

Association Between Artificial Intelligence Stroke Imaging Software Implementation and Increased Access to Endovascular Thrombectomy in Acute Ischaemic Stroke: A National Observational Study

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Abstract

Endovascular thrombectomy is now recognized as the primary therapeutic approach for individuals presenting with ischaemic stroke caused by large vessel occlusion. Imaging software powered by artificial intelligence (AI) is gaining wider application to improve the detection and triage of suitable candidates for this procedure. This investigation examined the influence of AI stroke-imaging tools on the provision of endovascular therapy in England. We used a prospective observational design, drawing on information collected from stroke services across England's National Health Service (NHS). Records for all patients aged 16 years or older admitted to NHS hospitals with a principal diagnosis of stroke were sourced from the national stroke registry, Sentinel Stroke National Audit Programme (SSNAP). We monitored endovascular thrombectomy utilization and interhospital transfer intervals through SSNAP at all 107 NHS hospitals handling acute stroke cases in England between 1 January 2019 and 31 December 2023. We assessed these indicators before and after the organized rollout of AI stroke software (Brainomix 360 Stroke) at 26 participating hospitals (six comprehensive stroke centers and 20 primary stroke centers; hereafter referred to as evaluation sites). We compiled aggregate hospital data for all institutions, while restricting detailed patient-level information to the evaluation sites. The principal measure was the percentage of stroke patients treated with endovascular thrombectomy. We compared treatment rate changes between individuals whose imaging was analyzed with AI assistance and those evaluated without such technology. During the study period from 1 January 2019 to 31 December 2023, 452 952 stroke patients were admitted to 107 hospitals. Patient-specific data were obtainable for 71 017 cases of ischaemic stroke admitted to the 26 evaluation sites. At these sites, endovascular thrombectomy was performed in 2.3% of patients (376 of 15 969) before implementation, rising to 4.6% (751 of 15 428) afterward—an exact doubling (100% relative increase). Non-evaluation sites showed an increase from 1.6% (1431 of 88 712) to 2.6% (2410 of 89 900), representing a 62.5% relative rise (odds ratio [OR] for site-by-time interaction 1.24 [95% CI: 1.08–1.43]; $P = 0.0026$). Patient-level analysis showed that AI software use was independently associated with higher odds of receiving endovascular thrombectomy (OR: 1.57 [95% CI: 1.33–1.86]; $P < 0.0001$) than standard care without AI support. To our knowledge, this investigation constitutes the largest prospective assessment of AI technology's influence on clinical outcomes in stroke care. The results show a beneficial impact of AI imaging support on access to endovascular thrombectomy and reinforce current guideline recommendations to incorporate such software into routine stroke pathways.

Keywords: Artificial Intelligence, Acute ischaemic stroke, Endovascular thrombectomy, Stroke imaging, Large vessel occlusion, Stroke care pathways

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Introduction

Patients with ischaemic stroke attributable to large vessel occlusion benefit substantially from reperfusion achieved through endovascular thrombectomy, whether used in isolation or combined with intravenous thrombolysis. This intervention can preserve threatened brain tissue, curtail infarct progression, and substantially decrease the

extent of permanent disability [1-3]. In England, the majority—nearly three-quarters—of stroke patients first attend their nearest hospital capable of intravenous thrombolysis, most frequently a primary stroke center [4]. These centers perform initial assessment, standard cross-sectional imaging (usually non-contrast CT with CT angiography), and thrombolytic treatment when indicated. However, they typically do not maintain the specialized neuroradiology or neurointerventional services required for endovascular thrombectomy, which remains confined to comprehensive stroke centers. Swift identification of large vessel occlusion is therefore vital to streamline decision-making and enable rapid transfer to facilities equipped to deliver this advanced therapy.

Research in context

Evidence before this study

Software based on artificial intelligence (AI) is increasingly applied to enhance the reading of emergency stroke CT scans and to support the selection of patients who qualify for advanced reperfusion treatments, including endovascular thrombectomy. Earlier retrospective analyses have established the independent reliability of these systems, frequently by direct comparison with specialist neuroradiologist interpretations, and have also documented improvements in clinician accuracy when the software is available. Nevertheless, robust prospective studies exploring the practical consequences of such tools on actual endovascular thrombectomy delivery rates are relatively scarce and have mostly been limited to individual institutions or regional networks. No systematic literature review was undertaken before launching the present study.

Added value of this study

This work provides what is believed to be the most extensive real-world evaluation of stroke AI imaging software performed to date. It is the first study to analyze country-wide data from England, involving systematic implementation of the technology across four separate stroke networks that together included 26 hospitals over a full five-year span. The analysis focused on the software's effects on critical clinical endpoints, including rates of endovascular thrombectomy and intravenous thrombolysis, transfer efficiency between hospitals, and patient outcomes, including disability and survival.

Implications of all the available evidence

This research strengthens the case for the broad applicability of prior results showing that AI-based imaging tools can expand access to urgent stroke therapies and shorten door-to-door-to-out intervals at primary stroke centers, specifically the time from patient arrival to departure for endovascular thrombectomy at a specialized facility. These findings align with current guideline recommendations endorsing the routine use of AI imaging software in assessing stroke patients.

Prolonged delays in patient recognition and subsequent transfer are known to worsen clinical prognosis or render individuals ineligible for effective interventions [5, 6]. The UK's 2024 Annual Report from the Sentinel Stroke National Audit Program (SSNAP) reported a national endovascular thrombectomy rate of 3.9%, which falls short of the European average and is considerably lower than the estimated 15% of patients who may be suitable candidates. The same report drew attention to ongoing difficulties in delivering timely specialized care, with just 46.7% of stroke patients admitted to a dedicated stroke unit within 4 hours of hospital presentation [7]. Refining stroke care processes has been shown to increase treatment rates and shorten the interval between symptom onset and therapy, thereby improving clinical outcomes [8, 9]. Referral speed from primary stroke centers to comprehensive stroke centers is typically evaluated using door-to-door time, which measures the interval between arrival at the primary center and transfer onward. Yet, numerous primary stroke centers lack immediate access to expert neuroradiologists for image analysis, frequently causing missed opportunities or postponed transfers for patients with large vessel occlusion.

Stroke guidelines in the UK [10] and the USA [11] promote integrating artificial intelligence (AI) decision-support systems for imaging, as these have shown benefits in improving case identification and reducing decision-making time for endovascular thrombectomy [12, 13]. The pathways through which such software enhances treatment delivery and operational performance are multifaceted. They encompass greater certainty in recognizing and measuring ischaemic changes on non-contrast CT scans [12-14], accurate detection of large vessel occlusion via CT angiography [15, 16], and facilitation of post-processing for CT perfusion or MRI data [12, 13, 17, 18].

The current study conducted a real-world assessment to examine whether AI software could increase utilization of mechanical thrombectomy, as reflected in elevated

treatment rates. Specific aims included determining the consequences of implementing stroke AI software on reperfusion therapy delivery (including endovascular thrombectomy and intravenous thrombolysis) and on door-to-door times. The analysis also explored effects at the individual patient level.

Materials and Methods

Study design and participants

This prospective observational investigation evaluated the practical clinical consequences of AI imaging software deployment across stroke units in England's National Health Service (NHS). Information was sourced from the national stroke audit registry (SSNAP at King's College London, London, UK).

The evaluation covered a 5-year window from 1 January 2019 to 31 December 2023. This interval included phases before, during, and after the introduction of AI software at 26 hospitals (20 primary stroke centers and 6 comprehensive stroke centers, termed evaluation sites) across four regional thrombectomy networks in England. We introduced Brainomix 360 Stroke software prospectively for this assessment. Sites were selected to capture varied stroke network configurations in both rural and metropolitan environments. Nationwide data from all remaining NHS stroke services in England, excluding the evaluation sites, served as the comparator group (81 non-evaluation sites).

The pre-implementation phase—during which no evaluation sites used AI software—ran from 1 January 2019 to 29 February 2020. The post-implementation phase—when all evaluation sites used the software—ran from 1 January 2022 to 28 February 2023.

Prospective data collection was conducted at NHS sites in England through the SSNAP registry. In July 2021, SSNAP added a patient-level field to indicate whether AI software supported the review of acute brain imaging. This indicator was available to patients at evaluation sites, enabling comparison of outcomes between cases managed with AI and those without it.

Pseudonymized clinical records for the period 1 January 2019 to 31 December 2023 were obtained from the national SSNAP database. This database covers all patients aged 16 years or older admitted to NHS hospitals with a primary stroke diagnosis. Comprehensive patient-level information was available only for those treated at the 26 evaluation sites. Hospital-level aggregates were available for non-evaluation sites across the same timeframe. We did not record individual clinical and

demographic characteristics for patients from non-evaluation sites. Gender data followed SSNAP conventions and were classified as male, female, or indeterminate.

Operating as a compulsory national quality improvement audit and disease registry, SSNAP acquires pseudonymized patient data without requiring individual consent, pursuant to Section 251 approval from the UK Health Research Authority's Confidentiality Advisory Group. Secure data handling and controlled access for healthcare advancement and research are managed under the Healthcare Quality Improvement Partnership (HQIP; co-controller with NHS England). Approval for use of the pseudonymized dataset was granted by the independent Data Access Review Group of the HQIP, which oversees SSNAP on behalf of NHS England. No separate ethics approval was required for data collection or quality improvement. All analyses were executed independently by the designated evaluation organization (Health Innovation Oxford and Thames Valley, Oxford, UK) and collaborating clinical researchers with no ties to the technology manufacturer (Brainomix, Oxford, UK), and reporting conformed to the STROBE guidelines.

Imaging

Each participating hospital maintained its own imaging protocols for suspected stroke cases, which ordinarily featured non-contrast CT scans of the brain supplemented by craniocervical CT angiography. Brain CT perfusion studies were performed chiefly at comprehensive stroke centers. Access to hyperacute MRI brain scans was limited and largely confined to comprehensive stroke centers. Upon software installation, imaging settings were adjusted to transmit optimized reconstructions to the dedicated processing server in compliance with manufacturer standards. Standard image reconstructions continued to be directed to the local radiology viewing system as determined by each hospital.

The evaluation employed the Brainomix 360 Stroke AI platform (version 10 or 11, with scheduled upgrades implemented in accordance with manufacturer guidelines; Brainomix, Oxford, UK). This included the e-ASPECTS, e-CTA, and e-CTP components. The system automatically evaluated non-contrast CT, craniocervical CT angiography, and CT perfusion imaging obtained from patients undergoing assessment for suspected acute stroke immediately upon image acquisition.

Outcomes and statistical analysis

The principal outcome measure was the fraction of admitted stroke patients who received endovascular thrombectomy. Monthly rates were determined for both evaluation and non-evaluation sites by dividing the number of thrombectomy procedures by the total stroke patient volume recorded in the SSNAP registry for each site (including patients with intracerebral hemorrhage to align with established SSNAP reporting practices).

Thrombectomy rates were additionally computed for the defined pre-implementation and post-implementation periods at evaluation and non-evaluation sites. Logistic regression models were constructed to evaluate the separate and combined effects of site type (evaluation versus non-evaluation) and temporal phase (pre-implementation versus post-implementation) on endovascular thrombectomy delivery.

Following the software rollout (from 1 January 2022 onward), patient-level data from evaluation sites were stratified by whether AI software had supported imaging review. Multivariate logistic regression quantified the independent contribution of AI software application to the probability of undergoing endovascular thrombectomy. We adjusted for clinically pertinent factors: patient age, gender, pre-stroke modified Rankin Scale (mRS) score, admission National Institutes of Health Stroke Scale (NIHSS) score, arrival timing, day/month/year of presentation, hospital site, and receipt of intravenous thrombolysis. Odds ratios (ORs) accompanied by 95% confidence intervals are displayed for all covariates. Model performance was summarised using McFadden's pseudo- R^2 and the area under the receiver operating characteristic curve as suitable measures.

Supplementary analyses repeated the thrombectomy regression separately within primary stroke center and comprehensive stroke center cohorts. Propensity score weighting was used as a sensitivity analysis to mitigate potential confounding.

Secondary measures included door-in and door-out times for patients transferred from primary stroke centers to comprehensive stroke centers for thrombectomy, rates of intravenous thrombolysis, and functional status at hospital discharge, as indicated by the mRS.

Door-to-door-out duration was computed as the interval between the patient's arrival at the primary stroke center and subsequent departure for transfer. We assessed

differences in these times across AI software utilization groups using the Mann–Whitney test. Multivariate linear regression evaluated the association between AI software use and door-to-door-out time, using the same set of adjustment variables as in the thrombectomy models.

Intravenous thrombolysis rates were examined at evaluation and non-evaluation sites using parallel statistical methods to those applied for thrombectomy. Logistic regression tested the impact of site category and time period on thrombolysis administration. We explored patient-level associations after software implementation (post-1 January 2022 at evaluation sites) using multivariate logistic regression, comparing AI-assisted and non-assisted cases and including the same clinical covariates.

Links between AI software applications and clinical outcomes were investigated using discharge mRS scores. Although SSNAP records 6-month mRS values, incomplete capture (22.6%) rendered this impractical as an outcome. Therefore, we analyzed discharge mRS data from the post-implementation period using the Cochran–Mantel–Haenszel method. Dichotomized mRS categories were also examined for associations with favorable recovery (mRS scores 0–2) and death (mRS score 6) using χ^2 tests and multivariate logistic regression, consistent with the thrombectomy analysis approach.

All statistical procedures were executed in R (version 4.4.0) using RStudio (version 2024.04.0).

Role of the funding source

The study funders played no part in the study design, data acquisition, statistical analysis, interpretation of findings, or drafting of this report.

Results and Discussion

The hospital-level SSNAP records documented 452 952 stroke admissions across 107 hospitals in England from 1 January 2019 to 31 December 2023. Patient-specific data were obtainable for 71 017 individuals diagnosed with ischaemic stroke who presented to the evaluation sites. **Table 1** presents a comparison of baseline demographic and clinical features between those whose imaging benefited from decision-support software and those who did not. These variables had a completeness rate of 97%.

Table 1. Baseline demographic and clinical features of patients with ischaemic stroke at evaluation sites

Parameter	Overall (n = 71,017)	After AI implementation (n = 28,670)		P-value*
		– Patients reviewed with AI support (n = 15,377)	– Patients reviewed without AI support (n = 13,293)	
Median age, years†	75–79	75–79	75–79	..
Gender				<0.033
Female	33,323(46.9%)	7,051 (45.9%)	6,264 (47.1%)	..
Male	37,694(53.1%)	8,326 (54.1%)	7,029 (52.9%)	..
Median premorbid mRS score	1 (0–2)	0 (0–2)	1 (0–2)	<0.0001
Median onset-to-admission time, h*	12–16	12–16	12–16	..
Median NIHSS score at presentation	4 (2–9)	5 (2–10)	4 (2–8)	<0.0001

Values are expressed as median bin, n (%), or median (IQR). AI=artificial intelligence. mRS = modified Rankin Scale. NIHSS = National Institutes of Health Stroke Scale.

* P-values reflect statistical comparisons between the with-AI and without-AI groups.

† Age and onset-to-admission intervals were categorized rather than recorded as continuous values; hence, median categories are reported, and IQR values cannot be derived for these measures.

Among the 28670 patients admitted to evaluation sites after 1 January 2022 (once AI software had been introduced), imaging review incorporated AI support in 15 377 cases (53.6%), while 13 293 cases (46.4%) proceeded without it (**Table 1**).

Figure 1 depicts overall endovascular thrombectomy utilization rates at evaluation and non-evaluation sites throughout the study. Evaluation sites recorded a pre-implementation rate of 2.3% (376 out of 15 969 patients), which rose to 4.6% (751 out of 15 428 patients) after implementation, equating to a 100% relative increase. Non-evaluation sites showed a change from 1.6% (1431

out of 88 712 patients) to 2.6% (2410 out of 89 900 patients), a 62.5% relative increase. Logistic regression showed significantly higher odds of thrombectomy at evaluation sites than at non-evaluation sites (OR: 1.46 [95% CI: 1.30–1.64]; $P < 0.0001$) and in the post-implementation phase than in the pre-implementation phase (OR: 1.66 [1.56–1.78]; $P < 0.0001$). A notable interaction term between site type and time period emerged (OR: 1.24 [1.08–1.43]; $P = 0.0026$), confirming a greater relative improvement at evaluation sites. The model achieved an area under the curve of 0.59.

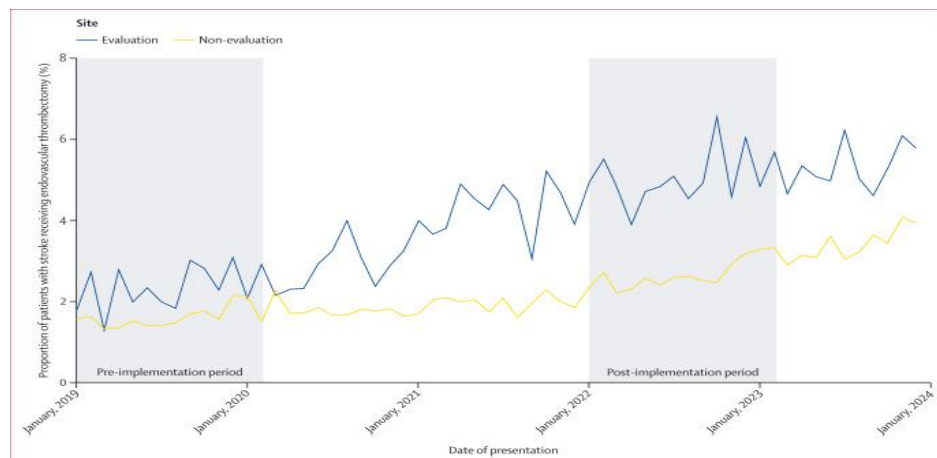


Figure 1. Monthly endovascular thrombectomy rates at evaluation and non-evaluation sites for all patients admitted with a primary diagnosis of stroke in English hospitals.

Consistent with earlier descriptions, evaluation sites had zero AI software utilization in the pre-implementation

window and complete adoption in the post-implementation window (progressing from 0% to 100%).

In contrast, among the 81 non-evaluation sites, 5 (6%) had introduced AI software (Brainomix 360 Stroke or comparable systems) by the conclusion of the pre-implementation period, expanding to 56 (69%) by the end of the post-implementation period.

Figure 2 shows post-implementation monthly trends in endovascular thrombectomy rates by AI support status at

the 26 evaluation sites. Patients whose scans were interpreted with AI assistance underwent thrombectomy at a significantly higher rate than those without such assistance (912 [5.9%] of 14 465 versus 453 [3.4%] of 12 840; $P < 0.0001$).

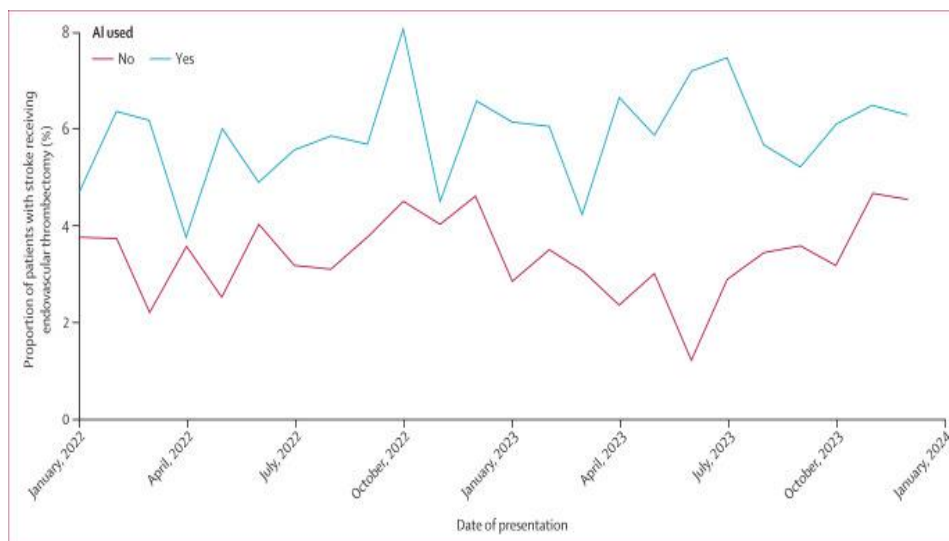


Figure 2. Monthly endovascular thrombectomy rates after implementation (from January 2022) at evaluation sites among patients reviewed with AI imaging support ($n = 15377$) versus without AI imaging support ($n = 13293$)

Table 2 summarises the results of multivariate logistic regression, which controlled for multiple predictors of thrombectomy eligibility. AI support was associated with 1.57 times the odds of receiving endovascular

thrombectomy (95% CI: 1.33–1.86; $P < 0.0001$) compared with standard review. Model fit, as indicated by McFadden's pseudo- R^2 , reached 0.320 (**Table 2**).

Table 2. Multivariate logistic regression results for receipt of endovascular thrombectomy

Variable	Odds ratio (95% CI)	P-value
Intercept	0.0000 (0.0000–0.0011)	< 0.0001
AI utilization (yes)	1.57 (1.33–1.86)	< 0.0001
Age 40–44 years	1.09 (0.64–1.84)	0.75
Age 45–49 years	0.86 (0.53–1.40)	0.54
Age 50–54 years	0.67 (0.43–1.05)	0.083
Age 55–59 years	0.75 (0.49–1.13)	0.17
Age 60–64 years	0.69 (0.46–1.04)	0.077
Age 65–69 years	0.68 (0.45–1.01)	0.058
Age 70–74 years	0.59 (0.40–0.88)	0.0090
Age 75–79 years	0.55 (0.38–0.82)	0.0027
Age 80–84 years	0.52 (0.35–0.76)	0.0010
Age 85–89 years	0.45 (0.30–0.67)	0.0001
Age ≥90 years	0.23 (0.14–0.36)	< 0.0001
Sex (male)	0.83 (0.73–0.94)	0.0037
Month and year	1.0005 (1.0002–1.0008)	0.0022
Stroke onset time: 0400–0800 h	1.98 (1.58–2.49)	< 0.0001

Stroke onset time: 0801–1200 h	1.68 (1.37–2.05)	< 0.0001
Stroke onset time: 1201–1600 h	1.39 (1.12–1.73)	0.0031
Stroke onset time: 1601–2000 h	0.98 (0.77–1.25)	0.90
Stroke onset time: 2001–2400 h	1.34 (1.04–1.72)	0.021
Stroke onset day: Monday	0.75 (0.60–0.94)	0.013
Stroke onset day: Tuesday	0.84 (0.67–1.05)	0.13
Stroke onset day: Wednesday	0.91 (0.72–1.13)	0.38
Stroke onset day: Thursday	0.95 (0.77–1.19)	0.67
Stroke onset day: Saturday	0.56 (0.44–0.71)	< 0.0001
Stroke onset day: Sunday	0.74 (0.58–0.93)	0.010
NIHSS score at admission	1.18 (1.17–1.19)	< 0.0001
Baseline premorbid mRS score	0.54 (0.51–0.58)	< 0.0001
Thrombolytic therapy	2.18 (1.89–2.51)	< 0.0001

Overall model fit (McFadden's pseudo- R^2) was 0.320. N = 28 670. AI = artificial intelligence. mRS = modified Rankin Scale. NIHSS = National Institutes of Health Stroke Scale.

In additional exploratory analyses, we reran the multivariate logistic regression using data limited to primary stroke centers. This yielded a stronger association, with an odds ratio of 2.34 (95% CI 1.78–3.10; $P < 0.0001$) for AI support on endovascular thrombectomy. When restricted to comprehensive stroke centers, the effect size was more modest yet remained statistically significant (OR: 1.28 [95% CI: 1.03–1.58]; $P = 0.023$).

We applied propensity score weighting in a sensitivity analysis to generate comparable groups with respect to observed covariates. The weighted logistic regression continued to demonstrate a meaningful positive link between AI software application and the probability of endovascular thrombectomy (OR: 1.29 [95% CI: 1.05–1.58]; $P = 0.016$). These conclusions held steady across multiple robustness checks, including propensity score matching, varied propensity estimation strategies, models with fewer covariates, and analyses that trimmed outlier weights.

We documented post-implementation door-in-to-door-out times for 747 patients transferred from evaluation sites. AI software was used for image review in 536 of these cases (72%), while 211 (28%) did not. Median door-in-to-door-out duration was 128 min (IQR: 96–185) with AI support, compared with 192 min (119–308) without it (Mann–Whitney test, $W = 74\,480$, $P < 0.0001$); (Figure 3). After multivariable adjustment, AI software remained a strong independent factor associated with reduced transfer times ($b = -90.84$, $SE = 21.20$, $t = -4.29$, $P < 0.0001$), with the complete model accounting for 27.5% of variance ($R^2 = 0.275$).

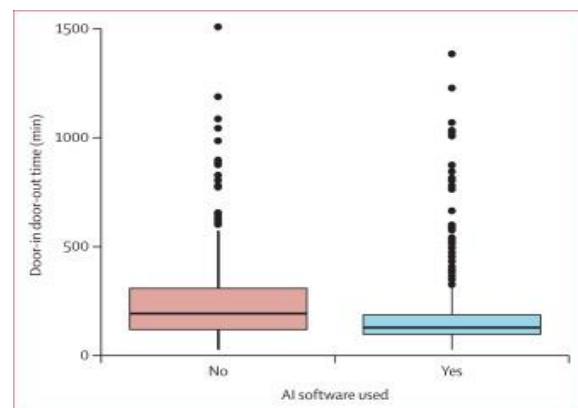


Figure 3. Door-to-door-to-out times for transferred patients at evaluation sites after AI software implementation, according to whether AI was used during image interpretation

Evaluation sites exhibited consistently elevated thrombolysis rates relative to non-evaluation sites throughout the observation period (OR: 1.60 [95% CI: 1.52–1.68]; $P < 0.0001$). A general downward trend in thrombolysis use was evident at both site types over time (OR: 0.91 [0.89–0.94]; $P < 0.0001$). Specifically, evaluation sites saw rates decline from 15.0% (2451 of 16 345) before implementation to 13.2% (2134 of 16 179) afterward. Non-evaluation sites decreased from 10.0% (9798 of 98 506) to 9.2% (9081 of 89 899). The interaction term between time period and site category was not significant (OR 0.94 [0.88–1.01]; $P = 0.09$).

At evaluation sites after implementation, intravenous thrombolysis was administered more often when AI software supported imaging review (2723 [17.7%] of 15 377) than when it did not (1191 [9.0%] of 13 293; $\chi^2 = 462$, $P < 0.0001$). Multivariate modeling confirmed AI use as an independent predictor of higher likelihood of

thrombolysis (OR: 1.99 [95% CI: 1.79–2.22]; $P < 0.0001$).

Discharge mRS scores indicated early clinical status. Cochran–Mantel–Haenszel testing revealed that AI-assisted cases were associated with significantly lower mRS values, signifying milder disability ($P < 0.0001$). Favorable outcomes (mRS 0–2) occurred more frequently with AI support (7249 [47.1%] of 15 377) than without (7238 [45.6%] of 13 293; $P = 0.0073$). AI utilization corresponded to greater odds of achieving a good functional result (OR: 1.16 [95% CI: 1.07–1.25]; $P = 0.0002$). In-hospital mortality rates (mRS 6) did not differ by AI use (1610 [10.5%] of 15 377 with AI versus 1399 [10.5%] of 13 293 without AI).

This prospective observational study, conducted in a real-world setting, found that deploying AI-based imaging software in stroke care was associated with a higher proportion of patients undergoing endovascular thrombectomy than in cases evaluated without such software. When comparing periods before and after implementation, the increase in endovascular thrombectomy rates was more substantial at sites using the AI software than at those without it—for patients initially presenting to a primary stroke center and requiring transfer to a comprehensive stroke center, the median door-to-door time decreased by 64 min with AI software. The positive association between software utilization and receipt of endovascular thrombectomy proved stronger at primary stroke centers than at comprehensive stroke centers. This pattern is consistent with the premise that decision-support tools deliver the greatest benefit at facilities lacking immediate endovascular thrombectomy capacity [4].

The investigation demonstrated a beneficial relationship between AI imaging software and the efficient, timely selection of patients for guideline-recommended therapy. These results illustrate the software’s practical impact within a functioning healthcare network and across a broad, representative group of stroke patients at a regional level. Changes in endovascular thrombectomy delivery rates and door-to-door intervals were clinically meaningful [19]. Better functional outcomes at hospital discharge aligned with higher treatment uptake and faster intervention times, even though extended follow-up data—the standard endpoint in most stroke trials—were unavailable.

To our knowledge, this constitutes the most extensive assessment of AI software applied to acute stroke imaging. The findings across multiple diverse networks

in England mirror the upward trends in treatment rates and reduced procedure times reported in earlier single-center analyses [12, 13, 20, 21]. Unlike prior work that has dissected the contributions of individual software elements [12–16, 18, 22–24], the current pragmatic study evaluated the technology as an integrated system in everyday practice. Specific modules may confer advantages, such as greater clinician confidence and greater accuracy in detecting large vessel occlusions via the e-CTA component [16], or enhanced recognition of early ischaemic signs on non-contrast CT scans through the e-ASPECTS component [22]. The importance of each module likely varies across hospitals and patient populations, depending on the challenges they face.

Much existing validation research on AI stroke imaging tools has emphasized their standalone diagnostic accuracy [24, 25] or their performance in controlled experimental settings [16]. Although such evaluations are vital for regulatory clearance, they may not capture the full range of benefits realized when the technology is embedded in routine hospital operations. In addition to helping non-radiologist clinicians review images faster and more precisely, stroke AI software enables instantaneous image sharing between primary and comprehensive stroke center teams. This capability accelerates clinical decisions and expands access to expert consultation [20, 21, 26].

The study found greater improvements in treatment rates at primary stroke centers than at comprehensive centers, reinforcing the idea that decision-support software is especially valuable at sites with fewer specialist staff that rely on standard imaging protocols such as non-contrast CT and CT angiography [27]. Failure to promptly identify and transfer patients with large vessel occlusion from primary stroke centers continues to hinder equitable and timely access to endovascular thrombectomy. In the UK, individuals presenting to primary stroke centers are 50% less likely to receive this intervention than those admitted directly to comprehensive centers [4]. Limited availability of real-time specialist radiological expertise at primary stroke centers—and during off-hours at comprehensive centers—impedes rapid identification of treatment candidates. The endorsement of AI imaging software in national stroke guidelines [11] aims to overcome this gap, yet robust supporting data have been sparse until recently [28].

While the improved modified Rankin Scale scores at evaluation sites are consistent with the known advantages of rapid endovascular thrombectomy, these results

should be interpreted with caution. Patients managed with the software at evaluation sites generally presented with greater stroke severity (higher NIHSS scores) yet had more favorable pre-stroke function (lower premorbid mRS scores). This baseline imbalance represents a study limitation. Although regression modeling accounted for these differences, some confounding of the association between AI support and the likelihood of endovascular thrombectomy may persist. Propensity score weighting provided additional adjustment, and the software's beneficial effect on thrombectomy rates remained significant. The scarcity of long-term outcome data is another constraint; however, the favorable discharge outcomes align with the established clinical gains from improved access to endovascular thrombectomy.

Information was unavailable concerning the specific reasons why clinicians decided against using AI software in selected patients. Such decisions may have arisen when clinical workflows necessitated manual transmission of patient data to the software upon a physician's request. Alternatively, limited experience with the platform or strong self-assurance in independent image interpretation could have reduced clinicians' inclination to adopt the tool. These considerations emphasize the critical roles of streamlined imaging protocols, universal application across all suspected stroke cases, and thorough staff education to optimize the benefits of novel technologies in clinical practice.

The comprehensive national evaluation, combined with the pragmatic study design, strengthens the external validity of the findings, though the observational methodology introduces certain constraints. Over the study period, stroke treatment criteria evolved, incorporating patients with more severe presentations and extended therapeutic windows. To minimize the influence of temporal changes, the relationship between AI software and endovascular thrombectomy was investigated using multiple complementary strategies: direct comparison with concurrent non-evaluation hospitals operating in the same healthcare environment; within-site analysis of patients managed with and without AI support during the identical interval; and statistical adjustment for patient characteristics through both regression models and propensity score weighting. Even so, some unmeasured confounding factors may have persisted.

Regarding broader applicability, the study did not examine how AI software interacts with varying models of stroke service organization. Divergent outcomes could

emerge in other systems, for instance, those that rely on telestroke services. Earlier research in such contexts has generally been constrained by modest sample sizes and reduced statistical power. Yet, the reported effects of AI implementation have been favorable and align with the current observations [26, 29]. Additionally, achieving substantial increases in treatment rates often depends on starting from a comparatively modest baseline; thus, the magnitude of benefit from AI software may be smaller in already high-performing healthcare systems. This could limit the transferability of these results to settings with higher baseline treatment performance.

While observational data cannot establish definitive causality between AI software use and enhanced patient outcomes, the pattern of results is consistent with a causal connection. As with other digital health innovations, the evaluation process itself may prompt changes in clinician practices and patient management unrelated to the technology being assessed. Potential confounders include greater familiarity with care pathways, process improvements, or concurrent initiatives to enhance service delivery. Disentangling these parallel developments from the software's direct effects is not feasible. The COVID-19 pandemic began after the pre-implementation phase of this study (after February 2020) and could have influenced endovascular thrombectomy activity [30]. Crucially, any pandemic-associated effects on stroke services would have impacted evaluation and non-evaluation sites alike.

The non-random selection of participating sites raises the possibility of selection bias among evaluation centers. Nevertheless, this would not account for the patient-level association between software application and treatment decisions observed within evaluation sites. Unlike pharmacological treatments, effective deployment of digital innovations requires hospital team commitment, making it difficult to separate the technology's effects from the systemic adaptations required for its introduction.

During the comparison of evaluation and non-evaluation sites, 69% of the non-evaluation hospitals introduced AI software of their own accord during the study. This independent adoption may have contributed to the rise in endovascular thrombectomy rates observed at non-evaluation sites. The comparatively larger benefit seen at evaluation sites highlights the added value of coordinated, network-wide implementation.

To our knowledge, this investigation constitutes the largest prospective assessment of AI technology's

influence on clinical outcomes in stroke care. The results reveal a beneficial impact of AI imaging support on access to endovascular thrombectomy and reinforce current guideline recommendations for incorporating such software into routine stroke pathways.

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