Neurocrit Care (2020) 32:5–79
https://doi.org/10.1007/s12028-019-00846-w

NEUROCRITICAL CARE SOCIETY

SPECIAL ARTICLE

Clinical Performance Measures for Neurocritical Care: A Statement for Healthcare Professionals from the Neurocritical Care Society

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Abstract

Background: Performance measures are tools to measure the quality of clinical care. To date, there is no organized set of performance measures for neurocritical care.

Methods: The Neurocritical Care Society convened a multidisciplinary writing committee to develop performance measures relevant to neurocritical care delivery in the inpatient setting. A formal methodology was used that included systematic review of the medical literature for 13 major neurocritical care conditions, extraction of high-level recommendations from clinical practice guidelines, and development of a measurement specification form.

Results: A total of 50,257 citations were reviewed of which 150 contained strong recommendations deemed suitable for consideration as neurocritical care performance measures. Twenty-one measures were developed across nine different conditions and two neurocritical care processes of care.

Conclusions: This is the first organized Neurocritical Care Performance Measure Set. Next steps should focus on field testing to refine measure criteria and assess implementation.

Keywords: Neurocritical care, Performance measures, Quality, Metrics

Introduction

Efforts to formally measure the quality of medical care have evolved over the past two decades, spurred on in part by the Institute of Medicine's call to action, *Crossing the Quality Chasm* [1]. A substantive aspect of these efforts has been the development of quality indicators or performance measures (PM), which offer organizations and healthcare providers a specific structure by which to measure, evaluate, and improve care. The Agency for Healthcare Research and Quality (AHRQ) defines quality indicators as "standardized, evidence-based measures of healthcare quality that can be used with readily available hospital inpatient administrative data to measure and track clinical performance and outcomes" [2]. The development and use of quality indicators or PMs are intended to promote the delivery of high quality and safe patient care. For the purposes of this document, the terms quality indicators and PM are considered interchangeable, and PMs will be used for clarity.

The delivery of neurocritical care encompasses multiple medical conditions, occurs in a variety of patient locations within the healthcare system, and involves a

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multitude of providers across different specialties. While PMs exist for some aspects of neurocritical care conditions such as stroke and seizures, there is no formal organized set of PMs specifically designated for neurocritical care. Recognizing this, the Neurocritical Care Society (NCS) convened a writing group in 2016 to develop PMs relevant across the spectrum of neurocritical care and the various inpatient acute hospital settings in which care is delivered (i.e., not limited to dedicated neurocritical care units or specialty-trained neurocritical care providers). The writing group aimed to develop a unified Neurocritical Care Performance Measure Set based on: (1) a systematic review of existing clinical practice guideline (CPG) recommendations that could be developed into new PMs, and (2) the identification and vetting of existing PMs for inclusion in the measure set. This initiative is part of a multifaceted effort to expand quality improvement resources for clinicians caring for neurocritically ill patients and to improve outcomes for these patients. This includes a recent publication on standards for Neurologic Critical Care Units that should be seen as complementary to this PM work, but addresses structural elements of care, whereas PMs address the process and outcomes of care provided [3].

The target audience for this Neurocritical Care Performance Measure Set is practitioners who care for neurocritically ill patients worldwide and the purpose is to improve the care of patients. The intent is to optimize patient-centered outcomes, though the implementation of PMs is often impacted by regulatory and/or financial drivers. Consumers, providers, accountable care organizations and payors are increasingly using PMs to demonstrate and measure the quality of healthcare. In the USA, payors sometimes use PMs to align financial incentives and penalties [4]. To be used in this manner, PMs must be well-developed, vetted, and tested to ensure that they are evidence-based, meaningful, valid, measurable, and reliable. Before these PMs are used in a regulatory setting (especially those that are new), beta testing is necessary. However, this should not delay their implementation as a framework for practitioners to improve the care of their patients.

Methods

Although there is no uniformly accepted process for developing PMs, there are examples from organizations and published medical literature that review and describe the components of reasonable methodologies that could be considered best practices [5–8]. Because this is the first set of PMs developed principally by the NCS, the first task of the writing group was to define a standard methodology for the selection and development of individual PMs and the collective measure set. The writing group employed a methodology that included eight key steps (Fig. 1). As established by the group a priori, PMs were derived solely from published evidence-based CPG recommendations or existing PMs, as opposed to reports utilizing expert consensus or intuition-based methodologies designed to drive aspects of care. A standardized form was used to document each PM, and includes a PM statement or definition, numerator, denominator, period of assessment, sources of data, rationale, sources of clinical recommendations, methods of reporting/type of score, type of PM, quality strategy domain, challenges to implementation, and analogous PMs endorsed by other organizations. The full PM set of measure specification forms (MSF) is included in the Appendix.

Composition of the Writing Group

An international, multidisciplinary writing group was formed through the NCS Guidelines Committee, and provided oversight for the PM development process. Writing group members were identified according to their expertise in neurocritical care and previous experience developing PM or leading healthcare quality initiatives. The group was diverse, representing multiple geographic areas across the USA and Europe. The writing group included pharmacy and nursing representatives, as well as physician neurointensivists from neurology, anesthesia, and neurosurgery. Work was conducted during regular conference calls and two in-person meetings. All authors disclosed relationships with industry and any other conflict of interest at the outset of the project and any potential conflicts were addressed according to NCS policy.

Scope of PM

For this set of PMs, neurocritical care was defined according to disease process and acuity of care. Thirteen medical conditions were identified from the modules

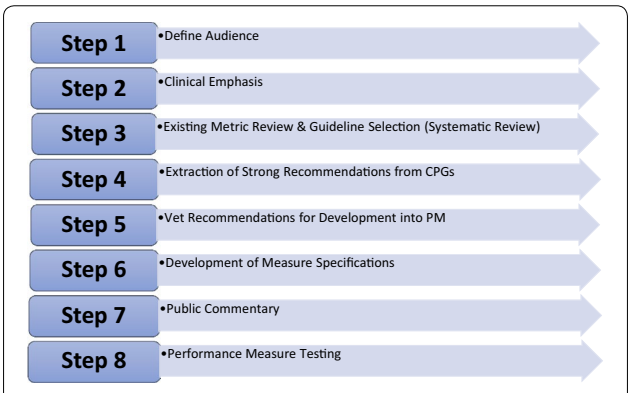

Fig. 1 NCS performance measure set development methodology

covered in the Emergency Neurological Life Support program (Table 1) and included for consideration in the development of neurocritical care PMs. Topics relevant to multiple neurocritical care disease conditions and represented by existing CPGs developed by NCS were also considered for inclusion (coagulopathy reversal, venous thromboembolism prophylaxis, external ventricular drain (EVD) management, management of devastating brain injury, and multimodality monitoring). In order to focus the scope of this neurocritical care PM Set, general critical care topics such as pain, sedation, and vascular access were not included. Also, scope was limited to include adults (age $\geq$ 18 years) only.

As the purpose of these PMs is to improve the quality of care for patients with neurocritical care diseases, PMs were specifically designed to be patient-centered, as opposed to focused on medical practitioner specialty or the physical location in which care is provided. This was considered particularly important because different care models in the USA and worldwide may involve different types of providers and physical structures depending on resource allocation and distribution. Thus, these measures do not apply, and are not intended to apply, solely to practitioners who self-identify as neurointensivists or only to patients cared for in a specifically designated neurocritical care unit. Applying these PMs broadly to all patients with the included conditions will necessitate collaborative work within and across hospitals to ensure that patients receive the appropriate quality of care regardless of the nature of the provider or the location of care. Therefore, these measures would be expected to be implemented in neurocritical care units, emergency departments, general intensive care units (ICU), or general hospital wards based on the customs, practices, infrastructure, and resources of the system in which the patient is receiving care. Because of the nature of neurocritical care, these PMs apply only to the inpatient acute care hospitalization related to the primary condition.

Since the target audience for these PMs is providers caring for neurocritically ill patients throughout the world, and in accordance with NCS's status as an international organization, CPGs and existing PMs from any country were included in the systematic review, provided the publication was in English. As such, the collective measure set reflects a diversity of neurocritical disease conditions from a global perspective. The burden of specific neurocritical care disease conditions varies considerably from country to country, as does quality measurement in healthcare and use of PMs. Consequently, certain PMs may have the potential for greater or lesser impact on quality of care, depending on country and disease condition prevalence.

Table 1 Disease processes considered for performance measure development

Acute ischemic stroke
Acute non-traumatic weakness
Coma
Intracerebral hemorrhage
Aneurysmal subarachnoid hemorrhage
Intracranial hypertension and herniation
Meningitis and encephalitis
Hypoxic-ischemic encephalopathy and targeted temperature management
Spinal cord compression
Status epilepticus
Traumatic brain injury
Traumatic spinal cord injury
Brain death

Results

We conducted a systematic database search in Ovid Medline/PubMed/Cochrane, CINAHL, and EMBASE to identify all CPGs and published PMs related to the neurocritical care management of the conditions included (Table 1). Only CPGs and PMs specifically related to the neurocritical care management of the diseases mentioned were considered for PM development. CPGs and PMs related to general critical care topics (e.g., pain or sedation) were not considered for PM development. Table 3 in appendix provides an overview of search terms used.

The websites of relevant professional societies and regulatory agencies including the Centers for Medicare and Medicaid (CMS), National Quality Forum (NQF), The Joint Commission (TJC), Det Norske Veritas (DNV) Healthcare, and the National Institute for Health and Care Excellence in the United Kingdom were hand-searched to identify existing PMs not published in an indexed database. Documents published in English between 2000 and 2018 were included. In order to be considered as a source document for potential PM development, only CPGs describing a robust consensus methodology used for generating recommendations were included, in accordance with AHRQ guideline criteria. Specifically, recommendations were included if rigorously developed, evidence-based and related to health outcomes, and there was clarity about the source(s) from which the review criteria were derived. In order for existing PMs to be considered for inclusion as a PM in this measure set, they had to include proposed inclusion and exclusion criteria and a measurable numerator and denominator, with or without clear abstraction guidelines.

The search identified 50,257 citations (Fig. 2). Each document underwent title and abstract review by two writing group members to identify CPGs and publications describing PMs. Of the 50,257 citations identified, 398 documents were taken to full text review, which included validation of the document as a CPG or a publication describing a PM. This stage included an analysis of each CPG using a modified Appraisal of Guidelines for Research and Evaluation II tool to ensure that the document met minimum established criteria for CPG quality

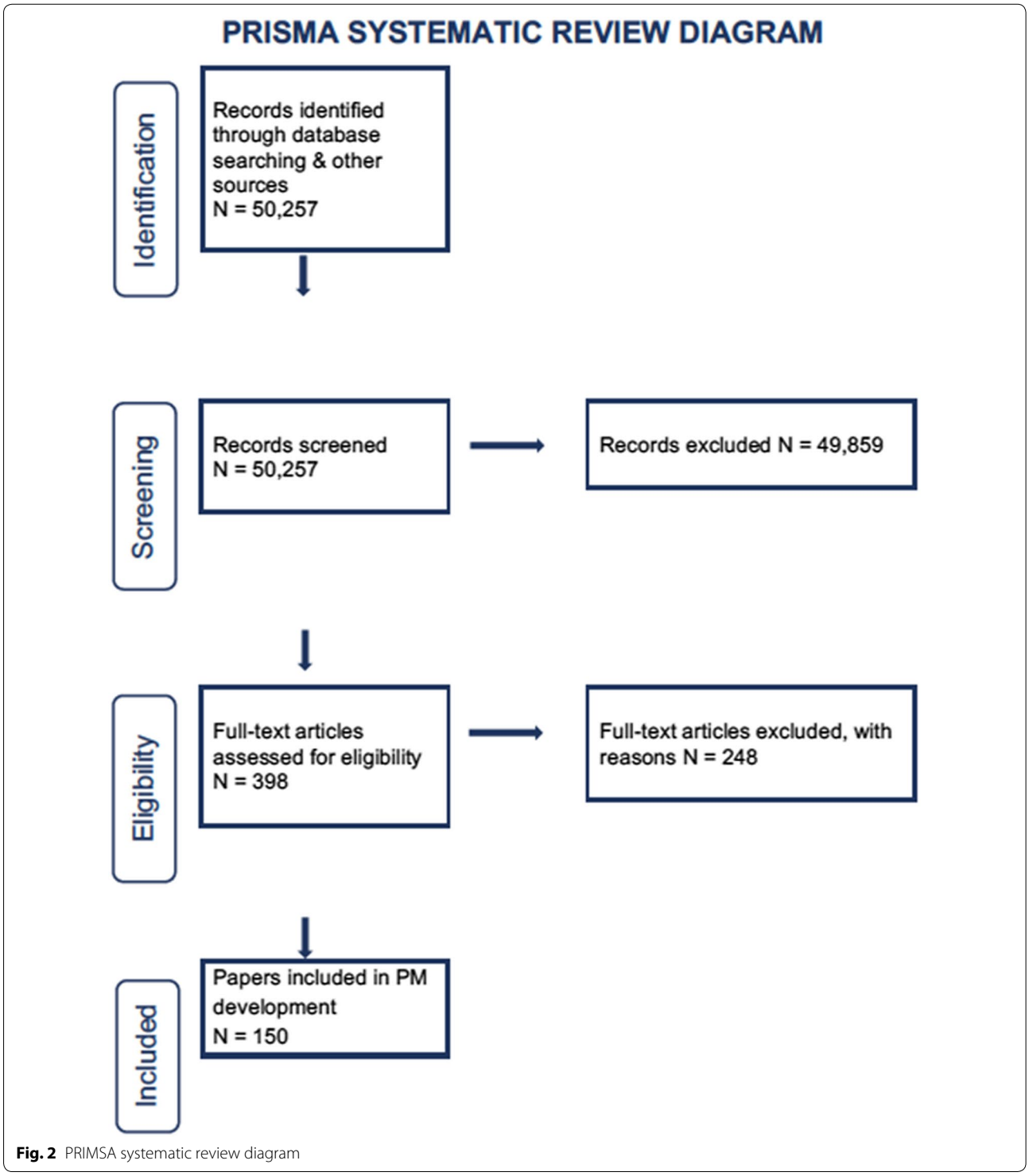

Fig. 2 PRIMSA systematic review diagram

[9]. This level of review identified 150 documents that underwent data extraction. Each phase of review was completed independently by two writing group members. Conflicts were discussed between the reviewers with a third writing group member adjudicating the conflict, if necessary. The systematic review was conducted using DistillerSR software™.

Extraction of Recommendations

The writing group employed a rigorous process to extract only the strongest recommendations based on the specific methodology used in the specific CPG. Strong recommendations were prioritized as most guideline methodologies give stronger ranking to recommendations with the highest quality of evidence to support the recommendation. Examples would include a *Strong* recommendation if the GRADE methodology [10] was used or a *Class I* recommendation of the American Heart Association/American Stroke Association (AHA/ASA) methodology [11] was used. Lesser recommendations were not considered for development into PMs. The most recent iterations of a guideline were prioritized for extraction. However, all guidelines were reviewed. Each extracted recommendation from the CPGs was collated with other similar recommendations according to disease and topic. To determine which recommendations should be proposed for development into a PM, each recommendation was critically reviewed using the following criteria:

- Importance of the recommendation to neurocritical care
- Scientific acceptability and evidence base is well-established
- Feasibility—the data required for the PM is likely to be obtained at a reasonable cost and during the period allowed for data collection
- Actionability—the degree to which a practitioner can influence the quality of care being delivered by a health system
- Denominator—the patient group to whom the PM applies is clinically meaningful
- Validity and reliability of the recommendation and resulting PM

Each recommendation was evaluated for inclusion according to these criteria. Consequently, there are some aspects of care that are likely reasonable and may represent current best practices, but based on the above criteria were not felt suitable as a formal PM. This should not be interpreted as suggesting that aspects of care that are not formal PMs are inappropriate or should not be performed. Rather, it should be understood that the writing group did not feel that inclusion among the relatively small group of rigorously developed PMs was warranted according to the methodology used.

Development and Review of MSF

Recommendations were developed into PMs using the criteria outlined in the MSF. Fifty-one proposed PMs were presented for discussion at an in-person writing group meeting in June 2018. Over the next 6 months, candidate PMs underwent an iterative process of development, discussion, and revision. The writing group then voted on the PMs using a predefined worksheet with a five-point Likert scale for each of the criteria described above and an additional question regarding overall suitability as a PM. Any PM with a score in any category less than four was reviewed and discussed further by the writing group. A draft set of PMs was presented at the NCS annual meeting in September 2018. Attendees were invited to provide written feedback to the writing group that prompted further review and editing of the PMs.

The revised candidate PMs were then posted for a 30-day general public comment period in December 2018. Relevant organizations and societies were invited via e-mail to review and comment on the candidate PMs. All comments were reviewed by the writing group to determine if changes to the PMs were warranted. The PMs were edited based on this public feedback a final time prior to drafting this manuscript. The final PM Set and accompanying manuscript underwent peer review prior to publication according to NCS policy. The final NCS PM Set and manuscript were approved by the NCS Guidelines Committee and the NCS Board of Directors prior to publication.

Patient Population and Care Period

The patient population is adults (age 18 years or older) with the primary discharge diagnosis of the relevant disease from the title of each specific PM. The care period is the acute hospitalization for diagnosis and management of that condition. This includes emergency department care and management in the ICU and hospital wards, with the specific period of assessment (e.g., entire hospitalization, first 24 h of care) specified in each individual PM. Patients with neurocritical care conditions may receive significant care in other locations such as the pre-hospital or post-acute care rehabilitation setting. However, these care periods were not included because of the focus of this initial PM Set. Likewise, children (age less than 18 years) were excluded as were patients who developed neurocritical conditions subsequent to an admission for another primary disease condition (e.g., in-hospital stroke following admission for myocardial infarction, or status epilepticus occurring after admission for sepsis). This should not be taken

to mean that relevant guidelines and treatments do not apply to these patients, but rather that specific decisions that were expected to capture the most relevant scope for these PMs had to be made at the beginning of the process. Hospital admissions with length of stay > 120 days were excluded, as is done in many NQF-endorsed PMs, to avoid double counting patients when generating quarterly reports. These PMs do apply to patients transferred from one acute care setting to another, with the sending and receiving hospital responsible for the appropriate aspects of the PM.

Discharge administrative records should be used when possible to identify eligible patients. In the USA, International Classification of Diseases version 10 codes, standardized disease registries, or surveillance of hospital admission logs may be used for this purpose. In other countries, codes used in national administrative or billing databases relevant to that country, disease registries, or admission surveillance logs are recommended. If none exist, then primary discharge diagnosis from chart review of hospital records should be used.

Brief Summary of the Neurocritical Care Performance Measure Set

Table 2 lists the full Neurocritical Care Performance Measure Set. The set consists of 21 PMs: Six that are similar or the same as stroke measures developed by the AHA/ASA and/or TJC, five that are similar or the same as the American Academy of Neurology (AAN) Inpatient and Emergency Neurology Quality Measurement Set (the development of which NCS was a participant), and ten newly proposed PMs. When including existing PMs, the writing group considered the evidence in support of the PM and whether revisions or adaptations were warranted to improve feasibility or actionability with the desire to minimize suggested changes in an effort to harmonize with prior efforts. Overall, ten PMs were related to stroke (including ischemic stroke, intracerebral hemorrhage, and subarachnoid hemorrhage), two involved neuromuscular diseases (Guillain–Barre Syndrome and myasthenia gravis), three were related to neuroinfectious diseases, two concerned status epilepticus, one with traumatic brain injury, one with global cerebral ischemia after cardiac arrest, and two with processes of neurocritical care delivery relevant to more than one disease condition. Of the 13 topics described in Table 1, PMs were not developed for five diseases (coma, intracranial hypertension, non-traumatic spinal cord compression, traumatic spinal cord injury, and brain death) due to lack of meeting criteria for inclusion.

The writing group developed a detailed Performance Measurement Specification Form for each PM (see Appendix) that provides a PM statement, numerator, denominator, period of assessment, sources of data, rationale, sources of clinical recommendations, methods of reporting/type of score, type of PM, quality strategy domain, challenges to implementation, and analogous PMs endorsed by other organizations. The Discussion section of this manuscript provides a brief summary of challenges related to the development of the PM Set, addresses concerns brought forth by the writing group and in public comment, and gives recommendations for further testing of the PMs. References for source documents or rationale for each PM are included in the individual MSF's to allow for ease of review and are also included here [5, 11–109].

Discussion

The 21 PMs in the NCS PM Set are the result of a systematic review of existing PMs and CPGs with extraction of the strongest recommendations into PMs. These PMs reflect an 18-month effort to vet the best evidence in neurocritical care and create PMs relevant to patients with neurocritical illness. The responsible development of PMs requires a careful balance: PMs aim to provide a framework to ensure that the best medical evidence is systematically applied in patient care, while also considering the intended and unintended consequences of the proposed PM. This is of particular concern in the USA where healthcare financial reimbursement may be aligned with PMs. PM must be validated in a real-world context prior to alignment with financial or accreditation outcomes. While creating the neurocritical care PM Set, we encountered a number of challenges across several domains including the scope of neurocritical care, establishing measurement criteria in the absence of clear evidence for specific criteria, harmonization with PMs from other organizations, and accepting that not all topics of interest to neurocritical care providers lend themselves to PM development. We believe a review of these challenges is relevant to understanding the current draft neurocritical care PM Set and setting a direction for ongoing PM development and refinement.

Scope Challenges

Ensuring a defined scope of neurocritical care for PM development was a priority for the writing group at the outset and continued to be revisited throughout the development of the neurocritical care PM Set. The perceived range and scope of neurocritical care differ by various providers and organizations; this was particularly evident from feedback during the public comment period. For example, some providers felt that a particular PM should not be included because it did not fall under care delivered within their specialty, such as care most often delivered in an emergency department (e.g., status

Table 2 NCS performance measure set

NCS performance measure	Same or similar to ASA performance measure	Same or similar to AAN performance measure	Same or similar to TJC performance measure	New measure
1. Baseline severity scale in stroke	X		X	
2. Admission unit for stroke	X			
3. Acute interventions in ischemic stroke				X
4. Vascular imaging in ischemic stroke				X
5. Symptomatic ICH after ischemic stroke intervention	X		X	
6. Decompressive craniectomy in ischemic stroke				X
7. Coagulopathy reversal in ICH	X		X	
8. Avoidance of steroids in ICH	X		X	
9. Nimodipine in aSAH	X		X	
10. Screening for vasospasm in aneurysmal aSAH				X
11. Immunomodulatory treatment for Guillain–Barre syndrome		X		
12. Immunomodulatory treatment for myasthenic crisis		X		
13. Dexamethasone in bacterial meningitis		X		
14. Acyclovir for herpes simplex virus encephalitis				X
15. Dexamethasone in tuberculosis meningitis				X
16. Benzodiazepine in status epilepticus		X		
17. Status epilepticus treatment with anticonvulsant medication		X		
18. Avoidance of steroids in traumatic brain injury				X
19. Targeted temperature management in cardiac arrest				X
20. Documentation of External ventricular drain insertion bundle				X
21. Venous thromboembolism prophylaxis in neurocritical care				X

AAN American Academy of Neurology, *ASA* American Stroke Association, *aSAH* aneurysmal subarachnoid hemorrhage, *ICH* intracerebral hemorrhage, *NCS* Neurocritical Care Society, *TJC* The Joint Commission

epilepticus) or by providers that might not identify as neurointensivists (e.g., neurointerventionalists). Others felt that inclusion criteria should be limited to patients cared for in a neurocritical care unit, and therefore patients with an identical condition would be excluded if they were cared for in a general ICU (e.g., traumatic brain injury patient in a surgical ICU). Others suggested that because they did not see many patients with a specific condition (e.g., tuberculous meningitis) in their practice, it was not of sufficient concern to include as a PM. Defining neurocritical care from each of these lenses could result in different priorities in PM development. We chose specifically to define neurocritical care from the perspective of a patient who has a specific disease

process, rather than based on the provider or location of care. The writing group maintained throughout the development of the neurocritical care PM Set that neurocritical care was defined by the acuity of illness in each of the diseases outlined in Table 1. Therefore, the PMs in our PM Set should be applicable to patients in multiple care settings, including the emergency department, ICU, or even acute care units in some instances. For example, PMs related to status epilepticus management, bacterial meningitis and acute stroke may be more likely to be measured in the emergency department than the ICU. However, due to the critical acuity of the neurologic illness, we included these measures as a part of the neurocritical care PM Set. Similarly, targeted temperature management (TTM) after cardiac arrest may be managed by different provider teams and in different ICUs depending on the organizational structure of different hospitals. However, hypoxic-ischemic encephalopathy after cardiac arrest is a critical neurologic illness and, therefore, included in the neurocritical care PM Set. Finally, some programs engage their neurocritical care providers in the acute management of stroke and other illnesses in the emergency department, telemedicine programs, or consult teams. By defining the scope of neurocritical care by the nature and acuity of illness, the focus remains on the patient and enables the highest number of patients worldwide to be helped by these PMs.

Measurement Criteria

We aimed to be evidence-based in all aspects of PM development. This approach directed our methodology in the systematic review and extraction of recommendations from CPGs. However, this was challenging at times during the development of the MSF's. Performance MSF requires clear measurement criteria (e.g., timeframes and frequency of assessment). This proved difficult in several instances where evidence clearly supported a clinical management approach, but extracted CPGs and their source documents did not specify certain information required to create a rigorous PM. For example, urgent treatment of status epilepticus resulting in prompt seizure cessation is recommended. However, the administration of benzodiazepines in status epilepticus and the treatment of ongoing status epilepticus with anticonvulsant medications can only be a measurable PM if a timeframe for administration is specified, and such a precise timeframe is not clearly specified in strong recommendations from CPGs. After much discussion, the writing group decided to adopt the American Epilepsy Society timeline that accompanies their status epilepticus CPG [44].

Conversely, the writing group felt that existing evidence did not lend itself to more specific measurement criteria for when and how often screening for vasospasm should occur in aneurysmal subarachnoid hemorrhage (aSAH). Even so, it was felt that having a PM for vasospasm (and delayed cerebral ischemia) screening was merited by existing CPG recommendations and that future efforts should focus on better refining the time window for screening. Likewise, numerous strong recommendations from several CPGs support the use of TTM in comatose patients after cardiac arrest. However, specific metrics for effectiveness of the intervention at achieving and maintaining a temperature target are not sufficiently evidence-based to become part of a PM. Finally, while the randomized trials assessing decompressive craniectomy in large hemispheric infarction demonstrate improved patient outcome and thirteen separate strong CPG recommendations are provided as sources in the MSF, it is recognized that some patients or their families would choose not to have this procedure even if discussed in a manner that did not reflect a bias of the practitioner providing the information. Thus, compliance with this measure can be met as either performance of decompressive craniectomy or clear documentation in the medical record of why the procedure was not performed, which should include documentation of patient or family preferences regarding medical decision-making. As more providers become aware of and begin to use PMs to improve their practice, this tension between implementing a CPG-based recommendation and the specific criteria by which compliance is measured will become important when considering the spirit and intent of a specific PM.

Performance Measure Harmonization

The writing group felt that it was both important and appropriate to include existing PMs put forth by other organizations, if they met the predefined methodological criteria, rather than assuming that their presence in other documents was sufficient. The purpose of this was to provide a comprehensive PM measure set across the a priori defined scope of neurocritical care even if these aspects had been considered separately in another context. Overall harmonization was prioritized unless evidence was identified that changes to the PM were warranted. For example, the measure regarding nimodipine administration in aSAH advocates for a shorter timeframe for

administration (within 24 h of hospital arrival) than the clinical trials from which the CPG source recommendations were developed. In this case, we noted this discrepancy and opted to endorse the measure as written to harmonize with existing measures that are already in use in programs across the USA.

Similarly, we endorsed existing PMs related to severity scoring in ischemic stroke, intracerebral hemorrhage (ICH) and aSAH by combining these into one PM. However, we concur with public comments that the timeframes specified in the PMs are subjective and that beta testing should be part of next steps. The writing group chose to endorse the existing AHA PM measuring the rate of symptomatic intracranial hemorrhage after ischemic stroke. After an exhaustive search of published CPGs and the existing TJC PM specifying this, we found no CPG recommendations from which this measure might have been extracted. However, the PM evaluates patient outcomes rather than process of care, and as an existing PM that is actively used as part of stroke center certification, at least in the USA, it may not be subject to CPG development. Therefore, we elected to endorse the measure, especially in the absence of information that existing use of this PM is inappropriate.

Worldwide Use of the Neurocritical Care PM Set

The intent was to develop a PM Set that could be utilized worldwide and the literature review and included CPG source documents reflect this. However, it is recognized that patient populations, resources, availability of specific medications and procedures, and custom and practice may vary and potentially influence the ability to precisely define measurement criteria for a PM even if the spirit of a specific CPG-based recommendation is upheld. Tuberculous meningitis is more prevalent in countries outside the USA, but is associated with significant morbidity and mortality. Given the strong CPG recommendation for the administration of corticosteroids in this patient population, a PM addressing the use of dexamethasone in tuberculous meningitis was warranted based on our PM development methodology.

The PM involving stroke severity score assessment specifies the use of the Hunt and Hess scale so as to harmonize with the existing TJC PM in place in the USA. However, it is recognized that the World Federation of Neurosurgical Societies (WFNS) scale may be more commonly used around the world. Beta testing is appropriate to assess whether this PM should be modified to include the WFNS scale in order to ensure worldwide implementation. Because of the lack of observational data regarding current practices, the prevalence of corticosteroid use throughout the world in ICH and traumatic brain injury is unclear. PMs discouraging the use of corticosteroids in these diseases were developed based on strong CPG recommendations even though actionability may be limited if compliance is already very high. A similar situation exists for the administration of intravenous acyclovir for the treatment of herpes simplex virus encephalitis as few other pharmacologic treatment options are available. Field testing will be useful to determine the impact of these and other PMs on treatment practices.

Excluded Recommendations

Finally, the neurocritical care PM Set reflects evidence-based PMs that were determined to be feasible, actionable and valid. There are a number of additional PMs published by other organizations that were not included in this PM Set. When reviewed, they were either not supported by strong CPG recommendations, or were excluded because they were assessed to be less feasible, less actionable, or lacking validity. There are also many other recommendations published in the 150 documents reviewed that were not developed into PMs because they either did not meet the minimum strength of recommendation or were not feasible, actionable, or valid after further consideration. For example, we extracted multiple strong recommendations for early rehabilitation after stroke. Given the recent support for early mobilization in the ICU, a PM supporting early rehabilitation and mobilization in the ICU was strongly considered. After discussion, the group felt that a PM could not move forward given the mixed outcomes in studies evaluating early mobilization after stroke and lack of randomized-controlled trials or strong recommendations supporting the practice in other populations. Other topics that the writing group considered were brain death determination, reversal of direct oral anticoagulant medications, screening for blunt cerebrovascular injury after trauma, and advanced care planning including palliative care, but none had strong recommendations from current CPGs that would allow PM development. This approach emphasizes the view of the writing group that PMs should generally not be “aspirational” or intended to create new approaches to care, but rather should be achievable and expected given current evidence-based care.

Future Considerations

Feasibility testing, often referred to as beta testing, is a key step in the process of PM development. Feasibility testing further evaluates the feasibility, actionability, validity, and reliability of proposed PMs through field testing with participating organizations. This process is critical to the further development of a data extraction algorithm, identifying a concurrent or retrospective process for data collection and identifying patients for data extraction, often through diagnosis-related groups. All proposed PMs in the neurocritical care PM Set, especially the ten newly proposed PMs, should undergo feasibility testing prior to further action. Additionally, members are invited to review these PMs within their own organization and report on the feasibility of data collection.

As with any new PMs, documentation at the patient level may need to be expanded or templated to enhance communication and ensure accurate data collection. We expect a number of measures may require expanded documentation, including the EVD insertion bundle, decompressive craniectomy for large hemispheric infarction, and avoidance of steroids in ICH. We believe this documentation will enhance communication at the bedside surrounding key clinical practice issues and facilitate measurement of the proposed PMs.

After reasonable feasibility testing, PMs may be considered for regulatory endorsement. Regulatory endorsement may include several programs through CMS, NQF, or other organizations that certify programs specific to neurosciences such as TJC, DNV, or the American College of Surgeons. Feasibility testing and a future course for regulatory endorsement will be part of the next steps coordinated by the NCS Quality Committee. Feasibility testing may be considered in conjunction with other partnering organizations interested in improving quality for neuroscience patients.

PM development should be ongoing and iterative in nature. In our effort to be rigorous and evidence-based, we may have excluded recommendations that would yield reasonable PMs. Further NCS PM writing groups may consider broadening the minimum criteria for strength of recommendation. As CPGs are developed, we suggest that all strong recommendations continue to be considered for PM development. Finally, most of these PMs focus on process, and this is a recognized limitation of many current PM. PM that evaluate patient outcome directly should be sought and developed.

Conclusions

Neurocritical care has advanced to a mature field in which CPGs exist for many aspects of care. PM can be a valuable tool in measuring quality of care and improving that care. This neurocritical care PM Set represents the first organized effort to develop formal PMs that extend across the scope of neurocritical care delivery for adults. The fact that this PM Set includes many new PMs and that half are identical or analogous to existing PMs emphasizes that collaboration across organizations may yield synergy. Next steps include field testing of new and existing PMs in order to refine inclusion and measurement criteria. In so doing, we must remind ourselves that the purpose of these PMs, and hopefully all PMs, is to improve patient care.

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Author contributions

This manuscript complies with all instructions to authors. Authorship requirements for all authors have been met and the final manuscript was approved by all authors. This manuscript has not been published elsewhere and is not under consideration by another journal. The group adhered to ethical guidelines and no IRB approval was needed for the development of this statement.

Source of Support

The NCS Performance Measure Writing Group phone and in-person meetings were supported financially by the Neurocritical Care Society. No additional funding or support was received by any group member for this work.

Conflicts of Interest

Dr. Livesay reports other from Legal/Expert Witness, other from Lombardi Hill/Stroke Challenges, other from Sarah Livesay, LLC, outside the submitted work. Dr. Fried has nothing to disclose. Dr. Gagnon has nothing to disclose. Dr. Karanjia reports other from Legal/expert witness, other from Bard, outside the submitted work. Dr. Lele reports other from LifeCenter Northwest, grants from Aqueduct Critical Care, outside the submitted work. Dr. Moheet has nothing to disclose. Dr. Taccone reports other from Bard, outside the submitted work. Dr. Olm-Shipman has nothing to disclose. Dr. Tirschwell has nothing to disclose. Dr. Wright reports other from Legal/Expert Witness, outside the submitted work. Dr. Hemphill reports other from Legal/Expert Witness, outside the submitted work.

Appendix 1

See Table 3.

Table 3 Systematic review search strategy

Medline/PubMed/cochrane	CINAHL	EMBASE
Database: Medline/PubMed < 1947 to 2018 February 15> Search Strategy: exp Algorithms/ algorithm$.ti,ab. benchmarking. benchmarking.af. exp organizational objectives exp "Outcome and Process Assessment (Health Care)"/ exp Quality Assurance, Health Care/ exp Quality Control/is, mt, st, sn [Instrumentation, Methods, Standards, Statistics & Numerical Data] exp "Quality of Health Care"/st [Standards] exp Quality Improvement/ Quality Indicator$ or quality metrics.ti,ab. exp "Reproducibility of Results"/ "Reproducibility of Results".af. exp "Sensitivity and Specificity"/ "Sensitivity and Specificity".af. exp Treatment Outcome/ guideline.pt. (15923) exp Guideline/(30228) exp Practice Guideline/ scientific statement.mp. protocol.ti,ab. (consensus or protocol$). guideline.af. consensus development conference.pt. not *Aftercare *patient discharge/ *"Length of stay"/ *Qualitative research/ *Patient satisfaction/ *"Surveys and Questionnaires"/ case reports.pt. letter.pt.	CINAHL via EBSCO Quality metrics MM "Algorithm (MM "Benchmarking") MH "Organizational Objectives MM "Quality of Care Research" MM clinical indicators MM "Quality Control Technology "Reproducibility of Results"/	Database: Embase Classic + Embase < 1947 to 2018 February 15 > Search Strategy: exp Algorithms/ algorithm$.ti,ab. benchmarking. benchmarking.af. exp organizational objectives exp "Outcome and Process Assessment (Health Care)"/ exp Quality Assurance, Health Care/ exp Quality Control/is, mt, st, sn [Instrumentation, Methods, Standards, Statistics & Numerical Data] exp "Quality of Health Care"/st [Standards] exp Quality Improvement/ Quality Indicator$ or quality metrics.ti,ab. exp "Reproducibility of Results"/ "Reproducibility of Results".af. exp "Sensitivity and Specificity"/ "Sensitivity and Specificity".af. exp Treatment Outcome/ guideline.pt. (15923) exp Guideline/(30228) exp Practice Guideline/ scientific statement.mp. protocol.ti,ab. (consensus or protocol$). guideline.af. consensus development conference.pt. Not *Aftercare *patient discharge/ *"Length of Stay"/ *Qualitative Research/ *Patient Satisfaction/ *"Surveys and Questionnaires"/ case reports.pt. letter.pt.
Acute Ischemic Stroke Brain Ischemia/and *Stroke (ischemia* adj3 (brain cerebral	(MH "Hypoxia–Ischemia, Brain + ") OR (MH "Cerebral Ischemia + ") OR "ischemic stroke"	Acute ischemic stroke.mp. or *brain ischemia/
Myasthenia Gravis	MM "Myasthenia Gravis") OR "Myasthenia Gravis"	exp myasthenia gravis/ Myasthenia.af. (2156)
Guillain–Barre syndrome acute inflammatory demyelinating polyneuropathy	(MH "Guillain–Barre Syndrome + ")	Guillain–Barre syndrome *acute inflammatory demyelinating polyneuropathy/
exp Coma/(20192) exp Persistent Vegetative State/(2779) exp STUPOR/(692) coma.af. [all field] (41762) comatose.af. (4659) pseudocoma	MM "Coma"	exp Coma/(20192) exp Persistent Vegetative State/(2779) exp STUPOR/(692) coma.af. [all field] (41762) comatose.af. (4659) pseudocoma
Intracerebral hemorrhage OR spontaneous intracerebral hemorrhage, intraparenchymal hemorrhage NOT traumatic	MH "Intracranial Hemorrhage + ") OR (MH "Cerebral Hemorrhage + ") OR (MM "Subarachnoid Hemorrhage Precautions (Iowa NIC)") OR "Intracerebral hemorrhage" OR (MM "Subarachnoid Hemorrhage") MH "Cerebral Edema + ") OR "cerebral edema"	Intracerebral hemorrhage OR spontaneous intracerebral hemorrhage, intraparenchymal hemorrhage NOT traumatic
Subarachnoid hemorrhage OR aneurysmal subarachnoid hemorrhage, NOT traumatic	Subarachnoid hemorrhage	Subarachnoid hemorrhage OR aneurysmal subarachnoid hemorrhage, NOT traumatic
Intracranial hypertension OR elevated Intracranial pressure	(MH "Intracranial Hypertension + ") OR "Intracranial hypertension" OR (MH "Intracranial Hemorrhage + ") OR (MM "Intracranial Pressure")	exp intracranial hypertension/

Table 3 (continued)

Medline/PubMed/cochrane	CINAHL	EMBASE
Cerebral herniation OR brain herniation OR cerebral edema	Cerebral herniation"	Brain herniation Cerebral herniation OR brain herniation OR cerebral edema
Meningitis OR ventriculitis	Meningitis + ") OR "Meningitis ventriculitis	MeningitisVentriculitis.mp. or exp brain ventriculitis/
Encephalitis	MH "Encephalitis + " OR "Encephalitis"	Encephalitis
Hypoxic-ischemic encephalopathy OR anoxic brain injury	MH "Hypoxia–Ischemia, Brain + ") OR (MH "Cerebral Ischemia + "OR "ischemic stroke"	Hypoxic-ischemic encephalopathy OR anoxic brain injury
Targeted temperature management OR hypothermia OR induced hypothermia, NOT perioperative hypothermia	MM "Hypothermia, Induced") OR "induced hypothermia"	Targeted temperature management OR hypothermia OR induced hypothermia, NOT perioperative hypothermia
Status epilepticus	Status epilepticus	Status epilepticus
Traumatic brain injury (mild or major, any severity)	Traumatic brain injury" TBI	Traumatic brain injury" TBI
Traumatic spinal cord injury	(MM "Spinal Cord Compression") OR "Spinal cord injury	Traumatic spinal cord injury
Spinal cord compression	MM "Spinal Cord Compression") OR "Spinal cord compression	Spinal cord compression
Brain death	MM "Brain Death") OR "Brain death"	Brain death

TBI traumatic brain injury

Appendix 2: Neurocritical Care Performance Measure Set

1: Baseline Severity Score Documentation – Ischemic Stroke (1A), Intracerebral Hemorrhage (1B) and Aneurysmal Subarachnoid Hemorrhage (1C) **Percentage of patients with acute ischemic stroke (AIS), intracerebral hemorrhage (ICH) or aneurysmal subarachnoid hemorrhage (aSAH) who have a documented severity measurement (NIHSS for AIS, ICH Score for ICH, Hunt and Hess Scale for aSAH)**	
Numerator	1A) All patients with AIS who have a documented National Institutes of Health Score Scale (NIHSS) score prior to endovascular intervention OR within 12 hours of hospital arrival for those who do not undergo endovascular intervention 1B) All patients with spontaneous ICH who have a documented ICH Score prior to surgical intervention OR within 6 hours of hospital arrival for those who do not undergo surgical intervention 1C) All patients with aneurysmal SAH who have a documented Hunt and Hess Scale prior to endovascular or surgical intervention OR within 6 hours of hospital arrival for those who do not undergo endovascular or surgical intervention
Denominator	**Included:** 1A) All patients with AIS admitted to the ICU. 1B) All patients with spontaneous ICH admitted to the ICU. 1C) All patients with aneurysmal SAH admitted to the ICU. **Excluded:** • < 18 years of age • Length of stay > 120 days
Period of Assessment	First 12 hours of ED arrival and/or hospital admission
Sources of Data	☒ Claims (only) ☒ Claims (other) ☒ EHR Hybrid ☐ EHR (only) ☐ Imaging-diagnostic ☒ Laboratory ☐ Pharmacy ☐ Registry ☐ Provider Tool ☐ Management Data ☐ Paper Records ☒ Patient reported data ☐ Non-medical Data ☐ Other: _____
Rationale The initial evaluation of critically ill stroke patients requires clinical neurological assessment. Baseline severity evaluation in the form of standardized and validated clinical grading scales can improve communication among providers and risk stratification for patients. Documentation of a baseline severity score may also facilitate initial therapeutic decisions such as thrombolysis and/or endovascular intervention, surgical intervention for hemorrhagic stroke, and triage decisions such as admission to ICU [1, 2]. The use of baseline severity assessment scales does not replace a complete neurological examination. While numerous scales exist for various types of stroke (AIS, ICH, aSAH), priority is placed on selecting one scale per condition in order to simplify reporting and standardization as well as harmonization with existing performance measures.	

Sources of Clinical Recommendations

From 2013 “Guidelines for the Early Management of Patients with Acute Ischemic Stroke: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association” [1]:

- The use of a stroke rating scale, preferably the NIHSS, is recommended. (Class I; Level of Evidence B)

From 2018 “Guidelines for the Early Management of Patients with Acute Ischemic Stroke A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association” [2]:

- The use of a stroke severity rating scale, preferably the NIHSS, is recommended. (Class I; Level of Evidence B)

From 2012 “Guidelines for the management of aneurysmal subarachnoid hemorrhage: a guideline for healthcare professionals from the American Heart Association/American Stroke Association” [3]:

- The initial clinical severity of aSAH should be determined rapidly by use of simple validated scales (e.g., Hunt and Hess, World Federation of Neurological Surgeons), because it is the most useful indicator of outcome after aSAH. (Class I; Level of Evidence B)

From 2015 “Guidelines for the management of spontaneous intracerebral hemorrhage: a guideline for healthcare professionals from the American Heart Association/American Stroke Association” [4]:

A baseline severity score should be performed as part of the initial evaluation of patients with ICH. (Class I; Level of Evidence B)

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☒Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Hunt and Hess is a standard score in the United States (US). However, The World Federation of Neurosurgical Societies (WFNS) grading system is often used internationally. When this measure is used outside the US, WFNS may be an appropriate substitute for Hunt and Hess.
- Difficulty abstracting the severity score data if it is entered via free-text into the medical record.
- The severity score at baseline is best interpreted in the context of premorbid condition assessment and/or post-discharge functionality documentation.
- It is unclear how the documentation of baseline severity score contributes to patient outcomes.
- Various validated clinical grading scales exist for all three stroke subtypes and may be preferred by certain providers.

Analogous Measures Endorsed by Other Organizations

- The Joint Commission (CSTK-1, CSTK-3) [5]
- Det Norske Veritas Measure [6]
- Clinical Performance Measures for Adults Hospitalized with Acute Ischemic Stroke: Performance Measures for Healthcare Professionals from the American Heart Association/American Stroke Association PM 13 [7]
- American Heart Association/American Stroke Association Clinical Performance Measures for Adults Hospitalized with Intracerebral Hemorrhage PM 1

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2: Acute Stroke Unit Admission **Percentage of patients with acute stroke (ischemic stroke, intracerebral hemorrhage and/or subarachnoid hemorrhage) who are admitted to an intensive care unit or dedicated stroke unit with physician and nursing neuroscience acute care expertise**	
Numerator	Patients with acute stroke (ischemic stroke, intracerebral hemorrhage and/or subarachnoid hemorrhage) who are admitted to an intensive care unit or dedicated stroke unit with physician and nursing neuroscience acute care expertise
Denominator	**Included:** All patients with acute stroke (ischemic stroke, intracerebral hemorrhage and/or subarachnoid hemorrhage) **Excluded:** • Patients with a co-morbid condition mandating care on a non-Stroke Unit or comparable ICU • < 18 years of age • Documentation of Comfort Measures Only at time of admission
Period of Assessment	Day of admission for acute stroke
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☐ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☒ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____

Rationale

Though the exact definition of a stroke unit may vary, it is usually clearly defined at the organizational level. The Joint Commission states, “Stroke units can be defined and implemented in a variety of ways. The stroke unit does not have to be a specific enclosed area with beds designated only for acute stroke patients, but it will be a specified unit to which most stroke patients are admitted” [1].

Observational studies, randomized trials, and meta-analyses of acute stroke populations globally all strongly support the effectiveness of “stroke units” in reducing morbidity and mortality. As such, hospitals that care for acute stroke patients should aspire to have all appropriate stroke patients admitted to what is defined as the organization’s “stroke unit”. In many circumstances, a designated ICU also meets requirements to be considered a stroke unit, and all stroke patients requiring ICU level care should be admitted to such a unit.

Sources of Clinical Recommendations

From the 2018 “Guidelines for the Early Management of Patients with Acute Ischemic Stroke: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association” [2]:

- The use of comprehensive specialized stroke care (stroke units) that incorporates rehabilitation is recommended. (Class I; Level of Evidence A)

From the 2015 “Guidelines for the Management of Spontaneous Intracerebral Hemorrhage: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association” [3]:

- Initial monitoring and management of ICH patients should take place in an intensive care unit or dedicated stroke unit with physician and nursing neuroscience acute care expertise. (Class I; Level of Evidence B)

From the 2014 “Recommendations for the management of cerebral and cerebellar infarction with swelling: a statement for healthcare professionals from the American Heart Association/American Stroke Association” [4]:

- Transfer to an intensive care or stroke unit is recommended for patients with a large territorial stroke to plan close monitoring and comprehensive treatment. (Class I; Level of Evidence C)

From the 2014 Spanish Neurological Society “Guidelines for the treatment of acute ischaemic stroke” [5]:

- Recommendations call for admission to an acute stroke unit with the necessary equipment. (Level of Evidence 1a; Grade A Recommendation)
- Treatment must be indicated by neurologists with expertise in stroke management and performed in centers equipped to provide specialist care, preferably in a stroke unit. These centers must also be able to treat potential complications. (Extrapolation from Level 1 studies; Grade B Recommendation)

From the 2012 “Guidelines for the intravenous application of recombinant tissue-type plasminogen activator (alteplase), the second edition, October 2012: a guideline from the Japan Stroke Society” [6]:

- It is recommended that patients be managed in a stroke care unit (SCU) or equivalent ward for at least 24 hours after initiation of treatment. (Level of Evidence Ia; Grade of Recommendation B)

From the 2011 “Singapore ministry of health clinical practice guidelines on stroke and transient ischemic attacks” [7]:

- Patients who have suffered an acute stroke should be admitted to a stroke unit. (Grade A, Level 1++)
- Acute inpatient care for patients admitted to hospital with a stroke should be organized as a multidisciplinary stroke service based in designated stroke units. (Grade A, Level 1++)

From the 2010 “South African guideline for management of ischaemic stroke and transient ischaemic attack 2010: A guideline from the South African Stroke Society (SASS) and the SASS Writing Committee” [8]:

- All stroke patients should be treated in a stroke unit. (Class I: Level A)

From the 2008 European Stroke Organization “Guidelines for Management of Ischaemic Stroke and Transient Ischaemic Attack 2008” [9]:

- It is recommended that all stroke patients should be treated in a stroke unit. (Class I; Level A)
- Admission to a stroke unit is recommended for acute stroke patients to receive coordinated multidisciplinary rehabilitation. (Class I; Level A)

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Definition of stroke unit may vary, but should be defined clearly by each organization
- Determination of sufficient physician and nursing neuroscience acute care expertise
- Criteria for ICU admission may vary across hospitals

Analogous Measures Endorsed by Other Organizations

American Heart Association/American Stroke Association ICH PM 9 [10]
Key performance indicators for stroke from the Ministry of Health of Brazil: benchmarking and indicator parameters [11]
Cross-National Key Performance Measures of the Quality of Acute Stroke Care in Western Europe [12]

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3: Acute Interventions for Ischemic Stroke **Percentage of patients with acute ischemic stroke who receive either (a) IV t-PA (a) and/or (b) Mechanical Thrombectomy**	
Numerator	3A) patients with a diagnosis of new ischemic stroke who arrived at hospital within 3.5 hours of last known well (LKW) and received IV t-PA within 4.5 hours of LKW or had a reason documented why they were not so treated 3B) patients with a diagnosis of new ischemic stroke who arrived at hospital within 14.5 hours of last known (LKW) who met criteria for mechanical thrombectomy (MT) and received MT, were transferred to another hospital for mechanical thrombectomy, or had a reason documented why they were not so treated
Denominator	**Included:** 3A) patients with a diagnosis of new ischemic stroke who arrived at hospital within 3.5 hours of LKW 3B) patients with a diagnosis of new ischemic stroke who met criteria for MT **Excluded:** • < 18 years of age • Length of stay > 120 days • Documented Comfort Measures Only status prior to stroke treatment decision
Period of Assessment	Acute hospitalization
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☐ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____

Rationale

Treatment of appropriately selected patients with acute ischemic stroke with IV tPA and/or MT to improve outcomes is supported by high levels of evidence from randomized trials. If these treatments are withheld, a clinical justification should be documented and might include (but not necessarily be limited to): non-disabling neurological deficits, neurological deficits which have rapidly resolved so as to be non-disabling, a specific contraindication, patient refusal, and/or a justifiable cause of delay. Eligibility for mechanical thrombectomy is not a valid justification for withholding IV t-PA.

Although one clinical trial found mechanical thrombectomy effective out to 24 hours after last known well in eligible patients, current guidelines include a time window of 16 hours as a Class I recommendation. Therefore, this shorter time window is used for this performance measure. A door-to-groin-puncture time of 90 minutes is one current goal for this intervention and therefore is subtracted from the 16 hour last known well time window in order to arrive at the 14.5 hour time frame included in this measure.

Sources of Clinical Recommendations

From the 2018 “Guidelines for the Early Management of Patients with Acute Ischemic Stroke: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association” **[1].**

- Patients should receive mechanical thrombectomy with a stent retriever if they meet all the following criteria: (1) prestroke mRS score of 0 to 1; (2) causative occlusion of the internal carotid artery or MCA segment 1 (M1); (3) age ≥18 years; (4) NIHSS score of ≥6; (5) ASPECTS of ≥6; and (6) treatment can be initiated (groin puncture) within 6 hours of symptom onset. (Class I: Level of Evidence A)
- Patients eligible for IV alteplase should receive IV alteplase even if EVTs are being considered. (Class I, Level of Evidence A)
- In selected patients with AIS within 6 to 16 hours of last known normal who have LVO in the anterior circulation and meet other DAWN or DEFUSE 3 eligibility criteria, mechanical thrombectomy is recommended. (Class I, Level of Evidence A)

From the 2015 “2015 American Heart Association/American Stroke Association Focused Update of the 2013 Guidelines for the Early Management of Patients with Acute Ischemic Stroke Regarding Endovascular Treatment A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association” **[2].**

- Patients eligible for intravenous r-tPA should receive intravenous r-tPA even if endovascular treatments are being considered. (Class I; Level of Evidence A)
- Patients should receive endovascular therapy with a stent retriever if they meet all the following criteria (Class I; Level of Evidence A): a. Prestroke mRS score 0 to 1; b. Acute ischemic stroke receiving intravenous r-tPA within 4.5 hours of onset according to guidelines from professional medical societies; c. Causative occlusion of the ICA or proximal MCA (M1); d. Age ≥18 years; e. NIHSS score of ≥6; f. ASPECTS of ≥6, and; g. Treatment can be initiated (groin puncture) within 6 hours of symptom onset.

From the 2015 “Canadian Association of Emergency Physicians Position Statement on Acute Ischemic Stroke” **[3]:**

- Patients with acute ischemic stroke whose neuroimaging excludes contraindications, and who can be treated within three hours of symptom onset, should be offered rt-PA with the goal of improving functional outcome. (Strong recommendation; high quality evidence)

From the 2015 “Initial hospital management of patients with emergent large vessel occlusion (ELVO): report of the standards and guidelines committee of the Society of NeuroInterventional Surgery” **[4]:**

- Endovascular therapy should complement and not replace IV administration of recombinant tPA in eligible patients. (Class I; Level of Evidence A)

From the 2014 Spanish Neurological Society “Guidelines for the treatment of acute ischaemic stroke” **[5]:**

- Thrombolytic treatment with IV rtPA dosed at 0.9 mg/kg is recommended as treatment for acute cerebral infarct up to 4.5 hours after stroke onset. Treatment should be performed as early as possible. Patient selection should follow established criteria strictly. (Level of evidence 1a; grade A recommendation).
- Thrombolytic treatment with IV rtPA dosed at 0.9 mg/kg is recommended as treatment for acute cerebral infarct up to 4.5 hours after stroke onset. Treatment should be performed as early as possible. Patient selection should follow established criteria strictly. (Level of evidence 1a; grade A recommendation).

From the 2013 “Guidelines for the Early Management of Patients with Acute Ischemic Stroke: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association” **[6]:**

- Patients eligible for intravenous rtPA should receive intravenous rtPA even if intra-arterial treatments are being considered. (Class I; Level of Evidence A)

From the 2013 “Consensus Statement on the Use of Intravenous Recombinant Tissue Plasminogen Activator to Treat Acute Ischemic Stroke by the Chinese Stroke Therapy Expert Panel” **[7]:**

- IV rt-PA is recommended to treat eligible patients with AIS within 4.5 h of onset. The treatment decision can be made based on the clinical manifestation and plain CT of brain. The earlier IV rt-PA is given, the more benefits and less risk will be for the patient. (Level I recommendation; Level A evidence).

From the 2012 “Guidelines for the intravenous application of recombinant tissue-type plasminogen activator (alteplase),

the second edition, October 2012: a guideline from the Japan Stroke Society" **[8]:**

- IV alteplase should be administered to patients with ischemic stroke who can be treated within 4.5 hours of symptom onset. (Level of evidence Ia; grade of recommendation A)

From the 2012 "Antithrombotic and Thrombolytic Therapy for Ischemic Stroke. Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines" **[9]:**

- In patients with acute ischemic stroke in whom treatment can be initiated within 3 h of symptom onset, we recommend IV recombinant tissue plasminogen activator. (Grade 1A)

From the 2012 Brazilian "Guidelines for acute ischemic stroke treatment – Part II: Stroke treatment" **[10]:**

- Intravenous rt-PA therapy is recommended in the first 4 hours and 30 minutes after the occurrence of ischemic stroke. (Level of Evidence 1; Class A Recommendation)

From the 2012 "Endovascular therapy of acute ischemic stroke: report of the Standards of Practice Committee of the Society of NeuroInterventional Surgery" **[11]:**

- The availability of intra-arterial therapy should generally not preclude the intravenous administration of recombinant tissue plasminogen activator (rt-PA) in otherwise eligible patients (American Heart Association Class I; Level of Evidence A, Centre for Evidence Based Medicine (CEBM) level 1b; grade A-B).

From the 2011 "Singapore ministry of health clinical practice guidelines on stroke and transient ischemic attacks" **[12]:**

- Intravenous recombinant tissue plasminogen activator is recommended for ischemic stroke patients within three-hours of stroke onset and without contraindication to this therapy, in centers with appropriate facilities and expertise. (Grade A; Level 1+)

From the 2010 "South African guideline for management of ischaemic stroke and transient ischaemic attack 2010: A guideline from the South African Stroke Society (SASS) and the SASS Writing Committee" **[13]:**

- Intravenous tPA (0.9 mg/kg, maximum 90 mg) with 10% of dose given as a bolus followed by infusion lasting 60 minutes is recommended within 4.5 hours of onset of ischaemic stroke. (Class I; Level A)

From the 2008 European Stroke Organization "Guidelines for Management of Ischaemic Stroke and Transient Ischaemic Attack 2008" **[14]:**

- Intravenous rtPA (0.9 mg/kg body weight, maximum 90 mg), with 10% of the dose given as a bolus followed by a 60-min infusion, is recommended within 3 h of onset of ischaemic stroke. (Class I; Level A)

Method of Reporting

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- A 90-minute door-to-groin-puncture time may lack widespread consensus for a maximum time to implement this intervention
- An extended time window for intervention should not delay transfer of patients to thrombectomy-capable hospitals
- All acceptable reasons for not undertaking mechanical thrombectomy are not detailed in this measure and may be patient specific

Analogous Measures Endorsed by Other Organizations

- 2016 American Academy of Neurology Endovascular Treatment and Imaging Measure Bundle [15]
- 2016 American Academy of Neurology Intravenous Fibrinolytic Treatment Measure Bundle [15]
- 2016 American Academy of Neurology Intravenous Fibrinolytic Treatment Measure Bundle [15]
- 2016 American Academy of Neurology Acute Stroke Endovascular Treatment Measure Bundle [15]
- Cross-National Key Performance Measures of the Quality of Acute Stroke Care in Western Europe [16]
- Clinical Performance Measures for Adults Hospitalized with Acute Ischemic Stroke: Performance Measures for Healthcare Professionals from the American Heart Association/American Stroke Association PM 4 [17]
- The Joint Commission Primary Stroke Center Performance Measure STK4: Thrombolytic Therapy [18]
- The Joint Commission Acute Stroke Ready Hospital Performance Measure ASR-IP-1 [19]
- The DNV Comprehensive Stroke Center Metrics [20]

References:

1. Powers, W.J., Rabinstein, A.A., Ackerson, T., et al. 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2018;49(3):e46-e110.
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13. Bryer, A., Connor, M., Haug, P., et al. South African guideline for management of ischaemic stroke and transient ischaemic attack 2010: a guideline from the South African Stroke Society (SASS) and the SASS Writing Committee. S Afr Med J 2010;100(11 Pt 2):747-78.
14. European Stroke Organisation Executive, C.Committee, E.S.O.W. Guidelines for management of ischaemic stroke and transient ischaemic attack 2008. Cerebrovasc Dis 2008;25(5):457-507.
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4: Vascular Imaging in Ischemic Stroke **Percentage of patients with ischemic stroke and who meet clinical criteria for mechanical thrombectomy who have vascular imaging (CTA or MRA) within one hour of their initial non-contrast CT brain**	
Numerator	Patients with ischemic stroke and who meet clinical criteria for mechanical thrombectomy (MT) who have vascular imaging (CTA or MRA) within one hour of their initial non-contrast CT brain
Denominator	**Included:** All ischemic stroke patients who present for emergency evaluation and who meet criteria for mechanical thrombectomy **Excluded:** • < 18 years of age • Intracranial hemorrhage on initial imaging • Other criteria that makes ischemic stroke patient ineligible for mechanical thrombectomy including findings on initial non-contrast brain CT • Length of stay > 120 days • Documented Comfort Measures Only status prior to stroke evaluation
Period of Assessment	Acute hospitalization – day of admission
Sources of Data	☒ Claims (only) ☐ Claims (other) ☐ EHR Hybrid ☒ EHR (only) ☐ Imaging-diagnostic ☐ Laboratory ☐ Pharmacy ☐ Registry ☐ Provider Tool ☐ Management Data ☐ Paper Records ☐ Patient reported data ☐ Non-medical Data ☐ Other: _____

Rationale

Mechanical thrombectomy is an effective treatment for patients with acute ischemic stroke who have a large vessel occlusion (LVO) identified on vascular imaging (CTA or MRA) within 24 hours of symptom onset. Therefore, vascular imaging should be expedited in this population. Identification of the LVO may then trigger additional imaging to assess eligibility for MT within the 24-hour time window. Patients where a “stroke code” or “stroke alert” is activated but have intracranial hemorrhage on their initial imaging are excluded from this measure.

Thrombolysis with t-PA should not be delayed due to CTA or MRA. Thus, depending on local algorithms CTA or MRA may occur subsequent to the initiation of t-PA therapy, but all efforts should be made to expedite this process. Ideally vascular imaging should immediately follow the initial non-contrast CT brain, but the mechanics of t-PA administration may reasonably delay immediate CTA or MRA. Thus, in order to provide consistency, this measure allows a maximum of one hour between initial non-contrast CT brain and CTA or MRA.

Sources of Clinical Recommendations:

From 2018 “Guidelines for the Early Management of Patients with Acute Ischemic Stroke: A Guideline for Healthcare Professionals from the American Heart Association/American Stroke Association.” **[1]:**

- For patients who otherwise meet criteria for EVT, a noninvasive intracranial vascular study is recommended during the initial imaging evaluation of the acute stroke patient but should not delay IV alteplase if indicated. For patients who qualify for IV Alteplase according to guidelines from professional medical societies, initiating IV alteplase before noninvasive vascular imaging is recommended for patients who have not had noninvasive vascular imaging as part of their initial imaging assessment for stroke. Noninvasive intracranial vascular imaging should then be obtained as quickly as possible. (COR I, LOE A)
- In selected patients with AIS within 6 to 24 hours of last known normal who have LVO in the anterior circulation, obtaining CTP, DW-MRI, or MRI perfusion is recommended to aid in patient selection for mechanical thrombectomy, but only when imaging and other eligibility criteria from RCTs showing benefit are being strictly applied in selecting patients for mechanical thrombectomy. (COR I, LOE A)

From 2015 “Canadian Stroke Best Practice Recommendations: Hyperacute Stroke Care Guidelines” **[2]:**

- All patients with suspected acute stroke (i.e. presenting within acute stroke treatment time windows) must undergo immediate noncontrast brain CT imaging, and vascular imaging with CTA including extracranial and intracranial arteries to guide hyperacute care [Evidence Level A].

Method of Reporting

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- The criteria “during the initial imaging evaluation” is not precisely defined in guidelines.

Analogous Measures Endorsed by Other Organizations

- DNV measure 1d Metric 4 [3]
- 2016 American Academy of Neurology Endovascular Treatment and Imaging Measure Bundle [4]

References:

1. Powers, W.J., Rabinstein, A.A., Ackerson, T., et al. 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2018;49(3):e46-e110.
2. Casaubon, L.K., Boulanger, J.M., Blacquiere, D., et al. Canadian Stroke Best Practice Recommendations: Hyperacute Stroke Care Guidelines, Update 2015. Int J Stroke 2015;10(6):924-40.
3. Det Norske Veritas, *Comprehensive Stroke Center Certification Program - Requirements*, 2012: By request from DNV,.
4. Neuorology, A.A.o. Endovascular Treatment and Imaging Measure Bundle. 2016.

5: Symptomatic Intracerebral Hemorrhage After Treatment for Ischemic Stroke **Percentage of patients with ischemic stroke who were treated with IV t-PA or mechanical thrombectomy and who developed symptomatic intracerebral hemorrhage (ICH) within 36 hours**	
Numerator	Adult patients who received IV t-PA or mechanical thrombectomy for ischemic stroke and who developed symptomatic ICH Symptomatic ICH is defined as a NIHSS score worsening of 4 or greater attributable to the hemorrhage.
Denominator	**Included:** Adult patients who received IV t-PA or mechanical thrombectomy for ischemic stroke **Excluded:** • < 18 years of age • Length of stay > 120 days • Patients transferred to this hospital following treatment with IV t-PA therapy
Period of Assessment	36 hours after IV t-PA or mechanical thrombectomy
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☐ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____
Rationale This measure is unchanged from The Joint Commission (TJC) Comprehensive Stroke Center (CSC) performance measure, which states: “Intravenous (IV) thrombolytic (t-PA) therapy for acute ischemic stroke was approved by the US Food and Drug Administration in 1996, following findings from the National Institute of Neurological Disorders and Stroke (NINDS) trial which demonstrated favorable outcomes in 31% to 50% of patients treated with recombinant tissue plasminogen activator (r-tPA), as compared to 20% to 38% of patients treated with placebo. Intra-arterial (IA) thrombolytic therapy (t-PA) has since been used to improve recanalization and clinical outcomes for select patients nonresponsive to IV therapy. Intracranial hemorrhage is the major risk of thrombolytic therapy with similar rates reported for both IV and IA routes. The NINDS trial found that 6.4% of patients treated with IV t-PA experienced symptomatic bleeding. Findings from the Prolyse in Acute Cerebral Thromboembolism (PROACT II) study found the intracranial hemorrhage with neurological deterioration within 24 hours occurred in 10% of patients treated with IA recombinant prourokinase. In addition to these agents, other available thrombolytic drugs include: streptokinase, p-anisoylated lys-plasminogen-streptokinase activator, tenecteplase, and urokinase. Endovascular reperfusion therapy in acute ischemic stroke comprises a number of pharmacological and mechanical procedures. Mechanical endovascular thrombectomy is a treatment option for patients with large vessel occlusions in whom pharmacological thrombolysis is contraindicated or might be ineffective. A number of mechanical endovascular thrombectomy devices, also known as clot retrieval devices, are currently undergoing clinical evaluation. Mechanical endovascular thrombectomy devices are intended to improve tissue rescue and diminish reperfusion hemorrhage while broadening the population eligible for therapy. These devices may be used alone or in conjunction with chemical	

thrombolysis (i.e., IV or IA t-PA)." [1]

While no clinical practice guideline recommendations directly support this measure, collecting rates of ICH after ischemic stroke treatment measures the outcome of care. Many outcome measures are not directly mapped to CPG recommendations and are still relevant for monitoring.

Sources of Clinical Recommendations

There are no clinical practice guideline recommendations related to this performance measure.

Method of Reporting/ Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☐ Process	☐ Process: Appropriate Use	☒ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☒Patient safety	☐Population/Public Health	☐Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Lack of documentation of NIHSS score needed to determine if an ICH is symptomatic

Analogous Measures Endorsed by Other Organizations

- The Joint Commission (TJC) Comprehensive Stroke Center (CSC) Measure: CSTK-05 (a &b) [1]
  - 5a Hemorrhagic Transformation for Patients Treated with Intra-Venous (IV) Thrombolytic (t-PA) Therapy Only
  - 5b Hemorrhagic Transformation for Patients Treated with Intra-Arterial (IA) Thrombolytic (t-PA) Therapy or Mechanical Endovascular Reperfusion Therapy

References:

1. The Joint Commission. *Comprehensive Stroke Certification: Standardized Performance Measures*. 2018 [cited 2018 November 1st]; Available from: https://www.jointcommission.org/performance_measures_for_comprehensive_stroke_centers/.

6: Decompressive Craniectomy after Large Hemispheric Infarction **Documentation of decompressive craniectomy performed in patients with large hemispheric cerebral infarction who deteriorate due to mass effect within 48 hours of stroke onset or who have a documented reason why it was not performed**	
Numerator	Patients with large hemispheric cerebral infarction defined as brain computed tomography ischemic signs involving > 50% of the middle cerebral artery territory or MRI diffusion-weighted imaging (DWI) volume > 145 cm^3, ***AND*** Decrease in the level of consciousness to a score of ≥ 1 on item 1a of the NIHSS (not alert but arousable by minor stimulation to obey, answer, or respond OR worse examination)
Denominator	**Included:** Patients 18-60 years old who deteriorate due to cerebral edema within 48 hours after a large hemispheric infarction **Excluded:** Ï Patient <18 years of age Ï Patients > 60 years of age Ï Length of stay > 120 days
Period of Assessment	From emergency department visit to Day 3 of hospitalization
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☐ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____

Rationale

Cerebral edema can cause significant neurologic deterioration in patients with large territory ischemic strokes, and in severe cases surgical treatment may be the only effective option. In such cases, timely decompressive surgery has can reduce mortality and improve functional outcome [1]. Although the optimal trigger for decompressive craniectomy is not clear, it is reasonable to use a decrease in level of consciousness attributable to cerebral edema as assessed by serial measurements of the Glasgow Coma Scale or National Institutes of Health Stroke Scale [2-4].

Pooled results of randomized controlled trials have demonstrated significant reduction in mortality when decompressive craniectomy was performed within 48 hours of malignant MCA infarction in patients younger than 60 years of age, with an absolute risk reduction in mortality of 50% (95% CI) at 12 months. These findings were noted despite differences in the clinical trials in terms of inclusion and exclusion criteria, percent of MCA territory involved, and surgical timing. At 12 months, independence (mRS score 2) was achieved in 14% of the total surgical group and 18% of survivors compared with 2% (of the total nonsurgical group and 8% of the nonsurgical survivors [1].

Despite the data and strong guideline recommendations for the procedure, there is concern that physician and surgeon bias may influence which patients are offered decompressive craniectomy and how the procedure, its risks, and potential outcomes are discussed. It is of great importance that patient-centered care is delivered through a shared decision-making process that involves careful and thorough discussion between families (and patients if able to participate) and experienced health professionals. If a decompressive craniectomy is not performed then the reason must be clearly documented in the medical record.

Sources of Clinical Recommendations

From the 2010 “Taiwan Stroke Society Guidelines for Large Hemispheric Infarction” [5]:

- In the past 1-2 decades, a number of literatures have revealed the benefits of decompressive craniectomy in improving survival, particularly when used along with intensive postoperative monitoring in the intensive care unit. (Class I; Level of Evidence A)

From the 2015 Update of the “Canadian Stroke Best Practice Recommendations: Hyperacute Stroke Care Guidelines” [6]:

- Hemicraniectomy should be considered in younger patients in the early stages of extensive (malignant) MCA territory ischemic stroke (Evidence Level A)
- Once decision for hemicraniectomy has been confirmed, surgery should take place within 48 h of initial presentation (Evidence Level A)

From the 2014 AHA/ASA :Recommendations for the management of cerebral and cerebellar infarction with swelling” [7]:

- In patients <60 years of age with unilateral MCA infarctions that deteriorate neurologically within 48 hours despite medical therapy, decompressive craniectomy with dural expansion is effective. The effect of later decompression is not known, but it should be strongly considered (Class I; Level of Evidence B)

From the 2013 and 2018 AHA/ASA “Guidelines for early management of patients with acute ischemic stroke” [1]:

- Patients with major infarctions are at high risk for complicating brain edema and increased ICP. Measures to lessen the risk of edema and close monitoring of the patient for signs of neurological worsening during the first days after stroke are recommended (Class I; Level of Evidence A)
- Decompressive surgery for malignant edema of the cerebral hemisphere is effective and potentially lifesaving (Class I; Level of Evidence B)
- In patients ≤60 years of age with unilateral MCA infarctions who deteriorate neurologically within 48 hours despite medical therapy, decompressive craniectomy with dural expansion is reasonable because it reduces mortality by close to 50%, with 55% of the surgical survivors achieving moderate disability (able to walk) or better (mRS score 2 or 3) and 18% achieving independence (mRS score 2) at 12 months (Class IIA; Level of Evidence A)

From the 2011 “Singapore Ministry of Health Clinical Practice Guidelines on Stroke and Transient Ischemic Attack” [8]:

- Early decompressive surgery is an option for treatment in patients aged between 18–60 years, with a space-occupying middle cerebral artery infarction (Grade !; Level 1++).

From the 2011 “Update of Acute Ischemic Stroke Treatment Guidelines of the Spanish Neurological Society” [9]:

- If clinical and imaging signs of MMCAI are present, doctors should consider decompressive hemicraniectomy within 48 hours of stroke onset in patients younger than 60 and where signs of transtentorial herniation are absent. Osmotherapy and hyperventilation are to be carried out in preparation for this procedure (Level of evidence 1a; Grade A recommendation).

From the 2010 South African “Guideline for Management of Ischemic Stroke and Transient Ischemic Attack” [10]:

- Decompressive surgery should be considered within 48 hours of symptom onset for patients with evolving malignant oedema of the cerebral hemisphere, but physicians should advise the patient’s family about the potential outcomes including survival and disability (Class I; Level of Evidence A).

From the 2008 “Guidelines for Management of Ischemic Stroke and Transient Ischemic Attack” by the European Stroke Organization [11]:

- Surgical decompressive therapy within 48 h after symptom onset is recommended in patients up to 60 years of age with evolving malignant MCA infarcts (Class I: Level A)

From the 2018 AHA/ASA “Guidelines for the Early Management of Acute Ischemic Stroke” [1]:

- Patients with large territorial supratentorial infarctions are at high risk for complicating brain edema and increased intracranial pressure. Discussion of care options and possible outcomes should take place quickly with patients (if possible) and caregivers. Medical professionals and caregivers should ascertain and include patient-centered preferences in shared decision making, especially during prognosis formation and considering interventions or limitations in care.(Level IC)
- Patients with major infarctions are at high risk for complicating brain edema. Measures to lessen the risk of edema and close monitoring of the patient for signs of neurological worsening during the first days after stroke are recommended. Early transfer of patients at risk for malignant brain edema to an institution with neurosurgical expertise should be considered. (Level IC)

Method of Reporting/ Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☒ Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐ Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Prioritization of patient-centered shared decision making
- The ideal timing of craniotomy is a challenge in patient care, as the timing of patient deterioration due to cerebral edema is dependent on a number of patient factors. This measure focuses on the timing of patient deterioration and not the timing of craniectomy. Documentation of deterioration related to edema will be essential for compliance with this measure.

Analogous Measures Endorsed by Other Organizations

None

References:

1. Powers, W.J., Rabinstein, A.A., Ackerson, T., et al. 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2018;49(3):e46-e110.

2. Vahedi, K., Vicaut, E., Mateo, J., et al. Sequential-design, multicenter, randomized, controlled trial of early decompressive craniectomy in malignant middle cerebral artery infarction (DECIMAL Trial). Stroke 2007;38(9):2506-17.
3. Juttler, E., Schwab, S., Schmiedek, P., et al. Decompressive Surgery for the Treatment of Malignant Infarction of the Middle Cerebral Artery (DESTINY): a randomized, controlled trial. Stroke 2007;38(9):2518-25.
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6. Casaubon, L.K., Boulanger, J.M., Blacquiere, D., et al. Canadian Stroke Best Practice Recommendations: Hyperacute Stroke Care Guidelines, Update 2015. Int J Stroke 2015;10(6):924-40.
7. Wijdicks, E.F., Sheth, K.N., Carter, B.S., et al. Recommendations for the management of cerebral and cerebellar infarction with swelling: a statement for healthcare professionals from the american heart association/american stroke association. Stroke 2014;45(4):1222-38.
8. Venketasubramanian, N., Pwee, K.H., Chen, C.P., Singapore Ministry of Health Clinical Practice Guidelines Workgroup on, S.Transient Ischaemic, A. Singapore ministry of health clinical practice guidelines on stroke and transient ischemic attacks. Int J Stroke 2011;6(3):251-8.
9. Alonso de Lecinana, M., Egido, J.A., Casado, I., et al. Guidelines for the treatment of acute ischaemic stroke. Neurologia 2014;29(2):102-22.
10. Bryer, A., Connor, M., Haug, P., et al. South African guideline for management of ischaemic stroke and transient ischaemic attack 2010: a guideline from the South African Stroke Society (SASS) and the SASS Writing Committee. S Afr Med J 2010;100(11 Pt 2):747-78.
11. European Stroke Organisation Executive, C.Committee, E.S.O.W. Guidelines for management of ischaemic stroke and transient ischaemic attack 2008. Cerebrovasc Dis 2008;25(5):457-507.

<table>
<tr><td colspan="2">7: Coagulopathy Reversal in Intracerebral Hemorrhage

Percentage of patients with intracerebral hemorrhage and an INR > 1.4 due to warfarin treatment who receive replacement of vitamin K-dependent clotting factors within 90 minutes of emergency department (ED) arrival and who also receive intravenous (IV) vitamin K</td></tr>
<tr><td>Numerator</td><td>Patients with intracerebral hemorrhage (ICH) and an INR > 1.4 due to warfarin treatment who receive replacement of vitamin K-dependent clotting factors* within 90 minutes of ED presentation and who also receive IV vitamin K</td></tr>
<tr><td>Denominator</td><td>Included:
Intracerebral hemorrhage patients with a known time of onset or time last seen well within the previous 12 hours, an INR >1.4 and known or presumed current warfarin use

Excluded:
< 18 years of age
Documented contraindication to treatment with an anticoagulant reversal agent
Documented Comfort Measures Only status prior to coagulopathy reversal decision
Length of stay > 120 days
Enrolled in a clinical trial that would impact the use of anticoagulant reversal agents
Use of anticoagulants other than warfarin
Elevated INR not due to warfarin (e.g. liver disease)
Patient transferred from another ED where replacement of vitamin K-dependent clotting factors was initiated</td></tr>
<tr><td>Period of Assessment</td><td>Initial 90 minutes after ED arrival</td></tr>
<tr><td>Sources of Data</td><td>☐ Claims (only)
☐ EHR Hybrid
☐ Imaging-diagnostic
☒ Pharmacy
☐ Provider Tool
☐ Paper Records
☐ Non-medical Data
☒ Claims (other)
☒ EHR (only)
☐ Laboratory
☐ Registry
☒ Management Data
☐ Patient reported data
☐ Other: _____</td></tr>
<tr><td colspan="2">Rationale

In intracerebral hemorrhage, coagulopathy due to vitamin K antagonists (VKA; principally warfarin) is a significant risk factor for hematoma expansion and poorer outcomes. These risks can be mitigated by the timely correction of the elevated INR and anticoagulant effect using prothrombin complex concentrates or fresh frozen plasma. Vitamin K must also be administered to ensure that coagulopathy does not return after the effects of initial reversal agents have subsided.

* Acceptable intravenous Vitamin K-dependent clotting factors to meet this measure are prothrombin complex concentrate (PCC) which is preferred, although fresh frozen plasma (FFP) is also acceptable. While some data suggest that PCC is superior to FFP, the level of evidence is considered insufficient to mandate its use [1]. Intravenous Vitamin K must be given to meet this measure, but it is not sufficient as monotherapy for warfarin-induced coagulopathy. A specific time frame for vitamin K administration is not delineated. Recombinant factor VIIa is not guideline-recommended and is not acceptable to meet this measure.</td></tr>
</table>

Sources of Clinical Recommendations

From the 2015 American Heart Association/American Stroke Association (AHA/ASA) "Guidelines for the Management of Spontaneous Intracerebral Hemorrhage" [1]:

- Patients with ICH whose INR is elevated because of vitamin K antagonists (VKA) should have their VKA withheld, receive therapy to replace vitamin K–dependent factors and correct the INR, and receive intravenous vitamin K. (Class I; Level of Evidence C)
- Recombinant factor VIIa (rFVIIa) does not replace all clotting factors, and although the INR may be lowered, clotting may not be restored in vivo; therefore, rFVIIa is not recommended for VKA reversal in ICH. (Class III; Level of Evidence C)

From the 2016 Neurocritical Care Society and Society of Critical Care Medicine "Guideline for Reversal of Antithrombotics in Intracranial Hemorrhage" [2]:

- We recommend urgent reversal of vitamin K antagonists in patients with intracranial hemorrhage. (Strong recommendation; moderate quality evidence)
- We recommend administering 3-factor or 4-factor PCC rather than FFP to patients with VKA-associated intracranial hemorrhage and INR > 1.4. (Strong recommendation; moderate quality evidence)
- We recommend administration of Vitamin K to ensure durable reversal of INR following VKA-associated intracranial hemorrhage. Vitamin K should be dosed as soon as possible or concomitantly with other reversal agents. (Strong recommendation; moderate quality evidence)
- Treatment with FFP and Vitamin K is recommended over no treatment. (Strong recommendation; moderate quality evidence)
- We recommend against administration of rFVIIa for the reversal of VKA. (Strong recommendation; low quality evidence)

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Initiation of coagulopathy reversal agent does not necessarily guarantee adequate INR correction
- The timeliness of administration for this measure relates to reversal agent, not vitamin K. Patients should receive vitamin K in a timely manner. However, an organization would meet the measure if they gave a dose of vitamin K regardless of the timing.
- Increasing use of non-VKA direct-acting anticoagulants, but strength of guideline recommendations insufficient for performance measure

Analogous Measures Endorsed by Other Organizations

- The Joint Commission (CSTK-04) [3]
- American Heart Association/American Stroke Association Clinical Performance Measures for Adults Hospitalized with Intracerebral Hemorrhage PM 2 [4]

References:

1. Hemphill, J.C., Greenberg, S.M., Anderson, C.S., et al. Guidelines for the Management of Spontaneous Intracerebral Hemorrhage: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2015;46(7):2032-60.
2. Frontera, J.A., Lewin, J.J., Rabinstein, A.A., et al. Guideline for Reversal of Antithrombotics in Intracranial Hemorrhage: A Statement for Healthcare Professionals from the Neurocritical Care Society and Society of Critical Care Medicine. Neurocrit Care 2016;24(1):6-46.
3. The Joint Commission. *Comprehensive Stroke Certification: Standardized Performance Measures*. 2018 [cited 2018 November 1st]; Available from: https://www.jointcommission.org/performance_measures_for_comprehensive_stroke_centers/.
4. Hemphill, J.C., Adeoye, O.M., Alexander, D.N., et al. Clinical Performance Measures for Adults Hospitalized With Intracerebral Hemorrhage: Performance Measures for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2018;49(7):e243-e61.

8: Avoidance of Corticosteroid Use for Elevated Intracranial Pressure in Intracerebral Hemorrhage

Percentage of patients with non-traumatic spontaneous intracerebral hemorrhage (ICH) who do not receive corticosteroids during acute hospitalization

Numerator	Patients with non-traumatic ICH who did not receive intravenous or oral corticosteroids
Denominator	**Included:** All patients with non-traumatic spontaneous ICH **Excluded:** • < 18 years of age • Length of stay > 120 days • Received corticosteroids at a different healthcare facility • Enrolled in a clinical trial in which corticosteroids are part of the investigational regimen • Documentation of a medical condition for which corticosteroids may be indicated, including but not limited to brain tumor, vasculitis, asthma, COPD, and cortisol deficiency (including need for "stress-dose steroids")
Period of Assessment	From Emergency Department arrival until acute care hospital discharge
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☒ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____

Rationale

Corticosteroids may be used for the treatment of cerebral mass effect and elevated intracranial pressure if vasogenic edema is present from brain tumors or cerebral abscess. A prior randomized clinical trial in intracerebral hemorrhage found increased complications and no outcome benefit [1].

Sources of Clinical Recommendations

From the 2015 AHA/ASA "Guidelines for the Management of Spontaneous Intracerebral Hemorrhage" [1]:

- Corticosteroids should not be administered for treatment of elevated ICP in ICH. (Class III; Level of Evidence B)

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☐ Process	☒ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☒Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Determining indication for corticosteroid administration when given for reasons other than cerebral edema

Analogous Measures Endorsed by Other Organizations

American Heart Association/American Stroke Association ICH PM 9 [2]

References:

1. Hemphill, J.C., 3rd, Greenberg, S.M., Anderson, C.S., et al. Guidelines for the Management of Spontaneous Intracerebral Hemorrhage: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2015;46(7):2032-60.
2. Hemphill, J.C., Adeoye, O.M., Alexander, D.N., et al. Clinical Performance Measures for Adults Hospitalized With Intracerebral Hemorrhage: Performance Measures for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke 2018;49(7):e243-e61.

9: Nimodipine Treatment in Aneurysmal Subarachnoid Hemorrhage

Percentage of patients with aneurysmal subarachnoid hemorrhage (aSAH) who receive enteral nimodipine within 24 hours of arrival

Numerator	Patients with aneurysmal SAH treated with enteral nimodipine within 24 hours of arrival
Denominator	**Included:** All patients with aneurysmal SAH **Excluded:** • < 18 years of age • Length of stay > 120 days • Documented Comfort Measures Only status prior to nimodipine decision • Enrolled in a clinical trial that would preclude the use of nimodipine • Patients transferred to another facility within 24 hours • Clinically significant hypotension or hemodynamic instability that would preclude administration of nimodipine • Contraindications to administration of an oral medication or placement of a feeding tube
Period of Assessment	Hospital arrival through the subsequent 24 hours
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☒ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____

Rationale

In patients with aSAH, vasospasm and delayed cerebral ischemia (DCI) are a major cause of morbidity [1]. Nimodipine is presumed to limit DCI and has been associated with improved outcomes in multiple randomized controlled trials [2]. Typical dosing in these trials was 60 mg every 4 hours for 21 days, initiated promptly after aneurysm rupture. Because of its hypotensive effects, nimodipine dosing is sometimes divided into different dosing intervals, decreased, or discontinued. Furthermore, the need for 21 days of treatment in good-grade SAH patients who no longer demonstrate vasospasm and are otherwise ready for acute care hospital discharge has not been thoroughly investigated. Thus, initiation of nimodipine at the time of hospital admission is emphasized for this performance measure. This also harmonizes with an existing Joint Commission Comprehensive Stroke Center performance measure.

While the term “oral” is used in many guidelines, “enteral” is a preferable term as nimodipine may be administered through a feeding tube if necessary. Alternative methods of administering calcium channel blockers have been investigated (intravenous nimodipine, intrathecal nimodipine or nicardipine), but none have demonstrated clear outcome benefit in sufficiently powered phase III clinical trials [3].

Sources of Clinical Recommendations

From the 2011 Neurocritical Care Society "Critical Care Management of Patients Following Aneurysmal Subarachnoid Hemorrhage: Recommendations from the Neurocritical Care Society's Multidisciplinary Consensus Conference" [1]:

- Oral nimodipine (60 mg every 4 h.) should be administered after SAH for a period of 21 days. (High quality evidence; strong recommendation)

From the 2012 American Heart Association/American Stroke Association "Guidelines for the Management of Aneurysmal Subarachnoid Hemorrhage" [2]:

- Oral nimodipine should be administered to all patients with aSAH. (Class I; Level of evidence A)

From the 2012 Spanish Society of Neurology's "Clinical management guidelines for subarachnoid haemorrhage. Diagnosis and treatment" [4]:

- Experts recommend early-onset treatment with nimodipine, whether by oral or intravenous routes, to improve clinical progress and prognosis in patients with aneurysmal SAH. (Level of evidence 1a; grade of recommendation A)

From the 2013 "European Stroke Organization Guidelines for the Management of Intracranial Aneurysms and Subarachnoid Haemorrhage" [5]:

- Nimodipine should be administered orally (60 mg/4 h.) to prevent delayed ischaemic events. (Class I; level A)

From the 2014 Croatian multi-society "Recommendations for the management of medical complications in patients following aneurysmal subarachnoid hemorrhage" [6]:

- Nimodipine should be administered orally (60 mg/4 h.) to all patients with aSAH for a period of 21 days to prevent delayed ischemic events. (High quality evidence; strong recommendation)

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Timing of nimodipine in aSAH in randomized trials is different than this performance measure. Harmonization with existing The Joint Commission (TJC) PM was prioritized.

- Defining clinically significant hypotension or hemodynamic instability that would preclude administration of nimodipine. This should be clearly documented in the medical record to be apparent during abstraction.

Analogous Measures Endorsed by Other Organizations

The Joint Commission (CSTK-6) [7]

References:

1. Diringer, M.N., Bleck, T.P., Claude Hemphill, J., 3rd, et al. Critical care management of patients following aneurysmal subarachnoid hemorrhage: recommendations from the Neurocritical Care Society's Multidisciplinary Consensus Conference. Neurocrit Care 2011;15(2):211-40.
2. Connolly, E.S., Rabinstein, A.A., Carhuapoma, J.R., et al. Guidelines for the management of aneurysmal subarachnoid hemorrhage: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2012;43(6):1711-37.
3. Tallarico, R.T., Pizzi, M.A.Freeman, W.D. Investigational drugs for vasospasm after subarachnoid hemorrhage. Expert Opin Investig Drugs 2018;27(4):313-24.
4. Vivancos, J., Gilo, F., Frutos, R., et al. Clinical management guidelines for subarachnoid haemorrhage. Diagnosis and treatment. Neurologia 2014;29(6):353-70.
5. Steiner, T., Juvela, S., Unterberg, A., et al. European Stroke Organization guidelines for the management of intracranial aneurysms and subarachnoid haemorrhage. Cerebrovasc Dis 2013;35(2):93-112.
6. Solter, V.V., Roje-Bedekovic, M., Breitenfeld, T., et al. Recommendations for the management of medical complications in patients following aneurysmal subarachnoid hemorrhage. Acta Clin Croat 2014;53(1):113-38.
7. The Joint Commission. *Comprehensive Stroke Certification: Standardized Performance Measures*. 2018 [cited 2018 November 1st]; Available from: https://www.jointcommission.org/performance_measures_for_comprehensive_stroke_centers/.

10: Screening for Cerebral Vasospasm After Aneurysmal Subarachnoid Hemorrhage **Percentage of patients with aneurysmal subarachnoid hemorrhage (aSAH) who undergo screening for cerebral vasospasm**	
Numerator	Patients with aSAH who undergo screening for detection of cerebral vasospasm Acceptable diagnostic tests for screening include: • Transcranial Doppler ultrasound (TCD) • Computerized tomography angiogram of intracranial vessels (CTA) • Digital subtraction angiogram (DSA)
Denominator	**Included:** All patients with aneurysmal subarachnoid hemorrhage **Excluded:** • < 18 years of age • Length of stay > 120 days • Documented Comfort Measures Only status prior to period of assessment
Period of Assessment	Days 3 to 14 from onset of aSAH
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☒ Imaging-diagnostic ☐ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☒ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____
Rationale Cerebral vasospasm occurs in approximately 30% of patients after aneurysmal subarachnoid hemorrhage [1]. Vasospasm can lead to delayed cerebral ischemia (DCI) and devastating infarcts, and identification of vasospasm, in conjunction with clinical neurological assessment, allows for treatment with medical interventions such as hypertensive therapy, angioplasty or vasodilator injection. TCD ultrasound has historically been the non-invasive monitoring modality of choice for vasospasm because it is noninvasive, relatively inexpensive, and portable. The American Academy of Neurology Expert Committee concluded that TCD is useful for the diagnosis of vasospasm [2]. Reports vary as to the sensitivity and specificity of TCD for detecting vasospasm in general, but it reliably detects severe spasm. In addition to TCD and conventional DSA, CTA can be used to detect large vessel vasospasm. DSA is considered the gold standard but is invasive. The highest risk period for vasospasm is 3-14 days after aneurysm rupture. While repeat monitoring and screening throughout this risk period seems reasonable, available recommendations do not specify frequency or timing.	
Sources of Clinical Recommendations From the 2011 “Critical care management of patients following aneurysmal subarachnoid hemorrhage: recommendations from the Neurocritical Care Society's Multidisciplinary Consensus Conference” [3] and 2014 recommendations from Croatian Society of Neurovascular Disorders and Croatian Society of Neurology “Recommendations for the management of medical complications in patients following aneurysmal subarachnoid hemorrhage“ [4]: • Imaging of vascular anatomy and/or perfusion can be used to confirm the diagnosis of DCI in monitored good-	

grade patients who show a change in neurological examination or TCD variables. (High quality evidence; strong recommendation)
- TCD is reasonable to monitor for the development of arterial vasospasm. (Moderate quality evidence; strong Recommendation)
- Thresholds of mean blood flow velocities < 120 cm/sec for absence and > 200 cm/sec and or MCA/ICA ratio > 6 for presence are reasonable. (Moderate quality evidence; strong recommendation)
- DSA is gold standard for detection of large artery vasospasm. (High quality evidence; strong recommendation)

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒ Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Unclear timing for initial and final screening as well as frequency of screening. Beta testing of this measure will need to address frequency and timing of screening
- Patients may not have insonation windows to conduct transcranial Doppler ultrasonography
- Vasospasm and DCI are not always linked
- Additional information from CT perfusion imaging and/or clinical examination may be necessary to direct intervention.

Analogous Measures Endorsed by Other Organizations

- American Heart Association/American Stroke Association “Metrics for Measuring Quality of Care in Comprehensive Stroke Centers” Metric 17 [2]

References:

1. Suarez, J.I. Diagnosis and Management of Subarachnoid Hemorrhage. Continuum (Minneap Minn) 2015;21(5 Neurocritical Care):1263-87.
2. Leifer, D., Bravata, D.M., Connors, J.J., 3rd, et al. Metrics for measuring quality of care in comprehensive stroke centers: detailed follow-up to Brain Attack Coalition comprehensive stroke center recommendations: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2011;42(3):849-77.
3. Diringer, M.N., Bleck, T.P., Claude Hemphill, J., 3rd, et al. Critical care management of patients following aneurysmal subarachnoid hemorrhage: recommendations from the Neurocritical Care Society's Multidisciplinary Consensus Conference. Neurocrit Care 2011;15(2):211-40.
4. Solter, V.V., Roje-Bedekovic, M., Breitenfeld, T., et al. Recommendations for the management of medical complications in patients following aneurysmal subarachnoid hemorrhage. Acta Clin Croat 2014;53(1):113-38.

11: Immunomodulatory Treatment for Guillain-Barré Syndrome

Percentage of nonambulatory patients with Guillain-Barré syndrome that receive immunosuppressive therapy (plasma exchange or intravenous immune globulin) and are not prescribed corticosteroids

Numerator	Nonambulatory patients with Guillain-Barré syndrome who receive immunosuppressive therapy using plasma exchange (PE) or intravenous immune globulin (IVIG) and are not prescribed corticosteroids

Denominator	**Included:**
	All nonambulatory patients with Guillain-Barré syndrome
	
	Excluded:
	• < 18 years of age
	• Length of stay > 120 days
	• Contraindications to both PE and IVIG:
	  ○ Plasma exchange: septic or hemodynamically unstable, allergy to fresh frozen plasma, albumin, or heparin, greater than 4 weeks from symptom onset
	  ○ Intravenous immune globulin: history of anaphylactic or severe systemic reaction to human immune globulin, IgA-deficient patients with antibodies to IgA and a history of hypersensitivity, greater than 2 weeks from symptom onset
	• Documentation of a medical condition for which corticosteroids may be indicated, including but not limited to brain tumor, vasculitis, asthma, COPD, and cortisol deficiency (including need for “stress-dose steroids”)
	• Enrolled in a clinical trial in which corticosteroids are part of the investigational regimen
	• Patient refusal

Period of Assessment	From Emergency Department arrival until acute care hospital discharge
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☒ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____

Rationale

Guillain-Barré syndrome consists of a group of neurologic conditions characterized by progressive weakness and absent or diminished tendon reflexes; the estimated incidence is 1-2 cases per 100,000 people per year [1, 2]. Treatment of Guillain-Barré syndrome centers on supportive care and immunosuppressive therapy. Plasma exchange has been shown to improve outcomes compared to supportive care [3]. Intravenous immune globulin has largely been compared to plasma exchange as the latter had become the standard treatment for Guillain-Barré syndrome by the time intravenous immune globulin was being studied. Intravenous immune globulin has been shown to be as effective as plasma exchange [4] .Corticosteroids are not recommended for the treatment of patients with Guillain-Barré syndrome due to a lack of supportive data [5].

Sources of Clinical Recommendations:

From the 2007 National Advisory Committee on Blood and Blood Products and Canadian Blood Services "Guidelines on the Use of Intravenous Immune Globulin for Neurologic Conditions" [6].

- Intravenous immune globulin is recommended as a treatment option for Guillain-Barré syndrome within 2 weeks of symptom onset for: 1. Patients with symptoms of grade 3 severity (able to walk with aid) or greater; or 2. Patients with symptoms less than grade 3 severity whose symptoms are progressing
- Based on consensus by the expert panel, the recommendations for use of intravenous immune globulin for Guillain-Barré syndrome also apply to patients with Miller-Fisher and other variants of Guillain-Barré syndrome

From the 2012 Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology "Evidence-based guideline: Intravenous immunoglobulin in the treatment of neuromuscular disorders" [7]:

- IV immunoglobulin is as efficacious as plasmapheresis and should be offered for treating Guillain-Barré syndrome in adults. (Level A Recommendation)

From the 2011 Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology "Evidence-based guideline update: Plasmapheresis in neurologic disorders: report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology" [8]:

- Plasmapheresis should be offered in the treatment of acute inflammatory demyelinating polyneuropathy / Guillain-Barré syndrome severe enough to impair independent walking or to require mechanical ventilation. (Level A Recommendation)

From the 2008 European Federation of the Neurological Societies "EFNS guidelines for the use of intravenous immunoglobulin in treatment of neurological diseases: EFNS task force on the use of intravenous immunoglobulin in treatment of neurological diseases" [9]:

- Intravenous immunoglobulin 0.4 g/kg/day for 5 days or plasma exchange can be used as first line treatment and are considered to be equally effective. (Level A Recommendation)

From the 2003 Quality Standards Subcommittee of the American Academy of Neurology "Practice parameter: Immunotherapy for Guillain–Barré syndrome" [10]:

- Plasma exchange is recommended for nonambulatory patients within 4 weeks of onset. (Level A Recommendation; Class II Evidence)
- IV immunoglobulin is recommended for patients with Guillain-Barré syndrome who require aid to walk within 2 weeks from the onset of neuropathic symptoms. (Level A Recommendation)
- Sequential treatment with plasma exchange followed by IV immunoglobulin is not recommended. (Level A Recommendation; Class I Evidence)
- Corticosteroids are not recommended for the treatment of patients with Guillain-Barré syndrome. (Level A Recommendation; Class I Evidence)

From the 2016 American Society for Apheresis "Guidelines on the Use of Therapeutic Apheresis in Clinical Practice—Evidence-Based Approach from the Writing Committee of the American Society for Apheresis: The Seventh Special Issue" [11]:

- Therapeutic plasma exchange is recommended for primary treatment of acute inflammatory demyelinating polyradiculoneuropathy/ Guillain–Barré syndrome (Grade 1A, strong recommendation; high quality evidence)

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Difficulty identifying nonambulatory status as trigger for treatment
- Difficulty identifying appropriate exclusions
- Time from symptom onset to treatment may be challenging to assess
- Specific aspects of treatment such as dose and timing of PE and IVIG are not addressed in this measure

Analogous Measures Endorsed by Other Organizations

- American Academy of Neurology Inpatient and Emergent Neurology Quality Measurement Set: Immunosuppressive Treatment for Guillain-Barré syndrome [12]

References:

1. Willison, H.J., Jacobs, B.C.van Doorn, P.A. Guillain-Barre syndrome. Lancet 2016;388(10045):717-27.
2. Sejvar, J.J., Baughman, A.L., Wise, M.Morgan, O.W. Population incidence of Guillain-Barre syndrome: a systematic review and meta-analysis. Neuroepidemiology 2011;36(2):123-33.
3. Chevret, S., Hughes, R.A.Annane, D. Plasma exchange for Guillain-Barre syndrome. Cochrane Database Syst Rev 2017;2:CD001798.
4. Hughes, R.A., Swan, A.V.van Doorn, P.A. Intravenous immunoglobulin for Guillain-Barre syndrome. Cochrane Database Syst Rev 2014;(9):CD002063.
5. Hughes, R.A., Brassington, R., Gunn, A.A.van Doorn, P.A. Corticosteroids for Guillain-Barre syndrome. Cochrane Database Syst Rev 2016;10:CD001446.
6. Feasby, T., Banwell, B., Benstead, T., et al. Guidelines on the use of intravenous immune globulin for neurologic conditions. Transfus Med Rev 2007;21(2 Suppl 1):S57-107.
7. Patwa, H.S., Chaudhry, V., Katzberg, H., Rae-Grant, A.D.So, Y.T. Evidence-based guideline: Intravenous immunoglobulin in the treatment of neuromuscular disorders: Report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. Neurology 2012;78(13):1009-15.
8. Cortese, I., Chaudhry, V., So, Y.T., et al. Evidence-based guideline update: Plasmapheresis in neurologic disorders: report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. Neurology 2011;76(3):294-300.
9. Elovaara, I., Apostolski, S., van Doorn, P., et al. EFNS guidelines for the use of intravenous immunoglobulin in treatment of neurological diseases: EFNS task force on the use of intravenous immunoglobulin in treatment of neurological diseases. Eur J Neurol 2008;15(9):893-908.
10. Hughes, R.A., Wijdicks, E.F., Barohn, R., et al. Practice parameter: immunotherapy for Guillain-Barre syndrome: report of the Quality Standards Subcommittee of the American Academy of Neurology. Neurology 2003;61(6):736-40.
11. Schwartz, J., Padmanabhan, A., Aqui, N., et al. Guidelines on the Use of Therapeutic Apheresis in Clinical Practice-Evidence-Based Approach from the Writing Committee of the American Society for Apheresis: The Seventh Special Issue. J Clin Apher 2016;31(3):149-62.
12. American Academy of Neuorology Stroke and Stroke Rehabiliation Work Group. *Quality Measurement Set*. 2017 [cited 2018 November 1st]; Available from: https://www.aan.com/siteassets/home-page/policy-and-guidelines/quality/quality-measures/17iemeasureset_pg.pdf.

12: Immunomodulatory Therapy for Myasthenic Crisis

Percentage of patients with myasthenic crisis given immunosuppressive therapies (plasma exchange [PE] or intravenous immunoglobulin [IVIG])

Numerator	Patients in myasthenic crisis (defined as disease exacerbation with respiratory compromise severe enough to warrant ICU admission) who receive immunosuppressive therapy (PE or IVIG)

Denominator	**Included:**
	All patients in myasthenic crisis (defined as disease exacerbation with respiratory compromise severe enough to warrant ICU admission)
	
	Excluded:
	• < 18 years of age
	• Length of stay > 120 days
	• Contraindications to both PE and IVIG:
	  ○ Plasma exchange: septic or hemodynamically unstable, allergy to fresh frozen plasma, albumin, or heparin
	  ○ Intravenous immune globulin: history of anaphylactic or severe systemic reaction to human immune globulin, IgA-deficient patients with antibodies to IgA and a history of hypersensitivity
	• Patient refusal

Period of Assessment	From Emergency Department arrival until ICU discharge
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☒ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____

Rationale

Myasthenic crisis is a neurologic emergency that causes neuromuscular weakness of the muscles of respiration and often necessitates intubation. It can be difficult to recognize, especially in patients who do not carry a preexisting diagnosis of myasthenia gravis. Common triggers include recent surgery, systemic infection, and medications. Prompt administration of immunotherapy with either plasmapheresis or intravenous immunoglobulin is associated more rapid weaning from mechanical ventilation, prevention of tracheostomy, and an improved likelihood of regaining functional independence [1-3]. While it is generally agreed that early recognition of crisis and prompt initiation of immunotherapy is ideal, a timeframe for the initiation of immunotherapy is not defined in published literature. Therefore, this performance measure does not dictate a timeframe for initiation of therapy. Patients should receive treatment promptly and as directed by the provider.

Sources of Clinical Recommendations

From the 2016 Writing Committee of the American Society for Apheresis “Guidelines on the Use of Therapeutic Apheresis in Clinical Practice” [4]:

- Therapeutic plasma exchange is recommended for moderate-severe disease. (Category 1; Grade 1B)

From the 2007 IVIG Hematology and Neurology Expert Panel “Guidelines on the Use of Intravenous Immune Globulin for Neurologic Conditions” [1]:

- Intravenous immune globulin is recommended as a treatment option for patients with severe exacerbations of myasthenia gravis or myasthenic crises. (Level of Evidence 1B)

From the 2006 European Federation of the Neurological Societies (EFNS) Task Force “Guidelines for the treatment of autoimmune neuromuscular transmission disorders” [3]:

- Intravenous immunoglobulin (IVIG and plasma exchange are equally effective for the treatment of MG exacerbations. (Level A Recommendation)

From the 2008 EFNS Task Force “Guidelines for the use of intravenous immunoglobulin in treatment of neurologic diseases” [5]:

- Intravenous immunoglobulin (IVIG) and plasma exchange are equally effective for the treatment of MG exacerbations. (Level A Recommendation)

Method of Reporting/ Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Difficulty determining severity triggers to identify ICU patients who would meet this measure
- Difficulty identifying exclusions
- Time from symptom onset to treatment may be challenging to assess
- Specific aspects of treatment such as dose and timing of PE and IVIG are not addressed in this measure

Analogous Measures Endorsed by Other Organizations

- American Academy of Neurology Inpatient and Emergent Neurology Quality Measurement Set: Immunosuppressive Therapy for Myasthenic Crisis [6]

References:

1. Feasby, T., Banwell, B., Benstead, T., et al. Guidelines on the use of intravenous immune globulin for neurologic conditions. Transfus Med Rev 2007;21(2 Suppl 1):S57-107.
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13: Dexamethasone Administration in Acute Bacterial Meningitis

Percentage of adult patients with acute bacterial meningitis who receive 10 mg intravenous dexamethasone before or with the first dose of antibiotics

Numerator	Patients with acute bacterial meningitis who received empiric dexamethasone 10 mg intravenously before or with the first dose of antibiotics.
Denominator	**Included:** Patients with acute bacterial meningitis. **Excluded:** • Length of stay > 120 days • Patients with contraindications to steroid administration (systemic fungal infection, hypersensitivity) • Patients treated with oral or parenteral antibiotics in the previous 48 hours • Patients with a recent history of neurosurgery or head trauma Patients with a CSF shunt or external ventricular drain. • Patients less than 18 years of age
Period of Assessment	From Emergency Department arrival until acute care hospital discharge
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☒ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____

Rationale

In acute bacterial meningitis, steroids may mitigate the inflammatory response and the bacterial lysis that occurs in response to antibiotic initiation.[1] In a 2015 Cochrane meta-analysis of 25 randomized controlled trials including 4121 participants, corticosteroids were found to significantly decrease rates of severe hearing loss, any hearing loss, and neurological complications. Corticosteroids did not significantly impact mortality, although a subgroup analysis demonstrated a reduction in mortality due to meningitis caused by *Streptococcus pneumoniae* [1].

The benefit derived from corticosteroids occurs when they are administered promptly before or simultaneously with the administration of antibiotics. Providers must therefore rapidly recognize the signs and symptoms of acute bacterial meningitis and treat empirically with steroids based on clinical suspicion prior to obtaining confirmatory CSF results.

Sources of Clinical Recommendations

From the 2016 “UK Joint Specialist Societies Guideline on the Diagnosis and Management of Acute Meningitis and Meningococcal Sepsis in Immunocompetent Adults” [2]:

- It is recommended that 10 mg dexamethasone IV 6 hourly should be started on admission, either shortly before or simultaneously with antibiotics. (Level I/strong recommendation; quality of evidence high/A)
- It is recommended that if pneumococcal meningitis is confirmed, or thought probable based on clinical, epidemiological and CSF parameters, dexamethasone should be continued for 4 days. (Level I/strong recommendation; quality of evidence low/C)
- It is recommended that if another cause of meningitis is confirmed, or thought probable, the dexamethasone should be stopped. (Level I/strong recommendation; quality of evidence low/C)

From the 2016 “European Society of Clinical Microbiology and Infectious Diseases Guideline: Diagnosis and Treatment of Acute Bacterial Meningitis” [3]:

- Empiric treatment with dexamethasone is strongly recommended for all adults (10 mg QID for 4 days) and children (0.15 mg/kg QID for 4 days) with acute bacterial meningitis in the setting of high-income countries. (Grade A strong recommendation; level of evidence category not provided)
- Treatment with dexamethasone is strongly recommended to be initiated with the first dose of antibiotic treatment. (Grade A strong recommendation; level of evidence category not provided)

From the 2008 “European Federation of the Neurological Societies Guideline on the Management of Community Acquired Meningitis” [4]:

- Adjuvant dexamethasone is recommended with or shortly before the first parenteral dose of antibiotics in all previously well and non-immunosuppressed adults with pneumococcal meningitis at a dose of 10 mg every 6 hrs. for 4 days. (Level A recommendation; Class I level of evidence)
- In acute bacterial meningitis because of other bacterial etiology, routine use of high dose dexamethasone is not presently recommended. (Level A recommendation; Class I level of evidence)

From the 2004 Infectious Diseases Society of America “Practice Guidelines for the Management of Bacterial Meningitis” [5]:

- On the basis of the available evidence on the use of adjunctive dexamethasone in adults, the use of dexamethasone (0.15 mg/kg q 6 hrs. for 2-4 days with the first dose administered 10-20 min before, or at least concomitant with, the first dose of antimicrobial therapy) is recommended in adults with suspected or proven pneumococcal meningitis. (Recommendation strength A; quality of evidence I)
- It is recommended that adjunctive dexamethasone should not be given to adult patients who have already received antimicrobial therapy, because administration of dexamethasone in this circumstance is unlikely to improve patient outcome. (Recommendation strength A; quality of evidence I)

From the 2017 “Guidelines for the Diagnosis and Management of Critical Illness-Related Corticosteroid Insufficiency (CIRCI) in Critically Ill Patients (Part II): Society of Critical Care Medicine (SCCM) and European Society of Intensive Care Medicine (ESICM) 2017” [6]:

- The use of corticosteroids in patients with bacterial meningitis is recommended. (Strong recommendation, low quality of evidence).

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Requires rapid diagnosis and empiric treatment of suspected bacterial meningitis prior to CSF results being available for confirmatory diagnosis
- Requires standardization of acute bacterial meningitis infection surveillance
- Patients who do not undergo lumbar puncture due to cerebral edema are included in this measure if their hospital discharge diagnosis is acute bacterial meningitis

Analogous Measures Endorsed by Other Organizations

American Academy of Neurology Inpatient and Emergency Neurology Quality Measurement Set: Treatment of Bacterial Meningitis [7]

References:

1. Brouwer, M.C., McIntyre, P., Prasad, K.van de Beek, D. Corticosteroids for acute bacterial meningitis. Cochrane Database Syst Rev 2015;(9):CD004405.
2. McGill, F., Heyderman, R.S., Michael, B.D., et al. The UK joint specialist societies guideline on the diagnosis and management of acute meningitis and meningococcal sepsis in immunocompetent adults. The Journal of infection 2016;72(4):405-38.
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5. Tunkel, A.R., Hartman, B.J., Kaplan, S.L., et al. Practice guidelines for the management of bacterial meningitis. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America 2004;39(9):1267-84.
6. Pastores, S.M., Annane, D.Rochwerg, B. Guidelines for the Diagnosis and Management of Critical Illness-Related Corticosteroid Insufficiency (CIRCI) in Critically Ill Patients (Part II): Society of Critical Care Medicine (SCCM) and European Society of Intensive Care Medicine (ESICM) 2017. Critical Care Medicine 2018;46(1):146-8.
7. Neuorology, A.A.o. *Quality Measurement Set*. 2016 [cited 2018 November 1st]; Available from: https://www.aan.com/siteassets/home-page/policy-and-guidelines/quality/quality-measures/17iemeasureset_pg.pdf.

14: Acyclovir Treatment for Herpes Simplex Virus Encephalitis

Percentage of patients with herpes simplex virus encephalitis who are treated with intravenous acyclovir within 6 hours of hospital admission

Numerator	Patients with herpes simplex virus encephalitis who are treated with intravenous acyclovir within 6 hours of hospital admission
Denominator	**Included:** All patients with herpes simplex virus encephalitis **Excluded:** • < 18 years of age • Length of stay > 120 days • Hypersensitivity to acyclovir or valacyclovir • Acyclovir-resistant herpes simplex virus
Period of Assessment	From Emergency Department arrival until acute care hospital discharge
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☒ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____

Rationale

The mortality of untreated herpes simplex virus encephalitis is approximately 70% and many survivors suffer from neurological deficits [1]. Intravenous acyclovir selectively inhibits viral replication and has been shown to reduce morality and improve functional outcome when compared to vidarabine [2-4]. The acyclovir treatment regimen is generally 10 mg/kg/dose administered intravenously every 8 hours for 14-21 days, and doses should be reduced in patients with renal impairment [5-7]. Enteral acyclovir should be avoided due to its poor bioavailability (10-20%) [8]. Treatment with enteral valacyclovir is not recommended due to a lack of supportive data [6].

Sources of Clinical Recommendations

From the 2012 Association of British Neurologists and British Infection Association "Management of Suspected Viral Encephalitis in Adults" [5]:

- Intravenous acyclovir (10 mg/kg three times daily) should be started if the initial cerebrospinal fluid and/or imaging findings suggest viral encephalitis, or within 6 h of admission if these results will not be available, or if the patient is very unwell or deteriorating. (strength of recommendation A; quality of evidence II)
- If the first cerebrospinal fluid microscopy or imaging is normal but the clinical suspicion of herpes simplex virus or varicella zoster virus encephalitis remains, acyclovir should still be started within 6 h of admission whilst further diagnostic investigations are awaited. (strength of recommendation A; quality of evidence II)
- The dose of acyclovir should be reduced in patients with pre-existing renal impairment. (strength of recommendation A; quality of evidence II)
- In patients with proven herpes simplex virus encephalitis, intravenous acyclovir treatment should be continued for 14-21 days. (strength of recommendation A; quality of evidence II)
- Immunocompromised patients with encephalitis caused by herpes simplex virus 1 or 2 should be treated

with intravenous acyclovir (10 mg/kg three times daily) for at least 21 days, and reassessed with a cerebrospinal fluid polymerase chain reaction assay; following this long term oral treatment should be considered until the CD4 cell count is >200 x 10^6/L. (strength of recommendation A; quality of evidence II)

From the 2008 Infectious Diseases Society of America "The Management of Encephalitis: Clinical Practice Guidelines by the Infectious Diseases Society of America" [9]:

- Acyclovir should be initiated in all patients with suspected encephalitis, pending results of diagnostic studies. (strength of recommendation A; quality of evidence III)
- Herpes simplex virus: acyclovir is recommended. (strength of recommendation A; quality of evidence I)

From the 2010 European Federation of the Neurological Societies "Viral meningoencephalitis: a review of diagnostic methods and guidelines for management" [6]:

- Acyclovir should be used for herpes simplex virus encephalitis. (level of rating A; class of evidence II)

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Duration of treatment is not addressed
- Optimal time to treatment initiation has not be clearly defined, although guidelines strongly recommend within 6 hours of hospital admission or if diagnostic tests suggest viral encephalitis

Analogous Measures Endorsed by Other Organizations

None

References:

1. Jouan, Y., Grammatico-Guillon, L., Espitalier, F., et al. Long-term outcome of severe herpes simplex encephalitis: a population-based observational study. Crit Care 2015;19:345.
2. Whitley, R.J.Gnann, J.W., Jr. Acyclovir: a decade later. N Engl J Med 1992;327(11):782-9.
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8. O'Brien, J.J.Campoli-Richards, D.M. Acyclovir. An updated review of its antiviral activity, pharmacokinetic properties and therapeutic efficacy. Drugs 1989;37(3):233-309.
9. Tunkel, A.R., Glaser, C.A., Bloch, K.C., et al. The management of encephalitis: clinical practice guidelines by the Infectious Diseases Society of America. Clin Infect Dis 2008;47(3):303-27.

15: Dexamethasone in Tuberculous Meningitis

Percentage of adult patients with tuberculous (TB) meningitis who are treated with adjunctive corticosteroids upon initiation of antituberculous treatment

Numerator	Adult patients with TB meningitis who are treated with adjunctive corticosteroids upon initiation of antituberculous treatment
Denominator	**Included:** Adult patients with TB meningitis who are treated with adjunctive corticosteroids upon initiation of antituberculous treatment **Excluded:** • < 18 years of age • Length of stay > 120 days • Contraindication to steroid administration such as systemic fungal infection or hypersensitivity to steroids • HIV positive • Documented Comfort Measures Only status prior to initiation of antituberculous treatment • Enrollment in a clinical trial that would preclude the use of steroids
Period of Assessment	Duration of hospital stay
Sources of Data	☐ Claims (only) ☐ Claims (other) ☐ EHR Hybrid ☒ EHR (only) ☐ Imaging-diagnostic ☐ Laboratory ☒ Pharmacy ☐ Registry ☐ Provider Tool ☐ Management Data ☐ Paper Records ☐ Patient reported data ☐ Non-medical Data ☐ Other: _____

Rationale

Tuberculous meningitis causes high mortality and morbidity, even when patients are treated with antituberculosis drugs [1]. Several guidelines recommend administering adjunctive corticosteroids to TB meningitis patients upon initiation of antituberculosis treatment, based on multiple high-quality trials demonstrating a significant reduction in mortality [2, 3]. Patients do NOT need to have laboratory confirmed TB meningitis before starting antituberculosis or steroid treatment. The available evidence supports treatment with steroids as soon as TB meningitis is clinically suspected and empirically treated. A Cochrane review states that the "intention-to-treat analysis in clinically diagnosed participants provides assurance that use of corticosteroids on the basis of clinical diagnosis does more good than harm. This is important because the decision to use corticosteroids is usually taken on a purely clinical basis when culture reports are unavailable and it is the balance of benefit and risk of such a decision that needs to be determined" [4].

Although a Cochrane review suggested some short-term mortality benefit from the administration of corticosteroids to HIV positive patients with TB meningitis, the evidence overall is not robust enough to substantiate including HIV positive patients in this measure [4].

Sources of Clinical Recommendations

From the British Infection Society "Guidelines for the Diagnosis and Treatment of Tuberculosis of the Central Nervous System in Adults and Children" [2]:

- We recommend that all patients with tuberculous meningitis receive adjunctive corticosteroids regardless of disease severity at presentation (Strength of recommendation A; Quality of evidence I). The regimen should follow those used in recent controlled trials (Strength of recommendation A; Quality of evidence II). Adults (>14 years) should start treatment with dexamethasone 0.4 mg/kg/ 24 h with a reducing course over 6-8 weeks.

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☒Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- TB meningitis is prevalent in countries lacking EHR infrastructure for documentation and monitoring
- The formal laboratory confirmed diagnosis of TB meningitis can be challenging and take an extended period of time to confirm, therefore a hospital discharge diagnosis of TB meningitis is used for patient inclusion in this measure.

Analogous Measures Endorsed by Other Organizations

None

References:

1. Christensen, A.S., Roed, C., Omland, L.H., et al. Long-term mortality in patients with tuberculous meningitis: a Danish nationwide cohort study. PLoS One 2011;6(11):e27900.
2. Thwaites, G., Fisher, M., Hemingway, C., et al. British Infection Society guidelines for the diagnosis and treatment of tuberculosis of the central nervous system in adults and children. J Infect 2009;59(3):167-87.
3. National Institute for Health and Care Excellence, N.N. Tuberculosis: Prevention, diagnosis, managment and service organization. 2016.
4. Prasad, K., Singh, M.B.Ryan, H. Corticosteroids for managing tuberculous meningitis. Cochrane Database Syst Rev 2016;4:CD002244.

16: Adult Patients with Generalized Convulsive Status Epilepticus Treated Rapidly with a Benzodiazepine **Percentage of adult patients presenting to the emergency department with generalized convulsive status epilepticus (GCSE) who are treated with benzodiazepines within 20 minutes of hospital arrival**	
Numerator	Adult patients with GCSE treated within 20 minutes of hospital arrival with a benzodiazepine (intravenous [IV] lorazepam, IV diazepam, or IV midazolam; if the patient does not have an IV then IM midazolam should be used)
Denominator	**Included**: Adult patients with generalized convulsive status epilepticus (GCSE) **Excluded:** • < 18 years of age • Length of stay > 120 days • Status epilepticus from hypoglycemia • Appropriate benzodiazepine dose already given in pre-hospital setting or at referring hospital
Period of Assessment	First 24 hours of hospitalization
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☐ Pharmacy ☒ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____
Rationale Status epilepticus (SE) is an under-recognized health problem associated with substantial morbidity and mortality. An estimated 152,000 cases occur per year in the United States, resulting in 42,000 deaths and an inpatient cost of $3.8 to $7 billion per year. For the purposes of this performance measure, convulsive status epilepticus is defined as five minutes or more of continuous clinical seizure activity or recurrent seizure activity without recovery (return to baseline) between seizures. Prompt treatment of ongoing convulsive status epilepticus with an appropriate non-benzodiazepine antiepileptic drug following or simultaneously ordered with a benzodiazepine shortens the duration of status epilepticus. Therefore, the guidelines for treatment of status epilepticus from the Neurocritical Care Society state: “Urgent control anti-epileptic drug treatment following administration of short acting benzodiazepines is required in all patients with Status Epilepticus unless the immediate cause is known and definitely corrected (e.g. severe hypoglycemia)” [1]. However, for the purposes of a performance measure, the literature lacks consensus regarding the definition of ‘urgent control’. The 2016 American Epilepsy Society Guideline includes an algorithm in which the phase for initial benzodiazepine treatment is no longer than 20 minutes from onset of seizure [2]. While many clinicians might consider 20 minutes to be an excessively long treatment window, the authors of this performance measure opted to use the best available published literature, which is the evidence-based guideline referenced above. Regarding dosing, the RAMPART prehospital status epilepticus trial used lorazepam 4 mg IV or midazolam 10 mg IM and these could be considered as reasonable.	

Sources of Clinical Recommendations

From the 2012 Neurocritical Care Society "Guidelines for the evaluation and management of status epilepticus" [1]:

- The treatment of convulsive SE should occur rapidly and continue sequentially until clinical seizures are halted (Strong recommendation; High quality of evidence).
- Benzodiazepines should be given as emergent initial therapy (Strong recommendation; High quality of evidence).

From the 2006 Italian League against Epilepsy Guidelines "Treatment of status epilepticus in adults" [3]:

- Treatment of GCSE must be started as soon as possible from the pre-hospitalization phase (Level 1B; Rating A).
- IV lorazepam or diazepam are indicated for the treatment of initial GCSE. IV lorazepam is the benzodiazepine of choice because it is associated with a lower risk of early relapses (Level 1B; Rating A).

From the 2015 Spanish Neurological Society "Official clinical practice guidelines in epilepsy" [4]:

- Initial pharmacological treatment for any prolonged seizure or SE episode should be a benzodiazepine (Grade A).

From the 2016 American Epilepsy Society Guideline "Treatment of Convulsive Status Epilepticus in Children and Adults" [2]:

- A benzodiazepine (specifically IM midazolam, IV lorazepam, or IV diazepam) is recommended as the initial therapy of choice, given their demonstrated efficacy, safety, and tolerability (level A; four class I RCTs).

From the 2017 European Federation of the Neurological Societies "Guideline on the management of status epilepticus in adults" [5]:

- In GCSE, the preferred treatment pathway is IV administration of 0.1 mg/kg lorazepam (Level A rating).

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- The maximum time window for initial benzodiazepine treatment has not been clearly defined in clinical trials and may be shorter than 20 minutes
- In pre-hospital status epilepticus clinical trials, lorazepam was superior to diazepam and IM midazolam was superior to lorazepam. It is unclear how this translates to emergency department care

Analogous Measures Endorsed by Other Organizations

- American Academy of Neurology Inpatient and Emergency Neurology Quality Measurement Set: Status Epilepticus Identification and Seizure Cessation [6]

References:

1. Brophy, G.M., Bell, R., Claassen, J., et al. Guidelines for the evaluation and management of status epilepticus. Neurocritical Care 2012;17(1):3-23.
2. Glauser, T., Shinnar, S., Gloss, D., et al. Evidence-Based Guideline: Treatment of Convulsive Status Epilepticus in Children and Adults: Report of the Guideline Committee of the American Epilepsy Society. Epilepsy Curr 2016;16(1):48-61.
3. Minicucci, F., Muscas, G., Perucca, E., et al. Treatment of status epilepticus in adults: guidelines of the Italian League against Epilepsy. Epilepsia 2006;47 Suppl 5:9-15.
4. Mauri Llerda, J.A., Suller Marti, A., de la Pena Mayor, P., et al. The Spanish Society of Neurology's official clinical practice guidelines for epilepsy. Special considerations in epilepsy: comorbidities, women of childbearing age, and elderly patients. Neurologia 2015;30(8):510-7.
5. Meierkord, H., Boon, P., Engelsen, B., et al. EFNS guideline on the management of status epilepticus in adults. Eur J Neurol 2010;17(3):348-55.
6. Neuorology, A.A.o. *Quality Measurement Set*. 2016 [cited 2018 November 1st]; Available from: https://www.aan.com/siteassets/home-page/policy-and-guidelines/quality/quality-measures/17iemeasureset_pg.pdf.

17: Status Epilepticus Treatment with Anticonvulsant Medication

Percentage of patients presenting to the emergency department with ongoing generalized convulsive status epilepticus (GCSE) treated with a non-benzodiazepine anticonvulsant medication within 40 minutes of hospital arrival

Numerator	Patients presenting to the emergency department with GCSE treated with a non-benzodiazepine anticonvulsant* following (or simultaneously ordered with) administration of a benzodiazepine within 40 minutes of hospital arrival
Denominator	**Included:** Patients presenting to the emergency department with ongoing GCSE **Excluded:** • < 18 years of age • Status epilepticus due to alcohol or benzodiazepine/barbiturate withdrawal • Status epilepticus due to hypoglycemia • Contraindication to anticonvulsant medication other than benzodiazepines • Transferred from other hospital
Period of Assessment	First 24 hours following ED arrival
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☒ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____

Rationale

Status epilepticus (SE) is an under-recognized health problem associated with substantial morbidity and mortality. An estimated 152,000 cases occur per year in the United States, resulting in 42,000 deaths and an inpatient cost of $3.8 to $7 billion per year. For the purposes of this performance measure, convulsive status epilepticus is defined as five minutes or more of continuous clinical seizure activity or recurrent seizure activity without recovery (return to baseline) between seizures.

Prompt treatment of ongoing convulsive status epilepticus with an appropriate non-benzodiazepine antiepileptic drug following or simultaneously ordered with a benzodiazepine shortens the duration of status epilepticus. Therefore, the guidelines for treatment of status epilepticus from the Neurocritical Care Society state: “Urgent control anti-epileptic drug treatment following administration of short acting benzodiazepines is required in all patients with Status Epilepticus unless the immediate cause is known and definitely corrected (e.g. severe hypoglycemia) ”[1].

There are two potential goals of urgent control therapy in Status Epilepticus. For patients who have responded to emergent initial therapy and have complete resolution of SE, the goal is rapid attainment of therapeutic levels of an anticonvulsant medication and continued dosing for maintenance therapy. For patients who fail emergent initial therapy, the goal of urgent control therapy is to stop SE. Definitive control of SE should be established within 60 min of onset. All patients presenting with SE will need emergent initial anticonvulsant therapy (i.e. 1st line) and urgent control anticonvulsant therapy (i.e. 2nd line) in addition to anticonvulsant maintenance therapy, even if SE is immediately

controlled.

The 2016 American Epilepsy Society Guideline includes an algorithm in which the phase for non-benzodiazepine anticonvulsant drug treatment is no longer than 40 minutes from onset of seizure [2]. While many clinicians might consider 40 minutes to be an excessively long treatment window, the authors of this performance measure opted to use the best available published literature, which is the evidence-based guideline referenced above.

*Acceptable non-benzodiazepine anticonvulsant medications satisfying this measure include a loading dose of IV fosphenytoin/phenytoin, valproate sodium, or levetiracetam. If none of the above are available, a loading dose of IV phenobarbital meets the requirements for this measure.

Sources of Clinical Recommendations

From the 2012 Neurocritical Care Society "Guidelines for the evaluation and management of status epilepticus" [3]:

- The treatment of convulsive SE should occur rapidly and continue sequentially until clinical seizures are halted (strong recommendation; high quality).
- Benzodiazepines should be given as emergent initial therapy (strong recommendation; high quality)
- Urgent control AED therapy recommendations include use of IV fosphenytoin/phenytoin; valproate sodium, or levetiracetam (strong recommendation; moderate quality)

From the 2006 Italian League against Epilepsy Guidelines "Treatment of status epilepticus in adults" [4]:

- Treatment of GCSE must be started as soon as possible from the pre-hospitalization phase (Level 1B; Rating A)
- I.V. lorazepam or diazepam are indicated for the treatment of initial GCSE. I.V. lorazepam is the benzodiazepine of choice because it is associated with a lower risk of early relapses (Level 1B; Rating A)

From the 2015 Spanish Neurological Society "Official clinical practice guidelines in epilepsy" [5]:

- Initial pharmacological treatment for any prolonged seizure or SE episode should be (benzodiazepines). (Grade A)

From the 2016 American Epilepsy Society Guideline "Treatment of Convulsive Status Epilepticus in Children and Adults" [2]:

- A benzodiazepine (specifically IM midazolam, IV lorazepam, or IV diazepam) is recommended as the initial therapy of choice, given their demonstrated efficacy, safety, and tolerability (level A; four class I RCTs).

From the 2017 European Federation of the Neurological Societies "Guideline on the management of status epilepticus in adults" [6]:

- In GCSE, the preferred treatment pathway is IV administration of 0.1 mg/kg lorazepam (Level A rating)

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- The maximum time window for initial non-benzodiazepine anticonvulsant drug treatment has not been clearly defined in clinical trials and may be shorter than 40 minutes
- The optimal first-line non-benzodiazepine anticonvulsant medication is not clear

Analogous Measures Endorsed by Other Organizations

- American Academy of Neurology Inpatient and Emergency Neurology Quality Measurement Set: Status Epilepticus Treatment with AED/Antiseizure Medication [7]

References:

1. Brophy, G.M., Bell, R., Claassen, J., et al. Guidelines for the evaluation and management of status epilepticus. Neurocritical Care 2012;17(1):3-23.
2. Glauser, T., Shinnar, S., Gloss, D., et al. Evidence-Based Guideline: Treatment of Convulsive Status Epilepticus in Children and Adults: Report of the Guideline Committee of the American Epilepsy Society. Epilepsy Curr 2016;16(1):48-61.
3. Brophy, G.M., Bell, R., Claassen, J., et al. Guidelines for the evaluation and management of status epilepticus. Neurocrit Care 2012;17(1):3-23.
4. Minicucci, F., Muscas, G., Perucca, E., et al. Treatment of status epilepticus in adults: guidelines of the Italian League against Epilepsy. Epilepsia 2006;47 Suppl 5:9-15.
5. Mauri Llerda, J.A., Suller Marti, A., de la Pena Mayor, P., et al. The Spanish Society of Neurology's official clinical practice guidelines for epilepsy. Special considerations in epilepsy: comorbidities, women of childbearing age, and elderly patients. Neurologia 2015;30(8):510-7.
6. Meierkord, H., Boon, P., Engelsen, B., et al. EFNS guideline on the management of status epilepticus in adults. Eur J Neurol 2010;17(3):348-55.
7. Neuorology, A.A.o. *Quality Measurement Set*. 2016 [cited 2018 November 1st]; Available from: https://www.aan.com/siteassets/home-page/policy-and-guidelines/quality/quality-measures/17iemeasureset_pg.pdf.

18: Avoidance of Corticosteroids in Moderate and Severe Traumatic Brain Injury

Percentage of patients with moderate and severe traumatic brain injury who do not receive corticosteroids during acute hospitalization

Numerator	Patients with moderate and severe (Glasgow Coma Score of 12 or less) traumatic brain injury who do not receive corticosteroids during acute hospitalization
Denominator	**Included:** Patients admitted to the hospital following moderate or severe traumatic brain injury (Glasgow Coma Score of 12 or less) **Excluded:** • < 18 years of age • Length of stay > 120 days • Received corticosteroids prior to arrival at hospital being assessed • Enrolled in clinical trial in which corticosteroids are part of investigational regimen • Documentation of a neurological or other medical condition for which corticosteroids may be indicated, including: brain tumor, vasculitis, asthma, COPD, cortisol deficiency (including need for "stress-dose" steroids)
Period of Assessment	From time of admission to acute care hospital discharge.
Sources of Data	☐ Claims (only) ☐ EHR Hybrid ☐ Imaging-diagnostic ☒ Pharmacy ☐ Provider Tool ☐ Paper Records ☐ Non-medical Data ☐ Claims (other) ☒ EHR (only) ☐ Laboratory ☐ Registry ☐ Management Data ☐ Patient reported data ☐ Other: _____

Rationale

The use of corticosteroids in traumatic brain injury is of no benefit and has consistently been demonstrated to be associated with a higher rate of death and severe disability [1]. The fourth edition of the Brain Trauma Foundation (BTF) Guidelines for the Management of Severe Traumatic Brain Injury found that the body of evidence for these outcomes is of high quality [2]. Anecdotal evidence suggests that the use of corticosteroids for TBI may be continuing in some centers despite prior BTF Guideline recommendations against corticosteroid use.

Sources of Clinical Recommendations

From the 2017 Brain Trauma Foundation Guidelines for the Management of Severe Traumatic Brain Injury, Fourth Edition [2]:

- The use of steroids is not recommended for improving outcome or reducing ICP. In patients with severe TBI, high-dose methylprednisolone is associated with increased mortality and is contraindicated. (Level I evidence)

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☐ Process	☒ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Determining indication of corticosteroid administration when administered for reasons other than TBI

Analogous Measures Endorsed by Other Organizations

None

References:

1. Roberts, I., Yates, D., Sandercock, P., et al. Effect of intravenous corticosteroids on death within 14 days in 10008 adults with clinically significant head injury (MRC CRASH trial): randomised placebo-controlled trial. Lancet 2004;364(9442):1321-8.
2. Carney, N., Totten, A.M., O'Reilly, C., et al. Guidelines for the Management of Severe Traumatic Brain Injury, Fourth Edition. Neurosurgery 2017;80(1):6-15.

19: Targeted Temperature Management After Cardiac Arrest

Percentage of adult patients with coma after out-of-hospital cardiac arrest (OHCA) due to a shockable rhythm with documentation of targeted temperature management (TTM) or of their reason for ineligibility for TTM

Numerator	Patients with coma after OHCA due to a shockable presenting rhythm of ventricular fibrillation (VF/VT) who have documentation of TTM performed (achieving a temperature of 32°C to 36°C). If a patient is deemed ineligible for TTM, then reason for ineligibility should be documented.
Denominator	**Included:** All patients with coma after OHCA with a shockable presenting rhythm of VF or VT **Excluded:** • Patients with a non-shockable presenting rhythm (although TTM may still be offered and be of benefit) • Patients with in-hospital cardiac arrest (although TTM may still be offered and may be of benefit) Patients presenting to the hospital > 6 hours from time of return of spontaneous circulation • <18 years of age • Length of stay greater than 120 days • Patients with Comfort Measures Only documented after return of spontaneous circulation but prior to initiation of TTM
Period of Assessment	From Emergency Department arrival through the first full hospital day
Sources of Data	☐ Claims (only) ☐ Claims (other) ☐ EHR Hybrid ☒ EHR (only) ☐ Imaging-diagnostic ☐ Laboratory ☐ Pharmacy ☐ Registry ☐ Provider Tool ☐ Management Data ☐ Paper Records ☐ Patient reported data ☐ Non-medical Data ☐ Other: _____

Rationale

In patients with coma after cardiac arrest, TTM may improve neurological recovery and is not associated with an increased incidence of complications. Two trials (a randomized control trial and a quasi-randomized control trial) demonstrated improved survival and neurological recovery with TTM of 32°C to 34°C in patients with OHCA with a presenting rhythm of VF/VT [1, 2]. A subsequent randomized control trial compared TTM of 36°C vs 33°C, to each other and to no TTM. Survival and neurological recovery were not superior with induced hypothermia of 33°C vs 36°C [3]. Based on this supporting evidence and the low rate of adverse events, a TTM strategy targeting temperatures between 32°C to 36°C is selected for this performance measure.

Exclusion criteria for TTM therapy remain controversial. It has been argued that there are no patients in whom TTM between 32°C to 36°C is contraindicated, given the potential for increased survival and neurological recovery and relatively low risk of adverse events [4]. Therefore, if an OHCA patient with VF or VT is deemed ineligible to receive TTM, then the reason for ineligibility must be documented to comply with this performance measure. Depending on the clinical scenario, possible reasons for ineligibility might include (but are not limited to):

From the 2017 “Targeted temperature management in the ICU: Guidelines from a French Expert Panel” French Intensive Care Society and the French Society of Anesthesia and Intensive Care Medicine (SFAR)” [8]:

- Targeted temperature management is recommended in order to improve survival with good neurological outcome in patients resuscitated from out-of-hospital cardiac arrest (OHCA) with shockable cardiac rhythm (ventricular fibrillation and pulseless ventricular tachycardia) and who remain comatose after return of spontaneous circulation (ROSC). (Strong recommendation; level of evidence not stated)

From the 2016 “Canadian Cardiovascular Society/Canadian Cardiovascular Critical Care Society/Canadian Association of Interventional Cardiology Position Statement on the Optimal Care of the Postarrest Patient” [9]:

- Targeted temperature management should be used in unresponsive out-of-hospital cardiac arrest survivors with an initial shockable rhythm after ROSC. (Strong Recommendation; Low-Quality Evidence).
- It is recommended that a temperature between 33 degrees C and 36 degrees C, inclusively, be selected and maintained for patients who undergo TTM. (Strong Recommendation; Moderate-Quality Evidence).

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☐Patient safety	☐Population/Public Health	☒Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Specific care delivery processes and implementation strategies that may impact clinical outcome are not addressed (such as time to initiation of TTM, duration of TTM, method of achieving TTM, and variability in methods of recording temperature)
- The definition of coma and its constitutive features may be susceptible to variation
- A standardized hospital protocol for delivery of TTM is strongly encouraged
- May require templated documentation for ease of abstraction
- Despite overall consistency across guideline recommendations that TTM is strongly recommended for comatose patients after OHCA with a shockable presenting rhythm of VF/VT, disparities exist in the interpretation of the level of evidence to support this (ranging from high to low)

Analogous Measures Endorsed by Other Organizations

None

References:

1. Hypothermia after Cardiac Arrest Study Group Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. N Engl J Med 2002;346(8):549-56.

2. Bernard, S.A., Gray, T.W., Buist, M.D., et al. Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. N Engl J Med 2002;346(8):557-63.
3. Nielsen, N., Wetterslev, J., Cronberg, T., et al. Targeted temperature management at 33 degrees C versus 36 degrees C after cardiac arrest. N Engl J Med 2013;369(23):2197-206.
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6. Donnino, M.W., Andersen, L.W., Berg, K.M., et al. Temperature Management After Cardiac Arrest: An Advisory Statement by the Advanced Life Support Task Force of the International Liaison Committee on Resuscitation and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation. Circulation 2015;132(25):2448-56.
7. Castren, M., Silfvast, T., Rubertsson, S., et al. Scandinavian clinical practice guidelines for therapeutic hypothermia and post-resuscitation care after cardiac arrest. Acta Anaesthesiol Scand 2009;53(3):280-8.
8. Cariou, A., Payen, J.F., Asehnoune, K., et al. Targeted temperature management in the ICU: guidelines from a French expert panel. Ann Intensive Care 2017;7(1):70.
9. Wong, G.C., van Diepen, S., Ainsworth, C., et al. Canadian Cardiovascular Society/Canadian Cardiovascular Critical Care Society/Canadian Association of Interventional Cardiology Position Statement on the Optimal Care of the Postarrest Patient. Can J Cardiol 2017;33(1):1-16.

<table>
<tr><td colspan="2">20: External Ventricular Drain (EVD) Insertion Bundle

Percentage of intensive care patients with EVDs inserted using a standardized EVD insertion bundle</td></tr>
<tr><td>Numerator</td><td>Number of patients with EVDs for whom all elements of an EVD insertion bundle are documented with each EVD insertion.

The EVD insertion bundle elements may include:
Use of antimicrobial impregnated catheter
Use of sterile technique upon insertion
Tunneling of the catheter
Periprocedural antibiotics
Use of a closed system
Use of a sterile dressing</td></tr>
<tr><td>Denominator</td><td>Included:
All intensive care patients with EVDs

Excluded:
<18 years of age
Patients with EVDs that were placed at an outside facility prior to transport
Length of stay >120 days</td></tr>
<tr><td>Period of Assessment</td><td>From emergency department arrival until removal of EVD</td></tr>
<tr><td>Sources of Data</td><td>☐ Claims (only)
☐ EHR Hybrid
☐ Imaging-diagnostic
☒ Pharmacy
☐ Provider Tool
☐ Paper Records
☐ Non-medical Data

☐ Claims (other)
☒ EHR (only)
☐ Laboratory
☐ Registry
☐ Management Data
☐ Patient reported data
☐ Other: _____</td></tr>
<tr><td colspan="2">Rationale

The purpose of this composite measure is to achieve high reliability/compliance with six components of the EVD insertion bundle, a group of evidence-based interventions that when implemented together result in better outcomes than when implemented individually.[1] Hospitals who have instituted EVD bundles have reported reduction in ventriculostomy related infection (VRI) rates to as low as 1% [1].

It is recognized that different hospitals may choose different components for their bundle. In order to be compliant with this measure, an institution must have a designated “EVD insertion bundle” with specifically listed components and compliance with this bundle will represent success on this performance measure.</td></tr>
<tr><td colspan="2">Sources of Clinical Recommendations:

From the 2016 NCS “Consensus Statement for Insertion and Management of External Ventricular Drains” [1]:
In adult patients with an EVD: We recommend using an EVD management bundle that includes aseptic insertion, limits manipulation of the closed system, and standardizes dressings and weaning to reduce ventriculitis related infections (VRI). (Strong recommendation; moderate quality evidence)
We recommend using antimicrobial-impregnated catheters as part of a comprehensive management protocol to</td></tr>
</table>

reduce the rate of VRI. (Strong recommendation; moderate quality evidence)
- We recommend against routinely changing catheter sites. (Strong recommendation; moderate quality evidence)

From the 2017 Infectious Diseases Society of America's "Clinical Practice Guidelines for Healthcare-Associated Ventriculitis and Meningitis" [2]:
- Periprocedural prophylactic antimicrobial administration is recommended for patients undergoing placement of external ventricular drains. (Strong recommendation; moderate quality evidence)
- Prolonged antimicrobial prophylaxis for the duration of the external ventricular drain is of uncertain benefit and not recommended. (Strong recommendation, moderate quality evidence)
- Use of antimicrobial-impregnated CSF shunts and CSF drains is recommended. (Strong recommendation; moderate quality evidence)
- In patients with external ventricular drains, fixed interval exchange is not recommended. (Strong recommendation; moderate quality evidence)
- Use of a standardized protocol for insertion of CSF shunts and drains is recommended. (Strong recommendation; moderate quality evidence)

Method of Reporting/Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with higher score

Type of Measure

☒ Process	☐ Process: Appropriate Use	☐ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☒ Patient safety	☐Population/Public Health	☒ Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Feasibility of accurate documentation and confidence that the procedure note 100% accurately reflects the practice
- Lack of evidence to support individual bundle components, even though clear evidence exists that a bundle improves outcomes
- Variable availability regarding antibiotic impregnated catheters and optimal type of impregnated antibiotic unclear
- Different recommendations regarding the use of EVD periprocedural antibiotics across different guidelines.

Analogous Measures Endorsed by Other Organizations

- None related to EVD management. Analogous measure for intravascular lines is National Quality Forum #0298 Central Line Bundle Compliance [3]

References:

1. Fried, H.I., Nathan, B.R., Rowe, A.S., et al. The Insertion and Management of External Ventricular Drains: An Evidence-Based Consensus Statement : A Statement for Healthcare Professionals from the Neurocritical Care Society. Neurocrit Care 2016;24(1):61-81.
2. Tunkel, A.R., Hasbun, R., Bhimraj, A., et al. 2017 Infectious Diseases Society of America's Clinical Practice Guidelines for Healthcare-Associated Ventriculitis and Meningitis. Clin Infect Dis 2017.
3. Forum., N.Q. *NQF #0298 Central Line Bundle Compliance,*. 2012 [cited 2018 November 1st]; Available from: http://www.qualityforum.org/.

<table>
<tr><td colspan="2">21: Venous thromboembolism (VTE) Prophylaxis in Neurocritical Care

Percentage of patients with an ICU stay who develop venous thromboembolism (VTE) during hospitalization who did not receive appropriate VTE prophylaxis between hospital admission and the day before VTE diagnosis</td></tr>
<tr><td>Numerator</td><td>Patients with an ICU stay who develop VTE who did not receive appropriate VTE prophylaxis during hospitalization (assessed daily between hospital admission and VTE diagnosis)

Appropriate VTE prophylaxis includes mechanical compression devices or pharmacological prophylaxis, or documentation why the patient was not eligible for either approach, such as:
Documentation of patient refusal
Documentation of medical conditions which would make mechanical compression devices unsafe, such as severe peripheral vascular disease, existing DVT, open leg wounds, etc.
Documentation of medical conditions which would make chemoprophylaxis unsafe within 24 hours of admission, such as active intracranial bleeding, ischemic stroke post-tPA, bleeding diathesis, coagulopathy, allergy, history of heparin-induced thrombocytopenia, etc.</td></tr>
<tr><td>Denominator</td><td>Included:
Patients who had an ICU stay who develop VTE; VTE must be confirmed using standard diagnostic methods
Excluded:
Length of stay > 120 days</td></tr>
<tr><td>Period of Assessment</td><td>ICU admission to acute care hospital discharge</td></tr>
<tr><td>Sources of Data</td><td>☒ Claims (only)
☐ EHR Hybrid
☐ Imaging-diagnostic
☐ Pharmacy
☐ Provider Tool
☐ Paper Records
☐ Non-medical Data

☐ Claims (other)
☒ EHR (only)
☐ Laboratory
☐ Registry
☐ Management Data
☐ Patient reported data
☐ Other: _____</td></tr>
<tr><td colspan="2">Rationale

Venous Thromboembolism, including deep vein thrombosis (DVT) and pulmonary embolism (PE) is a significant cause of morbidity and mortality in patients with critical illness [1]. Patients with neurologic diseases who require admission to an ICU may be at higher risk for VTE due to venous stasis exacerbated by paralysis and coma, endothelial activation and thrombosis exacerbated by brain neoplasm and inflammatory diseases, and vascular endothelium damage propagated by ischemic and hemorrhagic stroke [1]. Therefore, VTE prophylaxis is a key priority in the care of patients in a Neurocritical Care Unit. Multiple existing performance measures evaluate the daily documentation of VTE prophylaxis. However, this measure incorporates monitoring of VTE incidence and prompts a thorough review of the VTE prophylaxis measures when a patient is diagnosed with a VTE.</td></tr>
</table>

Sources of Clinical Recommendations

From the 2016 Neurocritical Care Society "Prophylaxis of Venous Thrombosis in Neurocritical Care Patients: An Evidence-Based Guideline: A Statement for Healthcare Professionals from the Neurocritical Care Society" [1]:

- We recommend the use of IPC with LMWH or UFH within 24 hours after standard craniotomy in the setting of glioma resection. (Strong recommendation, moderate-quality evidence)
- We recommend using IPC with either LMWH or UFH within 24 hours after craniotomy.(Strong recommendation, moderate-quality evidence)
- Measures to prevent deep venous thrombosis should be employed in all SAH patients.(Strong recommendation, high-quality evidence)
- Sequential compression devices should be routinely used in all patients. (Strong recommendation, high-quality evidence)
- We recommend initiating VTE pharmacoprophylaxis as soon as is feasible in all patients with acute ischemic stroke. (Strong recommendation, high-quality evidence)
- In patients with acute ischemic stroke and restricted mobility, we recommend dual (pharmacologic and mechanical), preferring prophylactic dose low-molecular weight (LMWH) over prophylactic dose unfractionated heparin (UFH) in combination with intermittent pneumatic compression (IPC). (Strong recommendation, high-quality evidence)
- We recommend the use of IPC and/or graduated CS (GCS) for VTE prophylaxis over no prophylaxis beginning at the time of hospital admission for ICH. (Strong, high-quality evidence)
- We recommend VTE prophylaxis with UFH in all patients with aSAH (strong recommendation, high-quality evidence) except in those with unsecured ruptured aneurysms expected to undergo surgery. (Strong recommendation, low-quality evidence)
- We recommend initiating IPCs as VTE prophylaxis as soon as patients with aSAH are admitted to the hospital. (Strong recommendation, moderate-quality evidence)
- We recommend VTE prophylaxis with UFH at least 24 hours after an aneurysm has been secured by surgical approach or by coiling. (Strong recommendation, moderate-quality evidence)
- We recommend VTE prophylaxis with either LMWH or UFH upon hospitalization for patients with brain tumors who are at low risk for major bleeding and who lack signs of hemorrhagic conversion. (Strong recommendation, moderate-quality evidence)
- We recommend initiating VTE prophylaxis as early as, within 72 hours of spinal cord injury (SCI). (Strong recommendation, high-quality evidence)
- We recommend using prophylactic doses of UFH (bid or tid), LMWH, or fondaparinux as the preferred method of VTE prophylaxis in patients with neuromuscular disease. (Strong recommendation, moderate-quality evidence)
- We recommend using IPC with LMWH or UFH in spinal surgery. (Strong recommendation, moderate- quality evidence)
- We recommend the use of IPC and/or GCS for VTE prophylaxis over no prophylaxis beginning at the time of hospital admission. (Strong recommendation and high-quality evidence)

From the European Stroke Organization 2017 "Recommendations from the ESO-Karolinska Stroke Update Conference" [2]:

- We recommend that graduated compression stockings should not be used in patients with ischaemic stroke. (Grade A)
- We recommend that intermittent pneumatic (IPC, thigh-length, sequential) should be used for immobile patients with ischaemic stroke. It should not be used in patients with open wounds on the legs and should be used with caution in those with existing DVT, heart failure, severe peripheral vascular disease or confusion (Grade A)
- Where prophylactic anticoagulation is indicated LMWH or heparinoid should be considered instead of UFH because of its greater reduction in risk of DVT, the greater convenience, reduced staff costs and patient comfort. These advantages should be weighed against the higher risk of extracranial bleeding, higher drug costs and risks in elderly patients with poor renal function (Grade A)

From the American Heart Association/American Stroke Association (AHA/ASA) 2014 "Recommendations for the Management of Cerebral and Cerebellar Infarction With Swelling" [3]:

- Deep venous thrombosis prophylaxis with subcutaneous or low-molecular-weight heparin should be used (Class I; Level of Evidence C).

From the AHA/ASA 2013 “Guidelines for the Early Management of Patients with Acute Ischemic Stroke” [4]:

- Subcutaneous administration of anticoagulants is recommended for treatment of immobilized patients to prevent DVT (Class I; Level of Evidence A).

From the Singapore Ministry of Health 2011 “Clinical Practice Guidelines on Stroke and Transient Ischemic Attack” [5]:

- Antiplatelet therapy is recommended in all patients with ischemic stroke to reduce deep venous thrombosis and pulmonary embolism (Grade A, Level 1+)

From the Spanish Neurologic Society’s 2014 “Guidelines for the Treatment of Acute Ischemic Stroke” [6]:

- Low molecular weight heparin or heparinoids are recommended to prevent deep vein thrombosis and pulmonary embolism in immobilised patients. If these treatments are contraindicated or an alternative is required, aspirin may be used. (Level of evidence 1a; grade A recommendation)

From the South African Stroke Society’s Writing Committee 2010 “Guideline for the Management of Ischemic Stroke and Transient Ischemic Attack” [7]:

- Low-molecular-weight heparins or low-dose subcutaneous heparin should be considered for patients at high risk of DVT or PE. (Class I, Level A)

From the American College of Chest Physicians 2008 “Antithrombotic and Thrombolytic Therapy for Ischemic Stroke” [8]:

- For acute stroke patients with restricted mobility, we recommend prophylactic low-dose SC heparin or low-molecular-weight heparins (Grade 1A).

From the Committee of the European Stroke Organization 2008 “Guidelines for the Management of Ischaemic Stroke and Transient Attack” [9]:

- It is recommended that low-dose subcutaneous heparin or low molecular weight heparins should be considered for patients at high risk of DVT or PE. (Class I, Level A)

From the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy 2004 “Antithrombotic and Thrombolytic Therapy for Ischemic Stroke” [10] :

- For acute stroke patients with restricted mobility, we recommend prophylactic low-dose subcutaneous heparin or low molecular weight heparins or heparinoids (Grade 1A).

From the Swiss 2009 “Decompressive Craniectomy for Space Occupying Hemispheric and Cerebellar Ischemic Strokes” [11]:

- General measures in management of patients at high risk for a space-occupying infarction:
    - Thromboembolic prophylaxis with subcutaneous low-dose heparin, low molecular weight heparin or heparinoids (Class I, Level A)

From the AHA/ASA 2018 “Guidelines for the Early Management of Ischemic stroke” [12]:

- In immobile stroke patients without contraindications, intermittent pneumatic compression (IPC) in addition to routine care (aspirin and hydration) is recommended over routine care to reduce the risk of deep vein thrombosis (DVT). (Class 1, Level of Evidence B)

From the NCS 2011 “Critical Care Management of Patients Following Aneurysmal Subarachnoid Hemorrhage” [13]:

- Measures to prevent deep venous thrombosis should be employed in all SAH patients. (high quality of evidence, strong recommendation)

Method of Reporting/ Type of Score

☐ Count
☒ Ratio/proportion
☐ Categorical (e.g. yes/no)
☐ CV (e.g. average)
☐ Other

Interpretation of Score: Better quality associated with lower score

Type of Measure

☐ Process	☐ Process: Appropriate Use	☒ Outcome
☐ Cost/Resource Use	☐ Efficiency	☐ Outcome: PRO
☐ Structure	☐ Intermediate Clinical Outcome	

Quality Strategy Domains

☐Patient and family engagement	☐Care Coordination	☐Efficient Use of Healthcare Resources
☒Patient safety	☐Population/Public Health	☐Clinical Process/Effectiveness

Challenges and Concerns with Implementation

- Tedious review of records when patient is diagnosed with VTE as multiple hospital days may need to be abstracted.

Analogous Measures Endorsed by Other Organizations

The Joint Commission Primary Stroke Measure: STK-5 Antithrombotic therapy by end of hospital day 2 [14]. (Also endorsed by DNV)
The Ministry of Health Brazil: Venous Thromboembolism Prophylaxis [15]
The AHA/ASA Clinical Performance Measures for Adult Hospitalized Patients with Acute Ischemic Stroke: Venous Thromboembolism Prophylaxis [16]
Measure similar to CMS/TJC/NQF hospital measure VTE-6 [17]

References:

1. Nyquist, P., Bautista, C., Jichici, D., et al. Prophylaxis of Venous Thrombosis in Neurocritical Care Patients: An Evidence-Based Guideline: A Statement for Healthcare Professionals from the Neurocritical Care Society. Neurocrit Care 2016;24(1):47-60.
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4. Jauch, E.C., Saver, J.L., Adams, H.P., et al. Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the american heart association/american stroke association. Stroke 2013;44(3):870-947.

5. Venketasubramanian, N., Pwee, K.H., Chen, C.P., Singapore Ministry of Health Clinical Practice Guidelines Workgroup on, S.Transient Ischaemic, A. Singapore ministry of health clinical practice guidelines on stroke and transient ischemic attacks. Int J Stroke 2011;6(3):251-8.
6. Alonso de Lecinana, M., Egido, J.A., Casado, I., et al. Guidelines for the treatment of acute ischaemic stroke. Neurologia 2014;29(2):102-22.
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8. Albers, G.W., Amarenco, P., Easton, J.D., Sacco, R.L.Teal, P. Antithrombotic and thrombolytic therapy for ischemic stroke: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest 2008;133(6 Suppl):630S-69S.
9. European Stroke Organisation Executive, C.Committee, E.S.O.W. Guidelines for management of ischaemic stroke and transient ischaemic attack 2008. Cerebrovasc Dis 2008;25(5):457-507.
10. Albers, G.W., Amarenco, P., Easton, J.D., Sacco, R.L.Teal, P. Antithrombotic and thrombolytic therapy for ischemic stroke: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. Chest 2004;126(3 Suppl):483S-512S.
11. Michel, P., Arnold, M., Hungerbuhler, H.J., et al. Decompressive craniectomy for space occupying hemispheric and cerebellar ischemic strokes: Swiss recommendations. Int J Stroke 2009;4(3):218-23.
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Publisher's Note

Published online: 22 November 2019

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