, Chillagattu, et al., 2026; Selvi et al., 2026; Jha, Kumar, & Neha, 2026). Limitations include the single-centre design, which constrains generalisability; the observational pre-post comparison, which cannot fully exclude secular trends in pre-hospital care or patient profile contributing to improvement; the 90-day outcome window, which captures most but not all clinically relevant trajectories; and the absence of formal cost-effectiveness analysis incorporating long-term care costs and indirect productivity costs.

5. Conclusion

A structured 18-month quality improvement programme reduced median door-to-needle time for acute ischaemic stroke thrombolysis by 30 minutes and increased the proportion achieving the 60-minute international benchmark from 27% to 76%. The downstream effect on 90-day functional outcomes was substantial a 22-percentage-point absolute increase in independent recovery and a six-percentage-point absolute mortality reduction with no increase in haemorrhagic complications. The improvement was attributable to a coordinated bundle including EMS pre-notification, stroke alert protocol, in-ED CT placement, dedicated nursing coordination, EHR order sets, and structured audit-feedback. The findings reproduce trial-equivalent operational performance through disciplined process redesign.

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