



Clinical Performance Measures for Emergency Department Care for Adults With Intracranial Hemorrhage

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Though select inpatient-based performance measures exist for the care of patients with nontraumatic intracranial hemorrhage, emergency departments lack measurement instruments designed to support and improve care processes in the hyperacute phase. To address this, we propose a set of measures applying a syndromic (rather than diagnosis-based) approach informed by performance data from a national sample of community EDs participating in the Emergency Quality Network Stroke Initiative. To develop the measure set, we convened a workgroup of experts in acute neurologic emergencies. The group considered the appropriate use case for each proposed measure: internal quality improvement, benchmarking, or accountability, and examined data from Emergency Quality Network Stroke Initiative-participating EDs to consider the validity and feasibility of proposed measures for quality measurement and improvement applications. The initially conceived set included 14 measure concepts, of which 7 were selected for inclusion in the measure set after a review of data and further deliberation. Proposed measures include 2 for quality improvement, benchmarking, and accountability (Last 2 Recorded Systolic Blood Pressure Measurements Under 150 and Platelet Avoidance), 3 for quality improvement and benchmarking (Proportion of Patients on Oral Anticoagulants Receiving Hemostatic Medications, Median ED Length of Stay for admitted patients, and Median Length of Stay for transferred patients), and 2 for quality improvement only (Severity Assessment in the ED and Computed Tomography Angiography Performance). The proposed measure set warrants further development and validation to support broader implementation and advance national health care quality goals. Ultimately, applying these measures may help identify opportunities for improvement and focus quality improvement resources on evidence-based targets. [Ann Emerg Med. 2023;82:258-269.]

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INTRODUCTION

Nontraumatic intracranial hemorrhage (ICH) including intracerebral hemorrhage and aneurysmal subarachnoid hemorrhage is associated with significant morbidity and mortality.¹⁻⁴ The American Heart Association (AHA)/American Stroke Association (ASA) guidelines recommend that patients with spontaneous intraparenchymal hemorrhage, one of the most common forms of ICH, receive care in a facility with neurocritical care and neurosurgical capabilities.^{5,6} However, many patients initially present and are diagnosed in emergency departments without on-site access to specialists or neurocritical care.⁷ As a result, patients with ICH are often transferred between hospitals.^{8,9} Prior work has demonstrated an association between the earliest hours of care and patient outcomes, including evidence that prolonged stays in the ED setting and delays to admission are associated with higher morbidity and mortality.^{10,11} Furthermore, although prior work has identified gaps in

ED-based care of patients with nontraumatic ICH, including inadequate blood pressure management and delayed anticoagulant reversal,¹² few efforts have sought to develop quality measures suitable for reinforcing the adoption of best practices for ED-based care. Given the success of previous initiatives to develop, implement and use performance measures in emergency care (eg, ischemic stroke care),¹³ similar efforts focused on early care of patients with ICH may fulfill an unmet need.

To date, a number of inpatient-based performance measures have been developed for the clinical care of patients with ICH, including severity score performance and documentation, coagulopathy reversal, venous thromboembolism prophylaxis, admission to an ICU with neurologic expertise, nimodipine treatment in aneurysmal subarachnoid hemorrhage, long-term blood pressure treatment, assessment for rehabilitation, and corticosteroid avoidance.^{14,15} In addition, one prior study from an academic center described the performance of ED-based

care for patients with nontraumatic ICH.¹⁶ These efforts demonstrate the importance of this topic whereas also underscoring the lack of measures oriented toward the *originating* community EDs to which patients often first present.¹⁶ Community-based EDs, where patients often first present, are less likely to be designated stroke centers and may have fewer stroke-specific resources than larger referral centers to which patients are often transferred.¹⁷ Therefore, to address this gap, we chose to address all nontraumatic ICH together because we aimed to move toward a clinically based syndromic rather than a specific diagnosis-based approach to measuring ED-based care, especially as initial management goals are largely overlapping.

As part of the Emergency Quality Network (E-QUAL) stroke collaborative through the American College of Emergency Physicians, we convened a group of experts to identify and design a set of measures to evaluate the initial ED-based care of patients with ICH. In this report, we present those measures. To provide context, we also include initial performance data on those measures from a sample of community EDs participating in the E-QUAL stroke collaborative. This work may provide a valuable foundation for future clinical administrative, policy, and payment efforts.

APPROACH

We present results from 2 stages of the E-QUAL stroke collaborative: (1) the development of measures relevant to ED-based care of patients with nontraumatic ICH, and (2) observational data on measure performance from a national sample of community-based EDs participating in the collaborative to demonstrate measure feasibility. The study did not include protected health information and was not considered human being subjects research.

E-QUAL Stroke Initiative

E-QUAL is a voluntary educational and quality improvement collaborative open to all US EDs.¹⁷ EDs voluntarily participate for quality improvement purposes and have the potential to satisfy the requirements of the Centers for Medicare and Medicaid Services Quality Payment Program. Participating EDs conduct a 6 to 9-month-long quality improvement activity locally, supported by educational materials and data benchmarking provided by E-QUAL.

A total of 69 EDs participated in the E-QUAL initiative in 2020, 2021, or 2022, and after excluding 19 in which minimum case count requirements for quality improvement benchmarking measures were not met (ie, fewer than 20 cases reviewed), 50 remained in our performance measure testing population.

Measure Identification and Development

As part of the E-QUAL Stroke Initiative, we convened a workgroup of leaders in acute neurologic emergencies and emergency care to review the literature and consider appropriate measures to evaluate the quality of emergency care delivery for patients with ICH in the ED. In addition to acute neurologic expertise, the group also included experts in quality measure development and ED evaluation and was enriched by individuals with particular insight into the resources and capabilities of smaller, community-based EDs typical of the originating or *transferring* EDs. The full details of the technical expert panel are presented in [Appendix E1](#) and [Table E1](#), available at <http://www.annemergmed.com>. As noted above, we addressed all nontraumatic ICH together because we aimed to move toward a clinically based syndromic rather than a specific diagnosis-based approach to measuring ED-based care. However, the available evidence base to support the development of these measures is primarily related to intracerebral (or intraparenchymal) hemorrhage and aneurysmal subarachnoid hemorrhage, with less available evidence for other somewhat less-frequently encountered types of ICH, such as nontraumatic subdural or tumor-related hemorrhage.

In advance of the first workgroup meeting focused on measure development, a thorough review of the literature was conducted, and 2 members (K.S.Z., A.K.V.) compiled a set of proposed candidate measures based on guidelines, clinical policies, and existing measures for the inpatient setting. These were presented to the workgroup and served as the basis for discussion and identification of an initial set of ED candidate measures at the first meeting. The initial set of candidate measures was used to guide data collection from E-QUAL participating EDs. A second workgroup meeting was held to review performance data from collaborative EDs on the initial set of candidate measures, during which there was an opportunity for candidate measures to be eliminated and for new candidate measures to be identified for consideration. A subsequent third workgroup meeting was held to review and ensure harmonization of our proposed measures with the 2022 updated guidelines from the AHA/ASA¹⁸ and to finalize the proposed set.

The expert workgroup focused primarily on measures reflecting the processes directly actionable in the ED. In the discussion for each measure, the group considered the appropriate use case, including internal quality improvement, benchmarking, or accountability. Measures recommended for accountability purposes were held to the most rigorous standards, given the potential for financial consequences to be attached to them.

Data Collection and Analysis

We collected 2 forms of quality improvement data to support measure validation and feasibility assessment. First, all participating EDs completed an annual web-based stroke capabilities assessment survey. This survey captured data such as critical access hospital status, safety-net status, rural location, government ownership, academic status, annual visit volume, and admission rate. This also captured stroke-related capabilities, including access to imaging and specialty consultants and the typical disposition of patients with stroke (local admission versus transfer). The survey was completed during the initial enrollment phase of the collaborative, typically during the first 2 months, with the majority completing by May of the given year.

Second, participating EDs conduct ED visit level chart audits every 6 months for quality improvement purposes. For example, EDs participating in 2022 reviewed patient visits during 2 distinct periods: November 2021 to February 2022 and July to October 2022. EDs were able to complete chart review and data submission at any time, though the deadlines for receiving benchmarking reports were July 22nd and December 2nd, respectively. Every ED site is provided with a data abstraction guide to submitting data using a web-based portal on 25 patients with ICH cared for in their ED during the previous quarter. In instances of small case volumes, EDs were permitted to extend the data collection period up to 6 months, consistent with prior work. Cases were not required to be consecutive. Data abstractors were not aware of the measure development process or candidate measures. The E-QUAL stroke collaborative defined patients with nontraumatic ICH based on *International Classification of Disease-10* codes I60.xx, I61.x, I62.0x, I62.1, I62.9, I67.0, and I67.1. The collaborative provided additional support to sites when needed, for example, by helping them connect with their information technology groups or billing companies to identify charts of interest. Once charts were identified, the abstraction was expected to take an average of 3 to 5 hours per site. We use descriptive statistics to present ED performance on measures for which we have available data from participating E-QUAL sites.

PROPOSED MEASURE SET

After conducting a literature review, with a particular focus on current guidelines and existing measures, the workgroup initially conceived of a set of 10 candidate measures identified based on the literature, current guidelines, and measures for evaluating inpatient care (Figure 1).^{5,13,19-24} Two measures were stratified, and 2 additional candidate measures were subsequently added for a total of 14. The workgroup reviewed data based on the

initial measure set collected from the collaborative to support measure validation and feasibility, further deliberated on the full set of 14 candidate measures, and ultimately selected the 7 felt to be most salient, supported by evidence, and useful for inclusion in final recommendations (Table 1).

This proposed 7-measure set includes 5 related to emergency care delivery (Severity Assessment in the ED; Last 2 Recorded Systolic Blood Pressure (SBP) Measurements Under 150; Anticoagulant Reversal; Platelet Avoidance; and Computed Tomography (CT) Angiography Performance), and 2 related to timeliness of transfer or admission (Median ED Length of Stay among admitted patients; Median ED Length of Stay among transferred patients).

Preliminary performance data were available from 50 participating EDs; 48 (96%) of these sites provided general characteristics and stroke-related capabilities. Characteristics of the EDs are presented in Table 2. Median annual volume was 45,000 (interquartile range [IQR] 31,783 to 55,000), 69% reported participation in any stroke registry, and 23 EDs (48%) reported typically transferring patients with ICH. Of those 23 EDs, 14 (61%) reported using telestroke to connect with the receiving hospital before transfer.

Selected Performance Measures

Blood pressure control. For patients with intraparenchymal hemorrhage of mild to moderate severity presenting with increased blood pressure and without contraindications, current AHA/ASA guidelines, and evidence support that acute lowering of SBP to a target of 140 mmHg (with a goal range of 130 to 150 mmHg) is both safe and effective.^{18,23,25-34} The guideline also notes the importance of careful titration of blood pressure lowering and smooth blood pressure control and recommends a goal of reaching the blood pressure target within an hour.²⁵⁻²⁷ For patients with aneurysmal subarachnoid hemorrhage, AHA/ASA guidelines support blood pressure control as well, noting that although the optimal magnitude of blood pressure control has not been established, a goal of <160 mmHg is reasonable.⁶ Our workgroup agreed on the appropriateness of a measure focused on blood pressure control, considered the evidence for intraparenchymal hemorrhage and aneurysmal subarachnoid hemorrhage, and sought to create a *safety* measure for blood pressure control. Although recognizing that different subtypes may have different ultimate goals, the workgroup considered the goal of smooth blood pressure lowering toward these targets in the ED phase of care of this heterogeneous population and agreed that from

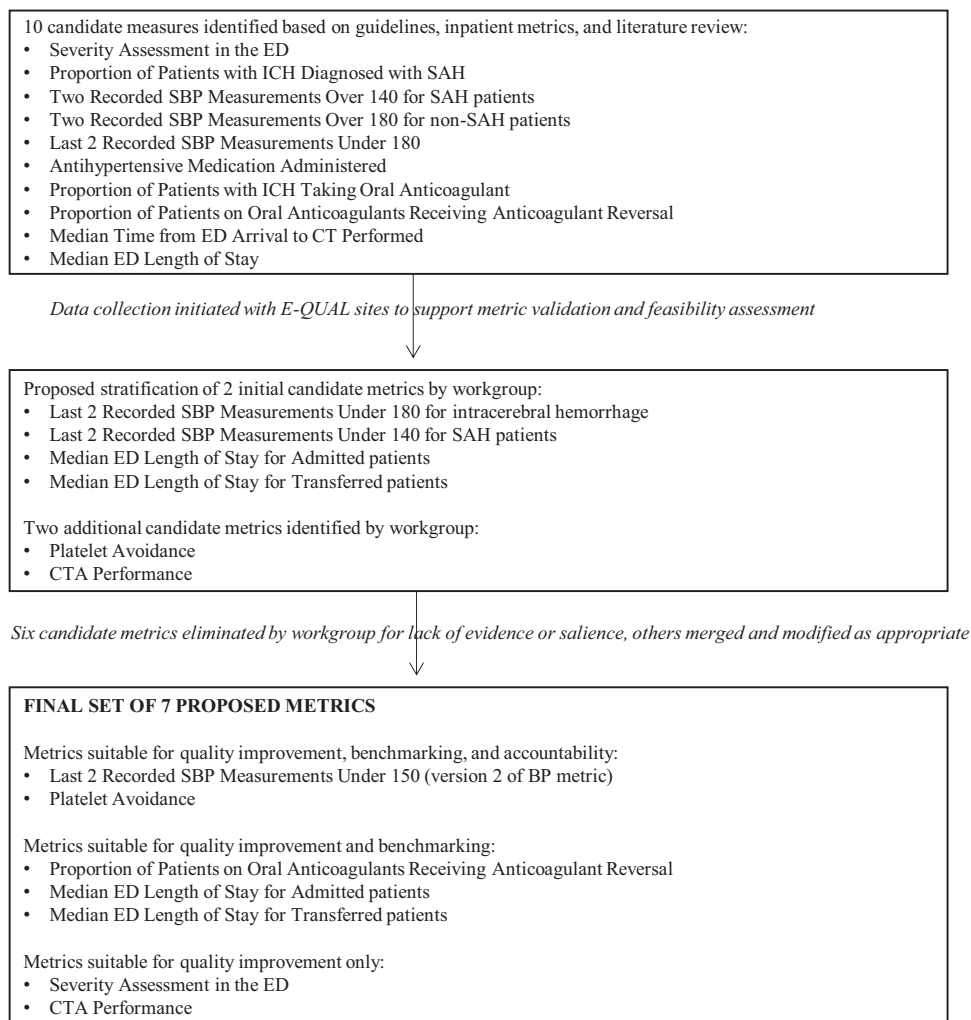


Figure 1. Metric evaluation and inclusion flow diagram. *BP*, blood pressure; *CT*, computed tomography; *CTA*, CT angiography; *E-QUAL*, Emergency Quality Network; *ICH*, intracerebral hemorrhage; *SAH*, subarachnoid hemorrhage.

an ED quality measure perspective, a goal of 150 mmHg is reasonable for balancing guideline recommendations with consideration to the practicalities of the environment in which they are applied. The evidence supports that a quality measure targeting an SBP of less than 150 is associated with less harm for both groups. This target also accommodates the heterogeneous syndrome of ICH, including intraparenchymal and aneurysmal subarachnoid hemorrhage. The choice of a target of 150 is the second version of the blood pressure measurement and was a change from our initial discussion, which started at a goal of less than 180 mmHg (version 1 of the blood pressure measurement). We made the change in response to the ongoing discussion of the evidence and a goal to ensure harmonization and consistency between collaborative specialty societies (in particular, the updated 2022 AHA/ASA guidelines for intracerebral hemorrhage).¹⁸ We also considered the guideline recommendation to ensure

smooth blood pressure control with careful titration of medication administration and sought to address the possibility of patients with very short times to admission or transfer. We thus limited the application of this measure to patients in the ED for at least 60 minutes, which is aligned with the guideline recommendation to achieve blood pressure control within an hour. We also considered concerns that the measure could result in overly aggressive blood pressure management, given the nature in which these measures are often implemented and the known risks associated with rapid reduction and hypotension for these patients. Future quality measures may consider the development of balancing measures, such as a safety measure identifying the proportion of patients receiving antihypertensives who experience hypotensive episodes. We additionally considered process measures around antihypertensive medication administration in addition to these proposed effectiveness measures, such as the

Table 1. Metrics for emergency department-based care of patients with nontraumatic intracranial hemorrhage.

Metrics (Numerator/Denominator)	Evidence-Based Rationale
For quality improvement, benchmarking, and accountability	
Last 2 recorded SBP measurements under 150 Patients whose last 2 recorded SBP measurements were <150 mmHg Cases of ICH with ED length of stay 60 minutes or longer	For patients with ICH presenting with increased blood pressure, acute lowering of SBP is safe and can be effective for improving functional outcomes. For patients with confirmed SAH presenting with increased blood pressure, acute lowering of SBP is safe and effective for improving functional outcomes.
Platelet avoidance Patients receiving platelets Cases of ICH without thrombocytopenia or emergency surgery	Platelet transfusions are potentially harmful to patients with spontaneous ICH being treated with antiplatelet agents and not scheduled for emergency surgery.
For quality improvement and benchmarking	
Proportion of patients on oral anticoagulants receiving anticoagulant reversal Patients receiving hemostatic medication Cases of ICH where patients are taking oral anticoagulant medication with INR >1.3 or direct oral anticoagulant dose within 18 hours	Rapid and effective coagulopathy reversal is important to reduce morbidity and mortality associated with hemorrhagic stroke.
Median ED length of stay for admitted patients Time difference between ED arrival and admission/transfer/discharge time	Prolonged ED length of stay has been associated with poor outcomes at hospital discharge among critically ill patients with ICH.
Median ED length of stay for transferred patients Time difference between ED arrival and admission/transfer/discharge time	Prolonged ED length of stay has been associated with poor outcomes at hospital discharge among critically ill patients with ICH.
For quality improvement only	
Severity assessment performed in the ED Patients on whom a severity assessment is performed Cases of ICH	Use of a standardized severity assessment is useful to quantify neurologic deficits, facilitate communication, and objectively monitor changes in patient status.
CT angiography performance Patients receiving CT angiography Cases of ICH	Rapid neuroimaging is recommended to confirm diagnosis and guide management. CT angiography during the hyperacute phase may identify patients at risk for subsequent hematoma expansion.

ICH, intracranial hemorrhage; INR, international normalized ratio; SAH, subarachnoid hemorrhage.

proportion of patients receiving a parenteral antihypertensive medication or a safety measure identifying the proportion of patients receiving antihypertensives who experience hypotensive episodes. However, given the differences we identified in data capture and data element reliability for items such as medication time stamps, our workgroup recommended the local development and implementation of blood pressure control process measures to complement this care effectiveness outcome measure more amenable to standardization for use in national benchmarking efforts and potential future accountability programs. The workgroup also determined that the considered safety measure would require further study to ensure that it would not inadvertently lead to harm related to under treatment.

Of the 50 EDs with data on blood pressure control, performance on the earlier version of the measure ranged from 0% to 100% of patients whose last 2 recorded SBP

measurements were below 180 mmHg (Figure 2). Median site-level performance was 90% (IQR 0% to 99%).

Platelet avoidance. The workgroup considered the evidence that platelet transfusions are potentially harmful to patients with nontraumatic ICH who are not scheduled for emergency surgery.³⁵ The group agreed that platelet avoidance would be a feasible and low-cost change for smaller EDs to improve clinical care and would be appropriate for quality improvement, benchmarking, and accountability. The measure was constructed as the proportion of patients with ICH not receiving platelets among all patients with ICH, excluding those scheduled for emergency surgery and those with thrombocytopenia. Unfortunately, no data were available from the E-QUAL collaborative to illustrate preliminary performance because the measure was identified after the data collection process had begun.

Administration of anticoagulant reversal therapies. Our workgroup recognized the importance of rapid and

Table 2. Characteristics of emergency departments contributing data.

Characteristics	N = 48*
Rural, n (%)	7 (15%)
ED bed size, median (IQR)	
Annual ED visit volume, [†] median (IQR)	45,000 (31,783 to 55,000)
Hospital stroke center status,* n (%)	7 (15%)
Comprehensive/thrombectomy-capable stroke center	
Primary stroke center	
Acute stroke-ready hospital	
No certification	
ICU in hospital,* n (%)	47 (98%)
24/7 operating room staffing,* n (%)	35 (74%)
Stroke unit,* n (%)	20 (42%)
Interventional service,* n (%)	20 (42%)
Stroke registry participation,* n (%)	33 (69%)
Get with the guidelines – stroke	31 (65%)
CDC Paul Coverdell registry	1 (2%)
Alternative stroke registry	1 (2%)
Patients with intracranial hemorrhage typically require a transfer from the ED,* n (%)	23 (48%)
If transferring, telestroke is used to connect with the accepting hospital prior to transfer,* n (%)	14 (29%)

ICU, intensive care unit; IQR, interquartile range; CDC, Centers for Disease Control and Prevention; QRA, Quality Readiness Assessment.

*Data from capabilities assessment – 483 responses.

[†]Data from QRA – 31 responses.

effective coagulopathy reversal among patients taking oral anticoagulation medication.^{36–46} Coagulopathy reversal was also recommended in the AHA/ASA Performance Measure Set for hospitals¹³ and in the 2022 AHA/ASA guidelines for managing ICH,¹⁸ and an analogous measure is included in the Joint Commission Measure Set. The workgroup determined hemostatic medication administration as a feasible measure for community EDs, constructed as the proportion of cases receiving hemostatic medication among all cases of ICH in which patients are taking oral anticoagulant medication. We considered the measure appropriate for quality improvement and benchmarking in settings with the capabilities for rapid reversal of anticoagulation. However, recognizing the varying resource levels between EDs (including blood bank capabilities), we considered this inappropriate as an accountability measure.

Of the 28 EDs with data on anticoagulation reversal, performance on the measure ranged from 32% to 100% of eligible patients in an ED (Figure 2). Across sites with

available data, there were 136 patients on anticoagulants for whom the administration of a hemostatic medication was documented. The most commonly administered were Prothrombin Complex Concentrate (n=95, 70.0%), vitamin K (n=68, 50.0%), and fresh frozen plasma (n=19, 13.1%). It is important to note that vitamin K on its own is not considered an acceptable sole reversal agent but rather one to augment faster-onset acute therapies.

ED length of stay. Finally, the workgroup agreed that a measure of ED length of stay would be of value for patients with ICH and agreed to use median (rather than mean) length of stay as a measure that is less influenced by outliers. We acknowledge that the length of stay is often outside the ED clinicians' control (eg, because of boarding or delayed availability of emergency medical services for transport). The workgroup did not think this would be a meaningful or actionable measure related to an individual physician or an individual ED's performance. Even so, the measure is still important as an indication of emergency care given that prolonged length of stay has been associated with worse outcomes among many populations, including those with ICH requiring neurocritical care.⁴⁷ Furthermore, data from the National Hospital Ambulatory Medical Care Survey indicated that the length of stay in the ED for patients with nontraumatic ICH had steadily increased over time as hospital inpatient capacity had decreased alongside increased demands for emergency care (Figure 3).⁴⁸ Given the differences between transferred and admitted patients, we recommend that this measure is stratified by disposition and examined separately as the median ED length of stay among transferred patients and median ED length of stay among admitted patients.

Among the 45 EDs with performance data available for this measure, the median EDs' median length of stay for admitted patients was 313.1 minutes (IQR 232.4 to 393.4), ranging from 135.0 to 820.0. Among the 34 sites reporting data for transferred patients, the ED-level median was 203.2 minutes for transferred patients (IQR 175.3 to 260.5), ranging from 103.0 to 1197.0 (Figure 2).

Severity assessment performance. Among all ICH patients, a standard severity assessment has value for quantifying neurologic deficits, standardizing communication, and monitoring patients' neurologic status.^{5,20} A severity assessment tool is also of value for risk-adjusting other patient-centered outcome measures.⁴⁹ Performance of a baseline severity score is included in the AHA/ASA Performance Measure Set for Hospitalized

Measure Definition	Histograms Illustrating Variation in ED Performance	Summary Statistics of EDs' Performance
<p>Last Two Recorded SBP Measurements Under 180*</p> <p>Patients whose last two recorded SBP measurements were <180 mmHg</p> <p>Cases of hemorrhagic stroke</p>	<p>Number of EDs</p> <p>Last Two Recorded SBP Measurements Under 180 mmHg</p>	<p>Number of EDs included in measure: N = 50</p> <p><u>ED-level proportion:</u></p> <ul style="list-style-type: none"> -Mean (SD): 0.5648 (.4677) -Median (IQR): . 8965 (0,0.9904) -Range:0-1
<p>Proportion of Patients on Oral Anticoagulants receiving Anticoagulation Reversal</p> <p>Patients receiving hemostatic medication</p> <p>Cases of hemorrhagic stroke where patients are taking oral anticoagulant medication</p>	<p>Number of EDs</p> <p>Proportion of Patients on Oral Anticoagulants receiving Hemostatic Medication</p>	<p>Number of EDs included in measure: N= 28 (22 sites missing data)</p> <p><u>ED-level proportion:</u></p> <ul style="list-style-type: none"> -Mean (SD): .6190 (.3741) -Median (IQR):.6667 (.3214-1) -Range:0-1
<p>ED Length of Stay for Admitted Patients</p> <p>ED Departure time – ED arrival time</p>	<p>Number of EDs</p> <p>ED Length of Stay among Admitted Patients</p>	<p>Number of EDs included in measure: N = 45 (5 sites missing data)</p> <p><u>ED-level time in minutes for admitted patients:</u></p> <ul style="list-style-type: none"> -Mean (SD): 321.5968 (133.1453) -Median (IQR): 313.1 (232.4 – 393.4) -Range: 135.0 -820.0
<p>ED Length of Stay Among Transferred Patients</p> <p>ED Departure time – ED arrival time</p>	<p>Number of EDs</p> <p>ED Length of Stay Among Transferred Patients</p>	<p>Number of EDs included in measure: N = 34 (16 sites missing data)</p> <p><u>ED-level time in minutes for transferred patients:</u></p> <ul style="list-style-type: none"> -Mean (SD): 268.0488 (212.789) -Median (IQR): 203.2 (175.3 – 260.5) -Range:103.0 – 1197.0
<p>Severity Assessment Performed in the ED</p> <p>Patients on whom a Severity Assessment is performed</p> <p>Cases of hemorrhagic stroke</p>	<p>Number of EDs</p> <p>Severity Assessment</p>	<p>Number of EDs included in measure: N = 50</p> <p><u>ED-level proportion:</u></p> <ul style="list-style-type: none"> -Mean (SD): 0.8362 (0.2710) -Median (IQR): 1 (0.8171,1) -Range: 0.1379-1

Figure 2. Performance on metrics for emergency department (ED) care of patients with intracranial hemorrhage among a sample of community-based EDs. No data were available for platelet avoidance of CT angiography performance. SD, standard deviation. *Performance data collected for this metric were based on version 1 implemented in 2020 (Last 2 SBP Measurements Under 180 mmHg).

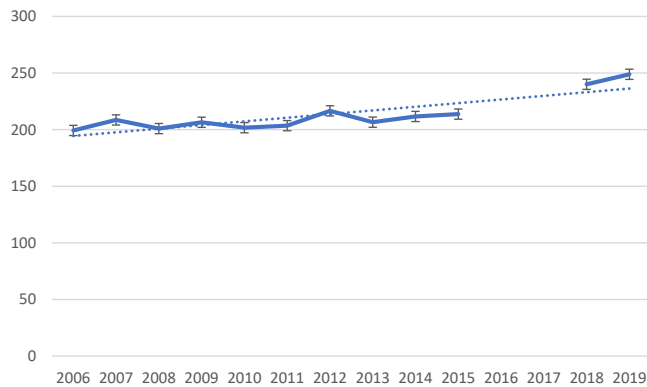


Figure 3. Emergency department length of stay among all visits for nontraumatic ICH, 2006 to 2019. Based on NHAMCS length of visit by year, missing 2016 and 2017, error bars indicate standard errors around the means. *ICH*, intracranial hemorrhage; *NHAMCS*, National Hospital Ambulatory Medical Care Survey.

Patients with ICH, is included in the Joint Commission Measure Set, and is endorsed by the National Quality Forum.¹³ Our workgroup discussed using the ICH score, the National Institutes of Health Stroke Scale, and the Glasgow Coma Scale. Based on its use as an inpatient measure and its value for supporting other potential outcome measures, if future research supports its generalizability to the ED, a severity score measure may become salient. However, the workgroup concluded that this measure might be useful for internal quality improvement purposes only but is not currently appropriate for benchmarking or accountability, given the lack of evidence closely linking scale documentation to outcomes.

Of the 50 EDs with data on severity assessment performance (any scale accepted), the median proportion of patients with severity assessment performed in the ED was 83.6%. However, there was substantial variation in performance, ranging from 13.8% of patients in the lowest-performing ED to 100% of patients in the highest-performing ED. The 25th and 75th percentiles were 81.7% and 100%, respectively (Figure 2).

CT angiography performance. CT angiography provides critical information in nontraumatic ICH, including identifying underlying aneurysms or other vascular malformations to guide ongoing care and identifying those at risk for subsequent hematoma expansion.^{6,50-55} The workgroup considered that CT angiography performance would be valuable to capture, constructed as the proportion of all nontraumatic ICH patients in whom a CT angiography was performed. However, the optimal timing of CT angiography performance relative to patient transfer may vary depending on local resources, transfer destination, and local care

systems. As a result, this measure is recommended only for local quality improvement purposes, and its usefulness is limited to sites where CT angiography is available and considered appropriate in the local care context. Unfortunately, CT angiography performance among E-QUAL sites was not measurable because of data quality issues.

DISCUSSION

We propose a set of 7 performance measures for evaluating and improving ED-based care for patients with nontraumatic intracerebral hemorrhage. These measures address key components of the initial evaluation and treatment of nontraumatic intracerebral hemorrhage and harmonize the best available evidence with the expected resources and capabilities of community-based EDs. Preliminary data from community EDs participating in the E-QUAL network demonstrate the feasibility of implementation and systematic monitoring of these metrics and also reveal substantial variation in performance. This sets a valuable foundation to improve care delivery and outcomes for patients with nontraumatic ICH – a condition associated with high morbidity and mortality rates.

Prior work in ischemic stroke has demonstrated the substantial result of quality improvement efforts and quality measurement for improving patient care and outcomes.^{13,56} For patients with ICH, a small number of prior studies suggest that focused quality improvement interventions directed at hemorrhagic stroke care may have similar potential. For example, in a quality improvement intervention focused on patients transferred to an urban academic center, improved timeliness of care for patients with nontraumatic ICH is reflected by reduced ED length of stay and boarding and also improved communication between clinicians.⁵⁷ Another study from an academic center leveraged ICH-relevant quality measures to evaluate and improve the care process for patients with ICH.¹⁵ Building on this promising early work, further research is needed to examine the utility of ED hemorrhagic stroke care, including the measures proposed here.

The workgroup discussed a number of measures that were ultimately not included in the final recommended set. This included measures that are descriptive to capture population characteristics but are not measures of the quality of care delivery (eg, proportion of patients with ICH diagnosed with subarachnoid hemorrhage or proportion of patients with ICH taking oral anticoagulant). This also included measures that characterize clinical presentation to inform eligibility for other measures (eg, 2

recorded SBP measurements over 180 mmHg). Finally, we discussed time-based measures of time from ED arrival to CT performed but did not find sufficient evidence to support the measures.

There are several potential use cases for the proposed measures, ranging from monitoring local quality improvement interventions to regional or national benchmarking to external accountability, such as accreditation or reimbursement-based quality programs. Platelet avoidance, for example, is a well-supported measure by the evidence, correlated with patient outcomes, and feasible for EDs of all sizes and resource levels. Although additional data will be valuable to understand the degree of variation in ED performance on the measure, our workgroup agreed that in addition to quality improvement, platelet avoidance is a good candidate for benchmarking and accountability. In contrast, others should be used only for quality improvement purposes. For example, severity assessment performance in the ED was recognized by our workgroup to be valuable for improved delivery of care and communication between care team members and for purposes of risk-adjusting patient outcome data. However, in the absence of evidence connecting the measure to improved patient outcomes, the measure is less suitable for benchmarking or accountability. Nevertheless, when implemented together across the spectrum of use cases, these 6 proposed measures may be complementary in advancing quality improvement and improving outcomes for patients with nontraumatic ICH.

Our process not only identified 7 measures potentially suitable to advance quality for nontraumatic ICH care in the ED but also was able to triangulate expert opinion with real-world data to test the feasibility of implementation and identify variation in performance among a small sample of community EDs.

It is important to note that the evidence base for these measures is not inclusive of patients with nontraumatic subdural hemorrhages or tumor-related hemorrhages who have been excluded from most studies. However, the nuances of those diagnoses may not always be apparent at index ED evaluation, and thus this set of measures focuses on the broad clinical syndrome. In addition, a major limitation of this work is that there are limited data on ED performance related to the proposed set of measures. We include preliminary data from a small sample of community EDs but acknowledge that this is a convenience sample of sites that have elected to participate in a quality improvement program, and performance is likely not representative of community EDs nationally. Additionally, the data included are based on nonconsecutive patient charts and may be prone to

desirability bias if abstractors preferentially submitted data from charts with higher performance. Nevertheless, even if these preliminary performance results are artificially high, our results reflect significant variation in performance and substantial room for improvement. We also do not have data specifically demonstrating that introducing any of these quality measures will translate to improved patient outcomes; we would not recommend adopting quality measures ahead of a pilot program demonstrating feasibility and appropriateness in implementation. Even so, this work provides an important first step in defining measures to guide future data collection and performance evaluation for further modification and refinement of the proposed measure set.

Through a combination of expert review and pilot quality improvement data, the American College of Emergency Physicians E-QUAL Stroke Initiative proposed a set of 7 measures to improve care delivery and outcomes for patients in the ED with nontraumatic ICH. After further testing and validation of the full measure set, applying these measures may help identify targets for improvement and provide focus to quality improvement efforts in community-based EDs. In addition, further research is needed to determine the result of quality improvement programs utilizing these measures on the efficiency of stroke systems of care and patient outcomes.

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