

Quality Improvement in Neurology

Concussion Quality Measurement Set

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Concussion represents the immediate and transient symptoms of a mild traumatic brain injury (TBI),¹ and is defined as a clinical syndrome of biomechanically induced alteration of brain function.² The term “concussion” is often used interchangeably with “mild traumatic brain injury.”¹

There are an estimated 1.1–1.9 million sports and recreation-related concussions in children each year in the United States.³ However, only about 600,000 are seen by a health care provider (office-based, inpatient, emergency department [ED], or high school athletic trainer).³ Approximately 1 million outpatient clinic and ED visits for minor head injury in children occur annually in the United States, with an additional 1 million in adults from a variety of etiologies.⁴ Twenty-nine percent of adults self-report having experienced a concussion in their lifetime.⁵ Concussion can occur in any age group, from early childhood through late adulthood, with the highest incidence in children age 10–19.⁶ There appear to be sex/gender differences in mild TBI/TBI incidence. Overall, the incidence of TBI is highest in men.⁷ However, in sports with similar rules between sexes/genders (e.g., basketball, soccer), females have a higher risk of concussion than males.⁸

Concussion results in significant economic burden, especially for those with persistent symptoms. The average patient with concussion incurs \$13,564 in concussion-related health care costs over the following 12 months (\$7,541 if diagnosed exclusively in a non-ED outpatient office setting).⁹ Children with persistent symptoms incur an average of \$3,557 in medical costs related to care administered following the first 4 weeks postinjury.¹⁰

Much of the existing research on concussion has focused on sports-related concussion. Most of the published guidelines and consensus statements pertain specifically to sports-related concussion.^{1,2,11-13} However, only half of pediatric ED visits for concussion are sport-related.¹⁴ Approximately 37% of self-reported concussions in adults are sport or recreation-related.⁵

Whereas most adults with sport-related concussion will return to preinjury levels of symptoms and functioning within 10 days, children often take longer to recover.¹ Approximately 20%–30% of children continue to have symptoms longer than 1 month after all-cause concussion.^{15,16} Females have higher risk of prolonged symptoms after sports concussion.^{1,16} Persistent postconcussion symptoms are associated with significant morbidity; children with persistent symptoms after all-cause concussion report lower quality of life than do children with many other childhood chronic diseases, including cancer, end-stage renal disease, and cerebral palsy.¹⁷

Concussion remains a clinical diagnosis, inevitably involving some degree of subjectivity and uncertainty. A validated objective biomarker has not been established for the diagnosis or



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Glossary

AAN = American Academy of Neurology; ED = emergency department; TBI = traumatic brain injury.

management of concussion. Whereas objective evidence regarding most aspects of concussion care is limited, several consensus statements and evidence-based guidelines are available to guide management.^{1,2,11-13,18,19}

Owing to the prevalence of concussion across the lifespan, the variability of clinical practice among providers, and the presence of several consensus and evidence-based guidelines, the American Academy of Neurology (AAN) sought to provide a standard by which to measure and improve the care of patients with concussion.

Methods

The AAN formed a work group of key stakeholders focused on concussion to participate in the development of this measurement set. Nominations for this work group were solicited from AAN membership, other physician and non-physician associations with an interest in concussion, as well as concussion patient and caregiver organizations. Details of the full measure development process are available online at aan.com/siteassets/home-page/policy-and-guidelines/quality/quality-measures/how-measures-are-developed/19_qualitymeasuredevprocman_v304.pdf

All work group members disclosed potential conflicts of interest and completed applications summarizing experiences and interests. The facilitator and Quality Measure Subcommittee Measure Expert Team independently selected members for the work group from the pool of qualified specialists and expert nominees. The selection of the 12-member work group was based on the nominee's experience in performance measures, quality improvement, and clinical activities with the goal of fielding a diverse, multidisciplinary group with broad representation in terms of practice type/location, background, and clinical expertise.

The measure development process included the following: (1) evidence-based literature search, (2) establishing a multidisciplinary work group adhering to the AAN conflict of interest policy, (3) drafting candidate measures and technical specifications, (4) convening the work group virtually to review candidate measures, (5) refinement and discussion of the candidate measures, (6) soliciting public comments on approved measures during a 30-day period, (7) refining the final measures according to input received during the public comment period and corresponding technical specifications, and (8) obtaining approvals from the work group, AAN Quality Measures Subcommittee, AAN Quality Committee, and AAN Institute Board of Directors.

The work group sought to develop evidence-based measures to support the delivery of high-quality care and to improve patient outcomes. Guided by a medical librarian, the work group conducted a comprehensive literature search identifying 4,665 abstracts relevant to the potential measures. This yielded 7 guidelines, systematic reviews, and meta-analyses that formed the core of the evidence base for the measures developed.^{1,2,11-13,18,19}

Over the course of several virtual meetings, a draft measurement set was developed and posted for public comment. The public comment period resulted in over 164 comments from 29 individuals and organizations.

The AAN plans to provide resources to review these measures every 3 years. Thus, this measure set should not be considered a long-term mandate, but rather a working framework for measurement. The ultimate goal is to test the validity of these quality measures and whether they affect patient outcomes.

Results

Current Standard of Care

Although the published consensus statements and evidence-based guidelines differ in some ways (i.e., targeted age, sports concussion vs all concussion), they generally converge on several key recommendations.^{1,2,11-13,18,19} These include (1) removal from and avoidance of at-risk activities, such as contact sports, until medical evaluation and clearance, (2) lack of an indication for acute neuroimaging for the routine diagnosis of concussion in absence of red flags, (3) assessment of concussion-related symptoms, (4) completion of a neurologic physical examination, and (5) a gradual return to physical and cognitive activities prior to medical clearance. The work group aimed to incorporate these key recommendations and several others into quality measures. However, lack of current evidence and anticipated difficulty with measurement implementation prevented the development of several proposed measures.

Approved Quality Measures

The work group developed 3 approved quality measures, each applicable to both the acute and chronic time frames post-concussion (Table). Two pertain to the diagnosis of concussion, specifically the assessment of symptoms and the neurologic examination. The third measure involves the medical clearance of patients returning to sports or other at-risk activities.

Concussion Symptoms Evaluation

The assessment of subjective symptoms of concussion is foundational to both the diagnosis and management of

Table 2020 Concussion Quality Measurement Set

Title	Numerator	Denominator	Exclusions
Concussion symptoms evaluation	Patients who had a symptom evaluation completed at initial visit	Patients ≥5 years of age diagnosed with concussion	<ul style="list-style-type: none"> • Patient/caregiver unable to report symptoms • Patient/caregiver refusal
Appropriate neurologic examination	Patients who had a neurologic examination that included all components: <ol style="list-style-type: none"> (1) Cervical assessment (2) Cognitive function (3) Vestibular function (4) Extraocular movements (5) Gait (6) Balance (7) Coordination 	Patients ≥5 years of age diagnosed with concussion seen for initial visit	<ul style="list-style-type: none"> • Patient/caregiver refusal • Patient unable to participate in neurologic examination
Documentation of return-to-play strategy or protocol	Patients who had documentation of a return-to-play strategy or protocol	Patients ≥5 years of age diagnosed with concussion who were cleared for full participation in sports	<ul style="list-style-type: none"> • Patient/caregiver refuse return-to-play strategy • Patients who are currently participating in sports without symptoms

concussion. Concussion is a clinical syndrome, and many patients do not have outward signs of a concussion (i.e., loss of consciousness, imbalance). Therefore, clinicians rely on the patient's report of symptoms to establish the diagnosis and track recovery. However, symptoms may be diverse and numerous. Validated symptom evaluations are used to (1) identify and grade current symptoms, (2) inform appropriate treatment plans and referral needs, (3) monitor for clinical change over time, and (4) aid in clearance decisions. Symptom rating scales are recommended for the evaluation of acute concussion in both children and adults.^{1,2,11-13,18,19} Several different symptom evaluations have been published, some appropriate for children down to age 5 years. A list of validated symptom evaluations is available on the National Institute of Neurological Disorders and Stroke common data elements Web site for sports-related concussion. These symptom scales can be used in any clinical setting but are commonly used in the outpatient setting. The work group acknowledges that providers should use symptom evaluations as a starting point to explore the symptoms affecting a patient with concussion, rather than the sole method for assessing symptoms. Symptom evaluations should be interpreted by a skilled provider. Many patients report symptoms at baseline (prior to injury), and this should be considered in clearance determinations.²⁰

Appropriate Neurologic Examination

The neurologic physical examination is a key part of the evaluation of a patient with concussion and is required in all clinical settings. Completion of a thorough neurologic examination is assumed or specifically recommended by all evidence-based and consensus guidelines.^{1,2,11-13,18,19} The examination functions to screen for other injury, such as moderate or severe TBI or cervical spine injury. Concussion can cause many different examination abnormalities, but the following examination elements are most commonly affected: cognitive function, vestibular function, extraocular movements, gait, balance, and coordination. Providers who diagnose and manage patients with concussion must be

proficient in the identification of abnormal neurologic examination findings. Examination abnormalities referable to concussion should be tracked on subsequent examinations until they resolve, but focal examination abnormalities should prompt additional testing such as neuroimaging.²¹

Documentation of Return to Play Strategy or Protocol

After concussion, a period of cerebral vulnerability exists during which a subsequent head impact may worsen the underlying injury.²² To safely return to a contact sport or other at-risk activity, patients with concussion are required to gradually increase physical activity in a series of planned steps.^{1,2,11-13,18,19} This return-to-play progression is intended to test the brain under progressive exertion and, if completed without a return of neurologic signs or symptoms, suggests that the concussion has resolved. Prior to providing formal clearance, clinicians should document that the patient completed an activity progression. This quality measure is intended for patients returning to an activity that places them at risk for future head impacts (such as contact sports). Student athletes who are being cleared for return to play should have already been cleared for school. The work group acknowledges that patients who are not returning to an at-risk activity do not need to complete a return-to-play progression. However, any patient may benefit from an exercise progression or possible progression in work duties in the course of injury management.²¹

Other Opportunities for Improvement

Neuroimaging

Conventional neuroimaging (CT or MRI) is not recommended for the routine diagnosis of acute concussion.^{1,2,11-13,18} There are multiple published prediction rules for the use of neuroimaging in children²³ and adults^{24,25} with head injury. For example, the Pediatric Emergency Care Applied Research Network (PECARN) head injury prediction rules utilize 6 signs and symptoms that, if absent, indicate a very low risk of clinically

severe injury.²³ The work group proposed multiple quality measures related to the use of neuroimaging in concussion, including an inverse measure for obtaining a conventional CT or MRI in the acute setting and also a repeat scan after an initial scan was negative. However, there are several situations and unanticipated circumstances in which a scan may be indicated, so the work group did not develop these measures. In addition, recent advances have introduced rapid blood-based biomarkers for the determination of the appropriateness of CT for acute head injury. Given the ever-changing science of concussion care, it is advised that providers follow the currently available guidelines on this topic.

Return to School and Work

A gradual return to academics or the workplace is recommended after concussion.^{1,18,19} The work group acknowledges the importance of providing patients with individualized multi-step plans for returning to school or work. However, there is considerable variability in the need for these plans, due to presence or lack of symptoms and due to injury timing in relation to the academic or work calendar and holidays. Due to this variability, at this time it is not feasible to measure adherence to a quality measure pertaining to these individualized plans.

Posttraumatic Headache

Headache is the most common symptom after concussion.²⁶ Nonopioid analgesics are recommended for the treatment of headache after acute concussion, although analgesic overuse should be avoided.¹⁸ There is limited evidence to guide the treatment of posttraumatic headache. However, chronic headaches after concussion are typically treated in the same way as the primary headache disorder they most represent. In addition, nonpharmacologic interventions and lifestyle modification are employed. The work group proposed 2 measures related to headache: (1) avoidance of medication overuse headache and (2) use of prescription preventative therapies for chronic posttraumatic headaches. These measures were not developed further due to lack of evidence and overlap with existing quality measures. The quality measurement set for headache was updated by the AAN in 2020.²⁷

Depression

The presence of preinjury mood disorders and anxiety places the patient at risk for persistent postconcussive symptoms.^{1,13} Concussion has been associated with an increased risk of the ideation, attempt, and completion of suicide.²⁸ The work group proposed measures aimed at screening patients with concussion for depression, both at the first visit and for those with chronic symptoms. However, these measures were not developed because most current consensus and evidence-based guidelines do not recommend the routine screening of patients with concussion for depression or other psychological diagnoses.

Multidisciplinary Clinic

A multidisciplinary care model is recommended for patients with persistent symptoms.^{1,18,19} The Concussion in Sport

Group defines persistent symptoms as more than 2 weeks in adults and more than 4 weeks in children.¹ However, what constitutes a multidisciplinary concussion clinic, and the most appropriate provider specialties involved, are not widely agreed upon. In addition, access to this type of care model varies based on geographic location, limiting the ability to implement a quality measure. Updates to this quality measurement set in the future may include a measure regarding referral to a multidisciplinary clinic for patients with persistent symptoms after concussion.

Care Setting and Time Since Injury

Concussion may be diagnosed in many different settings, including a sports sideline, ED, urgent care, inpatient hospital, or outpatient office. Because of the capabilities and limitations found in each setting, the expectation for what constitutes appropriate concussion care differs by setting. For example, documentation of a return-to-play progression prior to sports clearance is standard of care in the outpatient clinic setting, but concussion clearance during ED evaluation is not advocated or performed. Future quality measures should account for these differences, allowing for application in specific care settings.

The management of prolonged symptoms after concussion differs from the management of acute symptoms. Future quality measures may be adopted that are tailored to address different phases of injury recovery and possibly different mechanisms of injury.

Discussion

This measurement set addresses the 2 most widely accepted components in the diagnosis of concussion: assessment of symptoms and performance of a neurologic examination. The third measure addresses the clearance of patients for at-risk activities such as contact sports. Several other key recommendations from published guidelines were not developed into quality measures at this time due to an inability to accurately measure adherence or lack of feasible implementation into clinical practice. There is limited evidence available for the use of specific treatments for patients with concussion. Ongoing and future research studies of treatment efficacy will be incorporated into practice guidelines and inform the development of treatment-related quality measures.

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Sean C. Rose, MD	Nationwide Children's Hospital and The Ohio State University, Columbus	Study concept and design, acquisition of data, analysis and/or interpretation of data, drafting/revision of the manuscript, critical revisions of the manuscript for important intellectual content, and study supervision including responsibility for conduct of research and final approval

Appendix (continued)

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Daniel Feinberg, MD	Pennsylvania Hospital, Philadelphia	Acquisition of data, analysis and/or interpretation of data, drafting/revision of the manuscript, critical revisions of the manuscript for important intellectual content
Aravind Ganesh, MD, DPhil	University of Calgary, Canada	Acquisition of data, analysis and/or interpretation of data, drafting/revision of the manuscript, critical revisions of the manuscript for important intellectual content
Lauren Green, DO	University of Southern California, Los Angeles	Acquisition of data, analysis and/or interpretation of data, drafting/revision of the manuscript, critical revisions of the manuscript for important intellectual content
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Erin Lee	American Academy of Neurology, Minneapolis, MN	Drafting/revision of the manuscript for content, including medical writing for content; major role in the acquisition of data; analysis or interpretation of data

Continued

Appendix (continued)

Name	Location	Contribution
Adam Webb, MD	Emory University School of Medicine, Decatur, GA	Study concept and design, acquisition of data, analysis and/or interpretation of data, drafting/revising the manuscript, critical revisions of the manuscript for important intellectual content, study supervision including responsibility for conduct of research and final approval

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