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ORIGINAL ARTICLE

Prospective Evaluation of Artificial Intelligence Imaging Support Software for Acute Ischemic Stroke in the Mayo Clinic Telestroke Network

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Abstract

Objective: To explore the real-world impact of artificial intelligence-driven decision support imaging software for patients with acute ischemic stroke in a mature telestroke network in the United States.

Patients and Methods: We conducted a prospective evaluation of stroke imaging support software in a robust, predominantly rural telestroke network (17 sites in Minnesota and Wisconsin). Data was collected from all patients who underwent video telestroke evaluation in a 3-month preimplementation period before installation of the software (from February 10, 2024 to May 9, 2024) and a 3-month post-implementation period while the software was in use (from May 10, 2024 to August 9, 2024). The preimplementation and postimplementation cohorts were directly compared (no control group included). Primary outcome measures were treatment rates and time to treatment (both treatment decision and delivery) for intravenous thrombolysis (IVT) and endovascular therapy (EVT); secondary outcomes included transfer rates, transfer times, and end user survey results.

Results: Total of 444 telestroke cases were included in the preimplementation period, and 463 in the postimplementation period. Comparing preimplementation and postimplementation periods, the rate of IVT treatment delivery rose from 26.6% to 35.0% of potentially eligible patients (P=.24), whereas EVT treatment delivery remained at 31%. Time to IVT delivery reduced from 47 minutes to 41 minutes (P=.772), and time to EVT treatment rose from 156 minutes to 157 minutes (P=.771). Overall rates of treatment (IVT or EVT) rose from 23.1% to 23.9% of potentially eligible patients (P=.944). Although none of the clinical outcomes reached statistical significance, the survey results reported good user satisfaction with algorithm performance and image viewing.

Conclusion: This study reported a nonsignificant increase in treatment rates and a decrease in time to treatment decisions. Future trials with larger sample sizes are needed to validate the real-world benefits of decision support software for acute ischemic stroke in an established telestroke network.

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Ischemic stroke is a leading cause of mortality and morbidity in developed nations.[1] It is estimated that the annual incidence of stroke in the United States is over 700,000 per year,[2] with an incidence of large vessel occlusion (LVO) stroke of 24 of 100,000.[3]

Advances in stroke therapeutics have seen the routine adoption of drug and mechanical reperfusion therapies into clinical practice for acute ischemic stroke (AIS) patients presenting within specific time windows since they were last known to be well.[4,5] Regardless of time

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from onset, stroke therapies must be given as quickly as possible after stroke onset to offer the best chance of a good outcome. Patient outcomes are adversely affected by either not identifying those who would benefit from treatment or delays in the time to treatment.

Imaging is central to treatment decisions in AIS.[6,7] Although much of the information required for decision-making comes from routine brain imaging (non-contrast computed tomography [NCCT] and CT angiography [CTA]) available in most hospitals, these modalities can be challenging to interpret.[8,9] The expertise to acquire and interpret imaging in real-time to inform treatment decisions may not be readily available at hospitals where patients with acute stroke present (ie, primary stroke centers or acute stroke ready hospitals). Telestroke services play a key role in connecting these hospitals to neurologists with the expertise to interpret imaging and identify candidates eligible for acute reperfusion therapies.

Automated artificial intelligence (AI) decision support imaging software can be used to facilitate the interpretation of stroke imaging to support decision-making, and is advocated by the American Heart Association.[10] This software offers automated triage notifications of CT imaging with suspected acute stroke, and supporting image interpretation and communication between clinicians. Software such as Brainomix 360 Stroke has been shown to improve the accuracy of AIS detection, and the timeliness of clinical decision-making and treatment delivery,[11-14] but the clinical impact of Brainomix 360 Stroke software has not been evaluated prospectively in the US health system previously.

This prospective evaluation aimed to measure the real-world impact of Brainomix 360 Stroke software during a 3-month pilot study in a mature telestroke service (Mayo Clinic Health System). The primary objective was to assess whether implementation of Brainomix 360 Stroke was associated with increased treatment rates and faster treatment times for AIS patients in a US telestroke system; in addition, secondary outcome measures assessed clinicians' attitudes to the software through before and after pilot surveys. We hypothesize that this AI tool will be associated with increased treatment rates and reduced treatment times through several mechanisms: (a) facilitating earlier recognition of patients with LVO (especially when triaging multiple simultaneous telestroke activations); (b) improving telestroke physician confidence and timeliness in radiology interpretation (most telestroke consultations are completed prior to formal radiology interpretation); and (c) capturing patients with early ischemic changes or LVO that may have otherwise been diagnosed as an alternative diagnosis.

The study is reported following Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) guidelines.[15]

PATIENTS AND METHODS

Design

A prospective quality improvement design was used, whereby outcome measures were evaluated for 3 months before and 3 months after deployment of Brainomix 360 software in 17 predominantly rural hospitals within the Mayo Clinic Health System (as listed in Supplementary Appendix 1, available online at http://www.mcpiqojournal.org). The study duration and hence sample size was predetermined by local requirements governing permitted evaluation of novel technology to 90 days; therefore, our postimplementation analysis was limited to a 90-day period. The preimplementation period was from February 10, 2024, to May 9, 2024, representing baseline performance under the pre-existing standard of care, and the postimplementation period was from May 10, 2024, to August 9, 2024. The preimplementation and postimplementation cohorts were directly compared without the inclusion of a dedicated control group. Data were collected following local institutional review board approval, and the board has waived the need for informed consent.

Outcome Measures

The primary outcome measures were: (1) treatment rates, measured as the percentage of patients with AIS receiving and recommended intravenous thrombolysis (IVT) or endovascular therapy (EVT), and (2) time to treatment, measured as the time between telestroke consultation and IVT or EVT treatment delivery and time to treatment decision.

Secondary quantitative measures included sensitivity and specificity of AIS diagnosis at telestroke consultation (relative to discharge diagnosis); transfer rates (patients transferred to Mayo Clinic for consideration of emergent endovascular intervention); time to patient transfer; and length of stay. Secondary outcome measures included users' expectations of the benefits of the software before implementation, and users' subjective opinions on the accuracy and impact of the software after implementation.

Data Collection

Our telestroke consultation activation criteria include any adult patient (aged 18 years or older) with acute focal neurological deficits within 24 hours (or unknown) of last known well. The patients typically undergo telestroke activation before imaging, and data were collected for all patients who underwent video telestroke evaluation at a Mayo Clinic Health System telestroke site. Patients with hemorrhagic stroke were not included, as they were managed under an alternative clinical pathway and do not routinely undergo formal video telestroke evaluation. Clinical, demographic characteristics, and procedural datapoints were collected from patient case notes and existing audit infrastructure within the health care system and deidentified using an aggregated identifier. A full list of datapoints acquired is available in Supplementary Materials.

Imaging and Clinical Workflow

All patients had standard of care imaging, including NCCT brain scan. Additional imaging such as CTA, was delivered according to clinical need and existing imaging protocols. During the postimplementation period, telestroke providers had access to Brainomix 360 imaging support software (version 11.2; www.brainomix.com). Brainomix 360 is embedded within the stroke imaging workflow of each hospital, providing automated real-time image analysis, and cloud functionality that allows faster image sharing with the telestroke physician and viewing on mobile devices. The software modules available included Brainomix 360 e-ASPECTS, which uses NCCT imaging to identify acute ischemia and calculate an ASPECT score; Brainomix 360 Triage LVO, a triage and notification tool to identify suspected LVO on CTA imaging; Brainomix 360 Triage Stroke, a triage and notification tool to identify suspected ICH and LVO on NCCT imaging; e-CTA, which provides visualization, analysis, and post-processing of CTA imaging including, vessel density; and Brainomix 360 e-CTP, which provides visualization, analysis, and post-processing of CT perfusion (CTP) imaging. Of note, CTP is not a part of routine brain imaging protocols at most rural telestroke sites and is infrequently performed.

Given the brief pilot evaluation, telestroke physicians were the only end users of the Brainomix application and had the option to receive alerts to their telephone based on Brainomix AI outputs. Because well-established clinical workflows, most telestroke consultation requests preceded image acquisition, thus the telestroke physicians were typically already aware of the patient before Brainomix AI processing. During the pilot study, radiologists did not use routinely use the Brainomix software, nor did the software flag or prioritize scans for their interpretation.

Data Analysis

Treatment rates (for IVT and EVT) were calculated as the percentage of patients who received treatment out of the total number of patients with AIS stroke within either the preimplementation or postimplementation periods. Transfer rates were calculated similarly with the number of patients referred to Mayo Clinic for consideration of emergent endovascular intervention as the numerator. Treatment rates were further refined by calculating the percentage of potentially eligible patients receiving treatment. Eligibility for IVT was defined retrospectively as patients with a discharge diagnosis of AIS and a time since last known well of 4.5 hours or less. Eligibility for EVT was defined as AIS, a time since last known well of 24 hours or less and presenting the National Institutes of Health Stroke Scale (NIHSS) of 6 or greater.[7] Treatment and transfer rates in the preimplementaion and postimplementation periods were compared using χ^2 tests.

Time to decision and time to treatment (for IVT and EVT) were calculated from the time of telestroke activation to the treatment

TABLE 1. Questions in the Preimplementation and Postimplementation Survey Shared With Telestroke Providers

No.	Survey question
Preimplementation	
1.1	Do you expect treatment times, transfer times, or any other clinical outcomes to be improved by use of the software?
1.2	Do you agree that using the Brainomix software will add value to your practice?
Postimplementation	
2.1	Has the Brainomix algorithm accuracy performed in line with your expectation?
2.2	How satisfied are you with the Brainomix 360 image viewing and reconstructions?
2.3	Which of the Brainomix 360 modules do you find useful?
2.4	How frequently do you agree with Brainomix 360 e-ASPECTS scoring (NCCT)?
2.5	How frequently do you agree with Brainomix 360 Triage Stroke LVO notification (NCCT)?
2.6	How frequently do you agree with Brainomix 360 Triage Stroke ICH notification (NCCT)?
2.7	How frequently do you agree with Brainomix 360 Triage LVO notification (CTA)?
2.8	How frequently do you agree with Brainomix 360 e-CTA collateral assessment (CTA)?
2.9	To what extent do you trust Brainomix to give an accurate interpretation of the scan? 1 is the lowest level of trust and 5 is the highest
2.10	In your opinion, what positive changes have happened since the introduction of Brainomix?
2.11	In your opinion, has Brainomix helped to identify more eligible patients for endovascular therapy?
2.12	In your opinion, has Brainomix reduced the time taken to reach a decision to transfer a patient for / proceed with endovascular therapy?

Abbreviations: CTA, computed tomography angiography; ICH, intracerebral hemorrhage; LVO, large vessel occlusion; NCCT, non-contrast computed tomography.

decision time and treatment initiation time (needle time for IVT and groin time for EVT), respectively. The IVT decision time was captured by time to IVT order placement and time to EVT decision was captured by time to transfer call to interventional team at hub site. Length of stay was calculated as the number of days from admission to discharge. These measures were compared in the preimplementation and postimplementation period using Mann-Whitney U tests, due to nonparametric distributions.

Sensitivity and specificity of AIS diagnosis at the telestroke consultation were calculated using the final discharge diagnosis of AIS or transient ischemic attack (TIA) as ground truth, due to the challenges in differentiating TIA from AIS in the hyperacute emergency setting. Sensitivity was calculated as the number of true positives divided by the sum of true positives plus false negatives; specificity was calculated as the number of true negatives divided by the sum of true negatives plus false positives.

Survey Data

Anonymous surveys were conducted before and after software implementation to gather the subjective views of telestroke providers (ie, end users) on the utility of Brainomix 360. The surveys aimed to capture clinicians' expectations (preimplementation) and experience (postimplementation) of using the software. The questions (shown in Table 1) focused on the impact of the software on clinical decision-making and treatment delivery, as well as clinicians' subjective trust in the algorithm and software outputs.

RESULTS

Patient Cohort

A total of 907 patients were included; 444 in the preimplementation period and 463 in the postimplementation period. Of these, 379 (41.8%) were diagnosed with either AIS (291, 32.1%) or TIA (88, 9.7%) at discharge. The remaining cases had diagnoses of neurologic spell (24, 2.6%), seizure (20, 2.2%), toxic-metabolic encephalopathy (20, 2.2%), migraine (16, 1.8%), or other diagnosis (434, 47.9%). Table 2 shows the clinical and demographic characteristic details of the preimplementation and postimplementation patient cohorts. No significant differences between groups were observed.

Quantitative Outcome Measures

Treatment Rates. Table 3 shows outcome measures relating to treatment

TABLE 2. Clinical and Demographic Characteristics of the Preimplementation and Postimplementation Patient Cohorts[a,b]

Variable	Metric	Preimplementation	Postimplementation
N	N	444	463
Age (y)	Median (IQR)	70 (59-80)	71 (61-81)
Gender	% female (N)	50.9% (226/444)	53.1% (246/463)
Race/ethnicity	% white (N)	92.6% (411/444)	94.6% (438/463)
NIHSS	Median (IQR)	3 (1-6)	2 (1-6)
AIS/TIA diagnosis	% (N)	43.9% (195/444)	39.7% (184/463)
Time since last known well (min)	Median (IQR)	174 (71-581)	165 (65-607)
Time since last known well, AIS patients only (min)	Median (IQR)	197 (72 - 667)	162.5 (60-604)
Time from arrival to telestroke activation (min)	Median (IQR)	18 (10-34)	20 (11-33)
Eligible for IVT	% (N)	24.5% (109/444)	21.6% (100/463)
Eligible for EVT	% (N)	14% (62/444)	11.2% (52/463)

[a]Time since last known well was calculated from last known well to arrival.
[b]Abbreviations: AIS, acute ischemic stroke; EVT, endovascular therapy; IQR, interquartile range; IVT, intravenous thrombolysis; NIHSS, National Institutes of Health Stroke Scale.

recommendation and delivery rates for IVT and EVT, preimplementation and postimplementation of the Brainomix 360 software. There were nonsignificant increases in the percentage of patients recommended for and receiving IVT. When considering only patients who were potentially eligible for IVT, the treatment rate rose from 26.6% to 35.0% (P=.244). The EVT treatment delivery rates did not change, remaining at 31% of potentially eligible patients preimplementation and postimplementation. Overall rates of treatment (IVT and/or EVT) rose from 23.1% to 23.9% of potentially eligible patients (P=.994).

Time to Treatment. Table 4 shows time to treatment outcome measures. Comparing preimplementation and postimplementation periods, time from telestroke activation to IVT delivery reduced from 47 minutes to 41 minutes (P=.772), and time to EVT treatment rose from 156 minutes to 157 minutes (P=.771). After implementation of the software, treatment decision times and time to IVT delivery improved; however, time to transfer increased, with an overall increase in EVT delivery and reperfusion times. No changes in treatment times reached statistical significance.

Stroke Diagnosis. Using the discharge diagnosis as a ground truth, cerebral ischemia (AIS or TIA) was diagnosed at the telestroke consultation with a similar sensitivity and specificity in the preimplementation period (Table 5; sens=82%, spec=81%) and the postimplementation period (Table 5; sens=79%, spec=79%).

Survey Results

Preimplementation. A total of 22 telestroke physicians participated in telestroke shifts during the pilot study. Fourteen (64%) telestroke providers completed the preimplementation survey. Full responses to the survey questions are shown in Supplementary Materials. When asked whether they expected treatment times, transfer times, or any other clinical outcomes to be improved by use of the software (question 1.1), 5 (36%) said Yes, 7 (50%) said Maybe, and 2 (14%) said No. For question 1.2, 13 users (93%) expected that the software would add value to their practice, and one (7%) was neutral.

Postimplementation. Fourteen (64%) clinicians completed the postimplementation survey. The responses indicated a good level of confidence in the software's algorithm, with 10 users (71%) indicating that it performed in line with their expectations (question 2.1), and 11 users (78.6%) giving a rating of 4 out of 5 for their trust in the accuracy of the software's image interpretations (question 2.9). About 71.4% of users responded that

TABLE 3. Treatment and Transfer Rates for IVT and EVT, in the Preimpelmentation and Postimplementation Periods, and *P* values from χ^2 tests

Outcome measure	Preimplementation % (N)	Postimplementation % (N)	*P*
IVT recommended	15.9% (31/195)	20.1% (37/184)	.35
IVT received	15.4% (30/195)	19.6% (36/184)	.35
IVT received (eligible patients only)	26.6% (29/109)	35.0% (35/100)	.24
EVT recommended	12.8% (25/195)	12.0% (22/184)	.92
EVT received	10.8% (21/195)	8.7% (16/184)	.61
EVT received (eligible patients only)	30.6% (19/62)	30.8% (16/52)	>.99
IVT or EVT received	23.1% (45/195)	23.9 % (44/184)	.94

Abbreviations: EVT, endovascular therapy; IVT, intravenous thrombolysis.

they were satisfied or very satisfied with the software's image viewing and reconstructions (question 2.2).

When looking at individual software modules, users most frequently noted e-ASPECTS (57%), Triage LVO (50%), and e-CTA (43%) as being useful (question 2.3). Agreement ratings for individual modules (questions 2.4-2.8) were mixed, with a high number of users (53% of responses over 5 questions) reporting that they had not had enough cases to determine an opinion yet. However, 46% of respondents indicated that they agreed with the software modules at least 50% of the time, leaving only 1% (one response) that indicated less than 50% agreement (for LVO notifications from Triage Stroke).

When asked whether the software had helped to identify more eligible patients for EVT (question 2.11) or reduced the time taken to decide to transfer a patient for EVT (question 2.12), many responses indicated that there were not yet enough cases to determine an opinion (57% and 43% of respondents respectively). Of the remaining responses, clinicians were skeptical, responding No (29% and 36%, respectively) more often than Yes (14% and 21%, respectively).

Finally, when asked what positive changes had occurred since the software was introduced (question 2.10), improved confidence in decision-making (43%), faster triage (36%). and the ability to handle multiple

TABLE 4. Time to Treatment Outcome Measures in the Preimplementation and Postimplementation Periods, Such as Time to IVT/EVT Decision, Time to IVT/EVT Delivery, Time to Transfer, Time to Reperfusion After EVT, and Length of Stay[a,b]

	Preimplementation		Postimplementation		
Outcome measure	Median (IQR)	N	Median (IQR)	N	*P*
Arrival to IVT decision (min)	46 (38-69)	30	43 (30-72)	36	.56
TS to IVT decision (min)	36 (27-43)	30	31 (24-48)	36	.58
TS to IVT delivery (min)	47 (35-53)	30	41 (29-60)	36	.77
Arrival to EVT decision (min)	54 (35-73)	25	47 (35-62)	22	.65
TS to EVT decision (min)	34 (22-47)	25	32 (21-44)	22	.58
TS to EVT delivery (min)	156 (123-183)	21	157 (129 -185)	16	.77
TS to reperfusion (min)	178 (154-198)	20	189 (162-207)	15	.49
TS to transfer (min)	97 (78-128)	27	123 (89-145)	32	.83
Length of stay (d)	2 (1-4)	195	2 (1-4)	183	.43

[a]*P* values are reported from Mann-Whitney U tests.
[b]Abbreviations: EVT, endovascular therapy; IVT, intravenous thrombolysis; TS, telestroke.

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TABLE 5. Results of the Stroke Diagnosis Analysis, Comparing Diagnosis at Telestroke Consultation With the Ground Truth (Diagnosis at Discharge) Results in the Preimplementation Period, and in the Postimplementation Period

Preimplementation		Discharge diagnosis: Yes	Discharge diagnosis: No	Postimplementation		Discharge diagnosis: Yes	Discharge diagnosis: No
Telestroke diagnosis	Yes	TP=160	FP=48	Telestroke diagnosis	Yes	TP=146	FP=56
	No	FN=35	TN=200		No	FN=38	TN=210

Abbreviations: FN, false negative; FP, false positive; TN, true negative; TP, true positive.

simultaneous telestroke consultations (29%) were the most common responses.

DISCUSSION

This study reports outcomes and survey results from a 3-month pilot study evaluating Brainomix 360 decision support imaging software in a mature US telestroke network. The primary objective of the study was to assess whether the introduction of the software improved treatment rates and reduced time to treatment in patients with AIS. Although none of the comparisons reached statistical significance, this study did show a potential trend toward improvement in the frequency and speed of IVT delivery. The IVT treatment rates in potentially eligible patients increased from 26.2% before software implementation to 34.4% after; an absolute increase of 8.2%, and a relative increase of 31.3%. Time to treatment reduced from 47.5 to 40 minutes. Although none of these results were significant and may be due to random variation, the favorable trends suggest potential benefit in a larger cohort with greater statistical power, and these trends are consistent with the survey feedback from users.

Similar positive associations between the use of this stroke imaging software and clinical performance metrics (number of treatments given, speed of access to care, and system efficiency) have been observed in Europe,[14,16,17] and improved clinical outcomes have been observed as a result. However, it is important to note that the value to a health system of medical technology will depend on the unmet needs of the individual system. The value of these interventions needs to be reported in comparable systems of care before positive associations can be assured, rather than being assumed from other settings. This study is the first such evaluation of this software in a high-performing US telestroke network. The study showed findings consistent with the previous literature, but in this novel setting and showed that the comprehensive coverage across an entire network of hospitals appeared beneficial.

When considering EVT, there was a trend toward lower rates of EVT, but there was a reduction in time to decision for the telestroke physician. This was offset in the pilot study by longer transfer times, with an average delay of 15 minutes for patient transfer in the postimplementation period compared with the preimplementation period. These delays may be related to local factors, including weather, ambulance/helicopter availability, and local service variation between precohorts and postcohorts. Over a longer implementation period, we believe faster decision times and further integration of the software into existing infrastructure (eg leveraging mobile application communication and notification tools) would translate to faster EVT treatment times.

Survey results found that 93% of clinicians expected the software would add value to their practice; 71% found that the software's algorithms performed in line with their expectations, and 71% were satisfied or very satisfied with the software's image viewing and reconstructions. Some of the surveyed physicians felt that they did not have enough cases to appropriately gauge the impact on their clinical practice, reflective of the short duration of the pilot study and the limited cases that each individual telestroke physician experienced during that time.

There are several limitations of this study. First, the short 6-month trial period with 3

months preimplementation and only 3 months postimplementation led to limited underpowered results and inability to reach definitive conclusions. Although the design was governed by hospital policy, a longer trial period with more robust design (ie 2 week on/2 week off approach) may have yielded stronger conclusions. Second, the focus on telestroke physicians as the sole end user, rather than more robust engagement of emergency providers, radiologists, and interventionalists to maximize potential benefit. The study design has inherent limitations, such as potential mismatches between patient cohorts or other imbalanced factors affecting service delivery in the preimplementation and postimplementation periods. Moreover, the survey questions were phrased to specifically explore positive changes from the inclusion of the new AI software, and any negative concerns from the respondents could have been missed. This may have led to overstating the perceived positive impacts of the software on clinical practice.

Despite these limitations, the results provide insights into the impact of stroke imaging software in US telestroke health care systems, even in a mature academic-based telestroke system with baseline high performance. Access to stroke imaging software had not been previously available in every hospital in the network and the impact of truly comprehensive coverage was reported in this study. This has not been previously reported with this software. The results are consistent with previous real-world impact evaluations of Brainomix 360 software. In the European Union, use of the software has been shown to improve AIS treatment delivery, both at the level of single sites,[14,16], and stroke networks.[18] Accuracy of the software outputs have also been validated in prospective[19] and retrospective studies.[12,20-23] In addition, reader studies have observed that use of the software can improve clinicians' interpretation of acute stroke imaging.[11,13,24]

CONCLUSION

This study did not report any statistically significant improvement in clinical outcomes after deployment of AI decision support imaging software for AIS in an established telestroke network. The study did show numerical improvements in IVT treatment rates and treatment times, but not EVT rates or treatment times, and survey feedback from clinical end users was positive, highlighted by high level of trust and user satisfaction with the software. More robust studies are needed to determine the real-world impact of this AI imaging software in an established telestroke network.

POTENTIAL COMPETING INTERESTS

Drs Fernandez, Wood, Woodhead, Carone, and Harston are employees of Brainomix Limited and have share options; Dr English has received consulting fees from Brainomix Limited. All other authors report no conflicts of interest.

ETHICS STATEMENT

This study was approved by the Mayo Clinic Institutional Review Board and the IRB has waived the need for informed consent due to the retrospective nature of data collection.

SUPPLEMENTAL ONLINE MATERIAL

Supplemental material can be found online at http://www.mcpiqojournal.org. Supplemental material attached to journal articles has not been edited, and the authors take responsibility for the accuracy of all data.

Abbreviations and Acronyms: **AI**, artificial intelligence; **AIS**, acute ischemic stroke; **CTA**, computed tomography angiography; **CTP**, computed tomography perfusion; **EVT**, endovascular therapy; **IVT**, intravenous thrombolysis; **LVO**, large vessel occlusion; **NCCT**, non-contrast computed tomography; **TIA**, transient ischemic attack

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