



BRIEF RESEARCH REPORT

Neurology

A survey of stroke-related capabilities among a sample of US community emergency departments

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Abstract

Objectives: Most acute stroke research is conducted at academic and larger hospitals, which may differ from many non-academic (ie, community) and smaller hospitals with respect to resources and consultant availability. We describe current emergency department (ED) and hospital-level stroke-related capabilities among a sample of community EDs participating in the Emergency Quality Network (E-QUAL) stroke collaborative.

Methods: Among E-QUAL-participating EDs, we conducted a survey to collect data on ED and hospital stroke-related structural and process capabilities associated with quality of stroke care delivery and patient outcomes. EDs submitted data using a web-based submission portal. We present descriptive statistics of self-reported capabilities.

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Results: Of 154 participating EDs in 30 states, 97 (63%) completed the survey. Many were rural (33%); most (82%) were not certified stroke centers. Although most reported having stroke protocols (67%), many did not include hemorrhagic stroke or transient ischemic attack (45% and 57%, respectively). Capability to perform emergent head computed tomography and to administer thrombolysis were not universal (absent in 4% and 5%, respectively). Access to neurologic consultants varied; 18% reported no 24/7 availability onsite or remotely. Of those with access, 48% reported access through telemedicine only. Admission capabilities also varied with patient transfer commonly performed (79%).

Conclusion: Stroke-related capabilities vary substantially between community EDs and are different from capabilities typically found in larger stroke centers. These data may be valuable for identifying areas for future investment. Additionally, the design of stroke quality improvement interventions and metrics to evaluate emergency stroke care delivery should account for these key structural differences.

KEYWORDS

emergency department, emergency stroke care, stroke

1 | INTRODUCTION

1.1 | Background and importance

There is substantial variation in emergency stroke care delivery and stroke patient outcomes in the United States. Variation in care quality and patient outcomes exists at the patient level (ie, between patient groups), geographic level, and hospital level.¹⁻⁶ Regional and national efforts have aimed to standardize emergency stroke care delivery and reduce variation to ensure access to high-quality stroke care for all patients in all settings.⁷⁻¹⁰ However, even national studies often include (at best) 1500 of the nearly 5000 hospital-based emergency departments in the United States,¹¹⁻¹³ leaving much of the country's acute stroke care uncharacterized. The design of quality improvement interventions to improve stroke care delivery must take into account the stroke-related capabilities in the target EDs, particularly when those EDs may be smaller, community EDs and may have fewer resources than appreciated (eg, varying access to neurology consultants or varying advanced imaging capabilities).

1.2 | Goals of this investigation

To inform such stroke system quality improvement interventions, our objective was to characterize stroke-related capabilities among community EDs participating in the American College of Emergency Physicians (ACEP) Emergency Quality Network (E-QUAL) Stroke Collaborative. This is a voluntary educational and quality improvement collaborative open to all US EDs. EDs self-select for participation, and motivations may be related to a desire for quality improvement as well as related to the Quality Payment Program requirements.

2 | METHODS

2.1 | Study design, setting and selection of participants

EDs participating in E-QUAL conduct a 6-month long quality improvement (QI) activity locally, supported by educational materials and data benchmarking provided by E-QUAL. EDs elect to participate in this voluntary collaborative for QI purposes and also with the potential to satisfy the Quality Payment Program with the Centers for Medicare and Medicaid Services (CMS). Before participation, we distributed a survey to all EDs participating in the E-QUAL Stroke Collaborative during 2020 and 2021.

2.2 | Measurements

EDs self-reported characteristics, including critical access hospital status, safety net status, rural location, government ownership, and academic status in an Enrollment Survey ([Appendix](#)). EDs also completed a Quality Readiness Assessment in preparation for the collaborative including additional ED characteristics (eg, annual visit volume, admission rate; [Appendix](#)). We also cross-referenced published databases to identify sites' stroke center certification status.

2.3 | Capabilities survey and analysis

Our workgroup of leaders in stroke and emergency care delivery developed a survey to collect ED and hospital stroke-related capabilities, including questions and adaptations of questions that have been used

in prior similar research^{14,15} and questions to reflect specific guideline-recommended structural components of emergency stroke care.¹⁶ A version was piloted with leaders in emergency stroke research and stroke care as well as representatives from physician practice groups. Many involved in survey development provide remote neurologic expertise for acute stroke assessment and are familiar with the varying capabilities and limitations in more austere clinical settings. Survey questions covered the existence and contents of ED stroke protocols, the stroke code response, consultant availability, imaging and laboratory capabilities, hospital stroke-related capabilities, stroke patient volume and disposition questions, and any participation in prior QI activities. The survey also included an open-ended question about barriers experienced in providing access to high-quality stroke care (Appendix). The survey was administered via a web-based portal and was available for completion over an 11-month period (July 2020–May 2021). Surveys were completed by ED site champions, most often the medical or quality director. No direct incentive was provided for survey completion; however, survey completion was considered evidence of engagement for site completion of the CMS quality requirements. Survey responses are reported using basic descriptive statistics. Two investigators reviewed open-ended responses and identified common themes. All analyses were performed in R Statistics Package – The R Project for Statistical Reporting.¹⁷

3 | RESULTS

3.1 | General ED characteristics

The survey was completed by 97 of the 154 participating EDs (response rate 63%) from 30 different states (Figure 1). Thirty-two self-identified as rural (33%). Median annual ED volume was 4,250 (interquartile range 2450–15,000). A minority were in stroke center hospitals; 80 had no stroke center certification (82%), 0 were in

The Bottom Line

The capabilities of smaller community emergency departments (EDs) to provide optimal acute stroke care is unknown and challenging to study nationally. Although data from this Emergency Quality Network (E-QUAL) survey offer a selective picture, they are critical to understanding the potential ceiling and limits of these EDs.

acute stroke ready hospitals (the most basic level of certification), 14 were in primary stroke centers (14%), and 3 were in comprehensive or thrombectomy-capable stroke centers (3%; Table 1). Most EDs reported annual stroke volume of 120 patients or fewer (59%). Table 1 presents all ED characteristics stratified by those with annual stroke volume less than versus greater than 120.

Most EDs were in hospitals with an ICU (76%) and with a 24/7 operating room (OR) staff (53%). Fewer had stroke units (20%) or interventional radiology (25%). Fifteen EDs lacked an ICU, 24/7 OR, interventional radiology services, or a stroke unit (15%).

3.2 | Stroke protocols and registry participation

Sixty-five EDs reported having a written protocol for the management of acute stroke; however, protocols less often included hemorrhagic stroke, transient ischemic attack (TIA), and subarachnoid hemorrhage (67%, Table 1).

Participation in a stroke registry was reported by 42% of EDs ($n = 41$), most frequently American Heart Association/American Stroke Association Get with the Guidelines-Stroke ($n = 40$), with 3 in the Centers for Disease Control and Prevention Paul Coverdell registry,

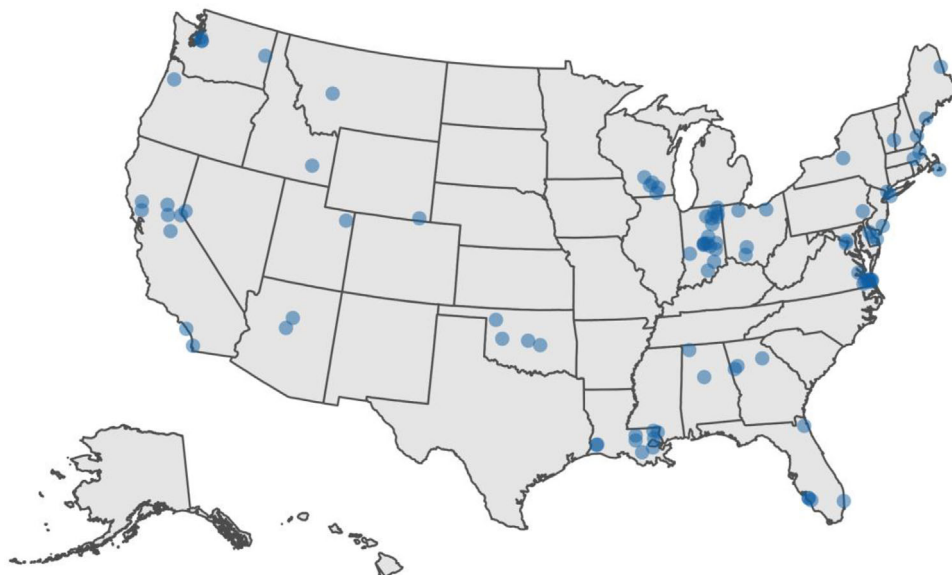


FIGURE 1 Geographic locations of participating EDs. ED, emergency department

TABLE 1 Emergency department stroke capabilities, by annual stroke volume

	Overall N = 97	Less than 120 strokes per year N = 57 ^a	120 or more strokes per year N = 38 ^a
Rural, n (%)	32 (33%)	26 (46%)	5 (13%)
ED bed size, median (IQR) ^a	27 (21–43)	22 (14–26)	42 (30–52)
Annual ED visit volume, median (IQR)	4250 (2425–15,000)	5000 (2500–14,250)	3550 (2000–26,250)
Hospital resources			
Stroke center status, n (%)	17 (18%)	9 (16%)	8 (21%)
Comprehensive/thrombectomy capable stroke center	3 (6%)	1 (2%)	2 (5%)
Primary stroke center	14 (14%)	8 (14%)	6 (16%)
Acute stroke ready hospital	1 (1%)	0 (0%)	1 (3%)
No certification	80 (82%)	48 (84%)	30 (79%)
ICU, n (%)	74 (76%)	36 (63%)	38 (100%)
24/7 operating room staffing, n (%)	51 (53%)	20 (35%)	31 (82%)
Stroke unit, n (%)	19 (20%)	5 (9%)	14 (37%)
Interventional services, n (%)	24 (25%)	4 (7%)	20 (53%)
Stroke protocols and response			
Written acute stroke protocol, n (%)	65 (67%)	32 (56%)	32 (84%)
Protocol structured into workflow, n (%)	62 (64%)	29 (51%)	32 (84%)
Written protocol includes			
ischemic stroke, n (%)	64 (66%)	31 (54%)	32 (84%)
Hemorrhagic stroke, n (%)	36 (37%)	15 (26%)	20 (53%)
TIA, n (%)	28 (29%)	10 (18%)	18 (47%)
Subarachnoid hemorrhage, n (%)	26 (27%)	12 (21%)	13 (34%)
Stroke code response includes			
ED nurse, n (%)	97 (100%)	57 (100%)	38 (100%)
ED physician, n (%)	95 (98%)	57 (100%)	37 (97%)
radiology, n (%)	91 (94%)	53 (93%)	37 (97%)
pharmacy, n (%)	81 (84%)	46 (81%)	35 (92%)
NPPs, n (%)	83 (86%)	49 (86%)	33 (87%)
Any stroke registry participation, n (%)			
GWTG-Stroke, n (%)	41 (42%)	13 (43%)	28 (79%)
CDC Paul Coverdell registry, n (%)	40 (41%)	12 (39%)	28 (79%)
CDC Paul Coverdell registry, n (%)	3 (3%)	0 (0%)	3 (13%)
Alternative stroke registry, n (%)	1 (1%)	1 (7%)	0 (0%)
Imaging capabilities			
Noncontrast head CT, n (%)	93 (96%)	54 (95%)	38 (100%)
CT angiography, n (%)	90 (93%)	52 (91%)	38 (100%)
CT perfusion, n (%)	38 (39%)	13 (23%)	25 (66%)
MRI, n (%)	48 (49%)	21 (37%)	27 (71%)
Time to non-contrast head CT performance, n (%)			
within 15 minutes	42 (43%)	21 (37%)	21 (55%)
within 45 minutes	47 (48%)	29 (51%)	17 (45%)
greater than 45 minutes	5 (5%)	5 (9%)	0 (0%)
not sure	2 (2%)	2 (4%)	0 (0%)

(Continues)

TABLE 1 (Continued)

	Overall N = 97	Less than 120 strokes per year N = 57 ^a	120 or more strokes per year N = 38 ^a
Acute stroke treatment capabilities			
Ability to administer iv thrombolysis, n (%)	91 (94%)	52 (91%)	38 (100%)
In-hospital hematoma removal/drainage, n (%)	30 (31%)	7 (12%)	23 (61%)
In-hospital endovascular therapy, n (%)	18 (19%)	1 (2%)	17 (45%)
In-hospital intracranial aneurysm coiling, n (%)	15 (15%)	1 (2%)	14 (37%)
Stroke patient disposition from the ED			
Typically transfer, n (%)			
patients requiring thrombectomy	76 (78%)	55 (96%)	21 (55%)
patients with intracranial hemorrhage	68 (70%)	52 (91%)	16 (42%)
thrombolysis-treated patients	49 (51%)	41 (72%)	8 (21%)
all stroke patients	13 (13%)	13 (23%)	0 (0%)
If transferring, telestroke is used to connect with accepting hospitals before transfer, n (%)	33 (34%)	23 (40%)	10 (26%)
Consultant availability			
24/7 neurology, n (%)	79 (81%)	45 (79%)	34 (89%)
24/7 neurology via telemedicine only	49 (51%)	34 (60%)	15 (39%)
24/7 neurology telemedicine or in-person	14 (14%)	6 (11%)	8 (21%)
24/7 neurology in-person only	16 (16%)	5 (9%)	11 (29%)
Neurology available but not 24/7, n (%)	1 (1%)	1 (2%)	0 (0%)
Neurology not available, n (%)	17 (10%)	11 (19%)	4 (11%)
If in-person neurology, response time: n (%)			
-under 30 minutes	21 (22%)	7 (12%)	14 (37%)
-30-59 minutes	8 (8%)	3 (5%)	5 (13%)
-60+ minutes	2 (2%)	2 (4%)	0 (0%)
24/7 neurosurgery, n (%)	36 (37%)	14 (25%)	22 (58%)
24/7 neurosurgery via telemedicine only	9 (9%)	7 (12%)	2 (5%)
24/7 neurosurgery via telemedicine or in-person	2 (2%)	0 (0%)	2 (5%)
24/7 neurosurgery in-person only	25 (26%)	7 (12%)	18 (47%)
Neurosurgery available but not 24/7, n (%)	6 (6%)	1 (2%)	5 (13%)
Neurosurgery not available, n (%)	55 (57%)	42 (73%)	11 (29%)
If in-person neurosurgery, response time: n (%)			
-under 30 minutes	16 (16%)	5 (9%)	11 (29%)
-30-59 minutes	13 (13%)	2 (4%)	11 (29%)
-60+ minutes	1 (1%)	1 (2%)	0 (0%)
24/7 radiology, n (%)	56 (58%)	31 (67%)	24 (63%)
24/7 radiology via telemedicine only	9 (9%)	6 (11%)	3 (8%)
24/7 radiology via telemedicine or in-person	36 (37%)	20 (35%)	15 (39%)
24/7 radiology in-person only	11 (11%)	5 (9%)	6 (16%)
Radiology available but not 24/7, n (%)	10 (10%)	7 (12%)	3 (8%)
Radiology not available/phone only, n (%)	31 (32%)	19 (33%)	11 (29%)

Abbreviations: CDC, Centers for Disease Control and Prevention; CT, computed tomography; ED, emergency department; GWTG, Get with the Guidelines; IQR, interquartile range; NPP, non-physician provider; TIA, transient ischemic attack.

^aStroke volume sample does not add up to overall. Not all respondents answered question on stroke volume.

and 1 also reporting alternative state-based stroke registries (multiple registries could be selected by a single site).

3.3 | Imaging and acute stroke treatment capabilities

The vast majority of EDs reported 24/7 availability of computed tomography (CT, 96%) and CT angiography (93%). Fewer reported 24/7 availability of CT perfusion (39%) or magnetic resonance imaging (49%). Imaging capabilities were more limited in lower-volume EDs (Table 1). The majority of EDs reported ability to administer intravenous thrombolysis (94%). Fewer noted in-hospital availability of intracranial hematoma removal/drainage, endovascular therapy, and coiling of intracranial aneurysm—these were primarily reported by higher-stroke volume EDs (Table 1).

With respect to stroke patient dispositions from the ED, some reported typically transferring *all* stroke patients regardless of reperfusion eligibility (12%). Half reported typically transferring patients who received intravenous alteplase (50%), and most reported typically transferring patients with intracranial hemorrhage (70%) and requiring thrombectomy (78%). This was particularly true among sites with annual stroke volumes less than 120 (91% and 96% reported transferring patients with intracranial hemorrhage and patients requiring thrombectomy, respectively).

When transferring stroke patients, 30% transferred to the first accepting hospital, but most transferred based on a preexisting relationship. Preexisting transfer relationships were typically within network (58%) and more common among EDs with a written ischemic stroke protocol (81% of EDs with a written protocol reported preexisting transfer relationships versus 48% of EDs without a written protocol). Many reported connecting with accepting hospitals via telestroke before transfer (49%).

3.4 | Consultant availability

Whether in person or via telemedicine, neurology expertise was available 24/7 to 81% of EDs; more frequently for higher-stroke volume EDs (Table 1). Of those that indicated no availability of neurology, 14 still reported capability to deliver thrombolysis (82%). In-person neurosurgery was available more frequently among higher-stroke volume sites and over half of EDs reported 24/7 radiology availability via telemedicine or in person (58%, Table 1).

3.5 | Barriers to high-quality stroke care

EDs reported barriers to providing high-quality stroke care in 3 categories: (1) resource limitations, (2) timeliness of care, and (3) process and consistency in response (Table 2).

Resource limitations described by EDs were often related to availability of individuals for a stroke team response or downstream care.

TABLE 2 Barriers to high-quality stroke care

Resource limitations

"In our 3-hospital system...[w]e don't get priority with resources so we have to be creative to be efficient and provide the highest quality of care." -

- *non-rural, higher stroke volume ED*

"Freestanding ED with no stroke team or Neurologist available for in person evaluations."

- *a non-rural, lower stroke volume ED*

"We do not have 24/7/365 on call neurology coverage. We have coverage 10 days per month." - *a non-rural, lower stroke volume ED*

"No in person neurology. At times tele-neurology difficult to obtain as quickly as desired."

- *a non-rural, lower stroke volume ED*

Timeliness of care

"Our biggest barrier to quality stroke care is calling a stroke alert as early as possible after patient arrival. We are currently averaging approximately 10 minutes." - *a non-rural, higher stroke volume ED*

"Neurology consultation time and transfer times." - *a non-rural, higher stroke volume ED*

"...minimizing cycle time of LVO recognition to leaving dept. for NIR (DIDO)" - *a non-rural, higher stroke volume ED*

Process and consistency in response

"Consistency in stroke symptom recognition by triage staff and activation of stroke alert." - *a non-rural, lower stroke volume ED*

"Inconsistency on decisions to admit vs transfer and what diagnostics are required to make that determination." - *a rural, lower stroke volume ED*

"Getting everyone on board and on the same page; from EMS to nursing; lab; imaging; and the providers." - *a rural, lower stroke volume ED*

Note: Sample quotations provided in open-ended response to "What is your biggest barrier to quality stroke care?"

Abbreviations: DIDO, door-in-door-out; ED, emergency department; EMS, emergency medical services; LVO, large vessel occlusion; NIR, neuro interventional radiology.

Respondents also described challenges with transfers, bed capacity, technology and imaging capabilities, and COVID-19 related constraints.

Challenges related to timeliness of care included decision-making for early activation of stroke codes, patient factors (eg, arrival times and decision making), radiology-related and transfer-related delays.

Finally, challenges in the process and consistency of acute stroke care included lack of structured processes contributing to inconsistent recognition of stroke symptoms, inconsistency in admission versus transfer protocols, communication challenges (eg, with prehospital emergency medical services or radiology), and absence of hospital infrastructure and commitment. Lack of structured process for stroke recognition and management was reported by EDs both with and without stroke protocols.

4 | LIMITATIONS

Limitations of this study include the likely selection bias of our sample as all were EDs participating in the E-QUAL stroke collaborative.

These EDs are more engaged and likely to be higher performers and may not be representative of all community EDs. However this underscores the possibility that other small community EDs that are not represented in these data may have even fewer resources available for acute stroke care. In addition, not all EDs participating in the E-QUAL stroke collaborative provided data and this may have biased our results given that we report results from the more engaged participants. Though we cannot know the impact on our results, we suspect that non-reporting EDs were those with fewer resources for full participation and that this would bias our results toward representing higher-resourced EDs. Finally, our data were self-reported and were thus dependent on respondent knowledge and may be subject to social desirability bias.

5 | DISCUSSION

We report data on stroke-related capabilities from a national sample of 97 mostly small-to-medium sized community EDs. These EDs ranged in size and patient volume, but 82% are not stroke centers or acute stroke ready hospitals and 58% are not participating in other stroke-related registries or QI initiatives (before E-QUAL enrollment). These EDs represent a unique sample of community EDs that are not typically captured in stroke-related reporting or large-scale QI networks such as Get with the Guidelines-Stroke or the Paul Coverdell National Acute Stroke Program. Our analysis has the unusual opportunity to examine stroke capabilities in these smaller, non-registry participating hospitals. Participating hospitals had lower annual ischemic stroke volumes and a greater proportion of rural sites (33% vs 11%) than hospitals represented in the Get with the Guidelines-Stroke registry.¹⁸ Similarly, Paul Coverdell Registry participating hospitals are more often stroke centers, academic, medium-to-large sized hospitals, the majority of which receive patients in transfer.¹⁹ This is in contrast to our sample in which EDs more often reported sending patients to other facilities in transfer. Quality gaps in rural stroke care delivery and outcomes are well described,²⁰ and these data provide critical insight into the capabilities and resource constraints in many smaller and more remote EDs. It is particularly worth noting that there are EDs that lacked basic stroke capabilities such as noncontrast head CT availability (4%), an ICU in the hospital (24%), or the ability to admit stroke and TIA patients even if not treated with thrombolysis (24%).

Our sample of 97 responding EDs is a small subset of EDs nationally. However, these responding EDs represent a segment of US EDs that are often missing from stroke registries and research. Given the underrepresentation of smaller, lower-volume EDs in most stroke studies, it is possible that the level of resources available to some EDs is lower than may have otherwise been assumed. For example, some may be surprised to note that there are EDs without noncontrast head CT capabilities. One may argue that such an ED should not receive patients with suspected stroke unless the nearest CT-capable hospital is prohibitively remote. It is critical that a system of care aiming to optimize patients' time to diagnostic evaluation and intervention take such varying resources capacities into consideration.

It is also imperative that resource constraints of smaller community EDs are considered when designing QI interventions and metrics to evaluate quality of care delivered. Particularly given that over one third of the US population is more than 60 minutes from a stroke center by ground ambulance,²¹ this may otherwise lead to inappropriate expectations of the capacity of an ED or hospital in care delivery. For example, time to brain imaging and thrombolysis delivery are commonly tracked metrics. However, as we reported, a small group of community EDs lack 24/7 CT availability and some also lacked 24/7 radiologist availability (though may have access by phone). These limitations affect their ability to achieve time-to-imaging and thrombolysis metrics. Another potential challenge is related to low case volumes that limit the reliability of condition-specific measures. In order to fairly and accurately capture the quality of care delivery among smaller EDs, there may be value in considering alternative approaches. One possibility may be to consider structural metrics such as the existence of a transfer protocol for rapid door-in-door-out times. Resource constraints may also provide an opportunity for advocacy for affected centers. Finally, challenges related to the ongoing COVID-19 pandemic continue to affect community EDs and their stroke care delivery and are important considerations when evaluating quality of stroke care delivery.

As a structural measure associated with improved quality of stroke care delivery,²² it is reassuring to note that the vast majority of EDs in our sample do have a written protocol for the care of stroke patients. It is also notable that the majority of these EDs do have access to a neurologist and that this often occurs via telestroke. As telestroke is increasingly used as a resource to connect patients with specialist expertise, it has potential to continue to shape stroke systems of care. Telestroke evaluations may facilitate more selectively identifying patients requiring transfer and who are potentially eligible for interventions for the sites initiating the consultation that have at least some capacity to admit stroke patients locally, particularly when used in conjunction with advanced imaging.

Resources for stroke care vary greatly in a national sample of small-to-midsized community EDs with many lacking essential, evidence-based structures to optimize outcomes. These data may be valuable for helping identify points for strategic health system investment. In addition, future quality measurement and improvement efforts should account for these structural differences when designing efficient stroke systems of care.

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CONFLICT OF INTERESTS

Marquita Decker-Palmer reports being an employee of Genentech and holding shares/stock in the company. William Meurer reports consulting fees from ACEP for methodology statistics review for Annals of EM, consulting fees (modest) from Berry Consultants, LLC, and grant funding relevant to stroke from the Agency for Healthcare Research and Quality. Kori S. Zachrison, Latha Ganti, Dhruv Sharma, Pawan Goyal,

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AUTHOR CONTRIBUTIONS

KSZ and AKV conceived the study. All authors contributed to study design. DS and CM led data collection and analysis. KSZ drafted the manuscript and all authors contributed to critical revisions. All authors approved the final submitted version.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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