EDITORIAL

Identifying Children and Adolescents at Risk for Persistent Postconcussion Symptoms

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It is estimated that more than 630 000 children and adolescents present to emergency departments (EDs) each year in the United States after sustaining a traumatic brain injury (TBI), with the vast majority of these categorized as mild TBI, also commonly referred to as concussion.[1,2] This is likely a significant underestimation of the true burden of mild TBI because many patients may seek care in nonemergency settings (such as physician offices) and are not routinely captured in systematic databases, whereas other patients with mild TBI may be evaluated on the sidelines of athletic events by nonphysicians or never seek care. In a consensus statement of the International Conference on Concussion in Sport,[3] mild TBI or concussion was defined as "a complex pathophysiological process affecting the brain, induced by biomechanical forces caused either by a direct blow to the head, face, neck or elsewhere on the body with an 'impulsive' force transmitted to the head" resulting in a "rapid onset of short-lived impairment of neurological function" that largely reflects a "functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies."

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Most individuals usually recover rapidly after mild TBI.[4] However, according to Eisenberg et al[4] and as reported by Zemek and colleagues[5] in this issue of *JAMA*, approximately one-third of children and adolescents with mild TBI will experience diverse patterns of physical, cognitive, or emotional symptoms beyond 1 month after injury that can affect every day functioning and quality of life.

In the immediate management of patients with TBI, the clinician's initial responsibilities include assessing the extent and severity of symptoms and signs, evaluating the patient for structural intracranial injury, treating symptoms, and arranging follow-up care. Prior research provides information regarding the identification of patients who are not likely to have clinically important TBIs and do not require neuroimaging.[6] Despite increasing research and attention given to TBI, evidence about postinjury management is limited and consequently patients, family members, and health care professionals are uncertain about trajectories of symptoms and effective interventions.

Risk factors have been identified for persistent postconcussive symptoms (PPCS), such as adolescent age, headache, nausea or vomiting, dizziness, and prior TBI in selected populations,[7,8] but a comprehensive, yet practical, clinical risk score using information readily available at the time of injury, regardless of the mechanism, is lacking. Ideally, a risk score for PPCS would be useful for assessing clinical prognosis and the need for postinjury accommodations and follow-up. In addition, such a risk score may help to identify patients at highest risk of prolonged symptoms that will most likely benefit from interventions to facilitate recovery and it could be used to stratify patients in concussion management research.

Zemek and colleagues[5] report a derived and validated score to stratify the risk for PPCS among children and adolescents presenting to the ED with acute concussion. The risk prediction estimates generated by this tool were superior to clinician prediction of risk for PPCS, which was no better than a coin toss. In their multisite (9 pediatric EDs across Canada), prospective observational cohort study of 3063 children and adolescents, aged 5 to 18 years, with 1 or more symptoms associated with concussion and a Glasgow Coma Scale score of 14 or 15, Zemek et al identified 9 factors that are easily obtainable from the history and physical examination from a potential pool of 46 variables that were highly associated with PPCS. The strongest risk factors were female sex, age of 13 years or older, migraine history, previous concussion with symptoms lasting longer than 1 week, headache, sensitivity to noise, fatigue, answering questions slowly, and 4 or more errors on the Balance Error Scoring System tandem stance. The primary study outcome was defined as the patient-reported presence of 3 or more new or worsening symptoms compared with recalled state of being prior to the injury documented on questionnaires administered 28 days postinjury via email or telephone.

Among the 3063 patients included in the study, 801 (31%) had PPCS, which is comparable with the estimate of 33% for most pediatric EDs.[4] The 9-factor model had fair ability to predict PPCS (area under the curve of 0.71). The authors generated a 12-point scoring regimen and proposed 3 levels of risk for PPCS. In the low-risk category, the probabilities of PPCS ranged from 4.1% to 11.8%. Because these patients would be unlikely to develop PPCS, an emergency clinician could provide some reassurance to the patient and family about the patient's likelihood of full recovery. High levels of subsequent resource use, such as referral to a specialty clinic, generally would not be necessary for these individuals. In the high-risk category, the probability of PPCS ranged from 57.1% to 80.8%, suggesting that these patients might benefit from close follow-up, anticipatory guidance about expected symptom recovery trajectory, activity modifications and school accommodations, and referral to specialty care. In the medium risk category, the probabilities of PPCS ranged from 16.4% to 47.6%. This is not much of a change from the pretest probability of 33%, and from a clinical point of view, this range of risk scores may not be low enough to be reassuring or high enough to de-

finitively indicate a need for increased resources because there is approximately a 70% chance of recovery within 1 month. Application of the risk score in practice should consider the local prevalence of PPCS and contextual factors such as the patient's social circumstances and medical history, and in the absence of evidence-based therapies for concussion, clinical management should be guided by practice guidelines.

This study has limitations, such as reliance on participant recall of preinjury symptoms assessed 28 days postinjury, exclusion of children with fewer but more severe symptoms, and use of remote questionnaires as opposed to in-person interviews. The lack of a non-brain-injured comparison group prohibits the ability to assess the specificity of the factors for children with concussion, and may limit use of the risk score for individuals with concussion and multitrauma.[9] Furthermore, because of the focus on early factors, it is unclear if intermediate assessments would further inform the model of recovery. Understanding influences on the trajectory of recovery and duration of impairment will be important in the future. Effects of acute interventions, such as analgesics (35%), and outpatient interventions were not considered in the analysis and may have affected the duration of symptoms. Inclusion of patients and clinicians only from specialized pediatric EDs raises concerns about the generalizability, as suggested by the lower computed tomography rate in this cohort compared with other EDs (7% vs 38%)[10] and the higher frequency of injuries arising from sports compared with other children's hospitals in the United States (67% vs 23%).[11]

The risk score derived by Zemek et al should be validated in other settings in which children and adolescents with acute concussion are evaluated, including general EDs, urgent care centers, and some office settings, including primary care, orthopedics, and sports medicine. Assessment of the PPCS risk score in other mild TBI populations is also needed, including those with multiple trauma, younger children, those with lower Glasgow Coma Scale scores (<14), and those with structural abnormality of neuroimaging (eg, complicated mild TBI). The performance of the model should be evaluated with the addition of other bedside vestibular ocular measures, serum biomarkers, genetic factors, and advanced neuroimaging measures associated with acute TBI.[12,13]

Because rigorous systematic clinical trials are lacking, postinjury management is based primarily on consensus guidelines and there is considerable variation in management approaches.[3] Anticipatory guidance, psychoeducation, and cognitive behavioral techniques are some of the currently used therapeutic interventions.[14] Guidelines recommend cognitive and physical rest followed by gradual return to cognitive and physical activities as tolerated by symptom burden,[3] yet effectiveness and dosing of rest to enhance recovery remain unclear.[15,16]

The clinical risk score developed by Zemek et al, if validated in other settings, may facilitate selection of patients who may be at highest risk of impairments as the optimal target population for much-needed interventional trials. Considering the variation in individual symptom profiles and trajectories, personalized patient-oriented approaches to ongoing assessments and delivery of postinjury interventions are needed to facilitate recovery in these vulnerable children and adolescents.

ARTICLE INFORMATION

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