Test Accuracy of the Screening Tool for Early Predictors of Post-traumatic Stress Disorder for Post-injury Mental Health in a Managed-Medicaid Population

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Objective To determine the Screening Tool for Early Predictors of Post-Traumatic Stress Disorder (STEPP) test accuracy in identifying children with new mental health diagnoses and psychotropic medications prescribed within 12 months after unintentional injuries in a managed-Medicaid population.

Study design We conducted a secondary analysis of a retrospective cohort that investigated mental health diagnoses and psychotropic medications pre- and post-injury in children ≤18 years of age treated at a pediatric trauma center from 2005 to 2015 (n = 2208). For this study, we analyzed children with STEPP scores from their injury admission (n = 85). For children without previous mental health diagnoses or psychotropic prescriptions, we calculated the sensitivity, specificity, and positive and negative predictive values for the child and parent STEPP.

Results Of 78 children without previous diagnoses, 12 had post-injury mental health diagnoses. Of 68 children without previous psychotropic medication use, 10 had psychotropic medications prescribed. The child STEPP sensitivity was 8.3% for mental health diagnoses (95% CI 0.2, 38.5) and 10% for psychotropic medications (95% CI 0.3, 44.5). The child STEPP specificity was 77.3% for mental health diagnoses (95% CI 65.3, 86.7) and 75.9% for psychotropic medication (95% CI 62.8, 86.1).

Conclusions We found that the STEPP performed poorly in identifying children who received new mental health diagnoses and new psychotropic medications following injury. *(J Pediatr 2019;210:127-33)*.

Approximately 25% of American children receive medical treatment for an injury each year. Children who experience a traumatic injury are at an increased risk of developing mental health symptoms, particularly symptoms of posttraumatic stress disorder (PTSD) including intrusive thoughts, avoidance of triggers, and hyperactive behaviors. Following unintentional traumatic injuries, up to 37.5% of children and adolescents under the age of 19 years have been diagnosed with PTSD and even more displayed post-traumatic stress symptoms (PTSS), meeting at least 1 criteria for PTSD.[1-4] Severity of injury is not related to the development of symptoms; rather, the development of PTSS is significantly associated with the child's perception of threat to his/her own life.[5] Timely detection of those children at risk of developing posttraumatic stress symptoms is essential to mitigate negative effects and is the first step toward prevention.[6]

Studies have investigated the impact of early, focused intervention involving cognitive behavioral therapy in mitigating long-term PTSS.[7] Early identification of maladjustment and PTSS allows for timely therapy and teaching of coping techniques. A variety of tools have been developed to assess PTSD and PTSS in children after traumatic injuries. These range from 10 to 90 items focused on details of the traumatic event and frequency of PTSS.[8,9] Tools have been designed to be either child- or caregiver-reported, and either self- or clinician-administered.[10-13] Assessments can take as little as a few minutes to as long as an hour.[14,15]

The Screening Tool for Early Predictors of PTSD (STEPP), a brief assessment of pediatric trauma patients and their parents, was developed specifically for the acute care setting to quickly identify children between 8 and 17 years of age

ADHD	Attention-deficit/hyperactivity disorder
AIS	Abbreviated injury score
DSM	*Diagnostic and Statistical Manual of Mental Disorders*
ED	Emergency department
GCS	Glasgow coma score
ISS	Injury severity score
PsySTART	Psychological Simple Triage and Rapid Treatment
PTSD	Post-traumatic stress disorder
PTSS	Post-traumatic stress symptoms
STEPP	Screening Tool for Early Predictors of PTSD

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and their parents who are at risk for developing PTSD.[16] It was first validated in a cohort of children with traffic-related injuries. Time is a primary limitation of the STEPP, as it requires information from the medical record, in addition to direct information from the child and parent.[16] A similar assessment tool, STEPP-AUS (Australian version), had a higher test accuracy when implemented in children within 4 weeks after injury when compared with the STEPP.[16] Researchers in the Netherlands applied the original STEPP 1 week after injury in children suffering from traffic accidents, sports accidents, and other injuries and assessed for PTSD 3 months after injury. They found the original cut-off scores of 4 for children and 3 for parents to not accurately predict PTSD diagnoses 3 months after injury. However, they found a cut-off score of 2 to predict PTSD with both a high sensitivity and high negative predictive value, supporting its use as a screening tool.[17]

The purpose of this study was to determine the test accuracy of the STEPP administered within 24 hours of emergency department (ED) visit to identify children with new mental health diagnoses and new psychotropic medications prescribed within 12 months after unintentional, nonfatal injuries in a managed-Medicaid population.

Methods

We conducted a secondary analysis of a retrospective cohort that investigated mental health diagnoses and psychotropic medications prescribed pre- and post-injury in children 0-18 years of age treated at Nationwide Children's Hospital, a level 1 pediatric trauma center, from 2005 to 2015.[18]

Inclusion Criteria

Original Study. The original study included all children 0-18 years of age in the Nationwide Children's Hospital Trauma Registry who were admitted for unintentional traumatic injuries between June 1, 2005 and May 31, 2015 and survived to discharge. Children were included in the original study if enrolled in the hospital's managed-Medicaid program, Partners For Kids, at the time of admission and for at least 1 healthcare visit in the preceding 12 months. This ensured that the injury event was not the patient's first interaction with the healthcare system and allowed us to identify children with previous mental health diagnoses. The STEPP was used in clinical practice to guide interventions for children 8-17 years of age.

STEPP Screening. We limited this analysis to those in the original cohort of children enrolled in Partners For Kids at injury admission and for at least one visit in the 12 preceding months, who had STEPP screenings completed within 24-48 hours of arrival to the ED. The STEPP was administered to children with injuries meeting criteria for a trauma alert activation. Children between the ages of 8 and 17 years and their parents were eligible for the STEPP. The screening was often initiated in the ED by a social worker. Patients who are discharged from the ED are screened prior to discharge and are provided with resources as indicated. Resources may include psychoeducation on acute stress symptoms and helping a child to cope following traumatic injury. Mental health treatment information is provided to the family, specific to their community and insurance coverage. Social workers may also complete a referral for mental health treatment if requested by the family. If the patient is admitted to an inpatient unit, the tool may be completed upon admission during the social work follow-up assessment. Screening results are considered for inpatient interventions (ie, psychology consultation as well as outpatient referrals to mental health providers at time of discharge).

Exclusion Criteria

Original Study. The Trauma Registry excludes children admitted for injuries acquired during medical care and children admitted for injuries such as venomous animals/plants, cellulitis without surgical intervention, poisonings, or asphyxia from a foreign body. Children that could not be verified in the electronic medical record by first name, last name, date of birth, admission date, and medical record number were excluded. Also excluded were children discharged home from the ED without admission to the hospital; children suffering from self-inflicted or child abuse injuries as they receive automatic referrals to mental health services; children who died during hospitalization; or children with multiple injury events after an initial recorded injury.

STEPP Screening. The STEPP screen is not administered to children presenting with self-inflicted injuries or children nonverbal because of a developmental delay or disability. Because the child score includes an indicator intended to be answered by the parent, "Does your child have any behavior problems or problems paying attention?" the child section cannot be scored if the parent is unavailable to be screened.

Data Sources and Variables

Original Study. Nationwide Children's Hospital's Trauma Registry was used to identify children 0-18 years of age hospitalized for traumatic injuries within 30 days of the injury event. The Trauma Registry data consists of patient demographics, mechanism of injury, trauma type, Glasgow coma score (GCS) upon ED arrival, abbreviated injury score (AIS), overall injury severity score (ISS), and hospital disposition. An AIS rating of 1-2 indicates a minor to moderate severity injury whereas a rating of 3-6 would be serious to un-survivable in severity. A GCS score of 15 is normal and a score of 3-14 indicates a brain injury. More specifically, a score of 4-8 indicates a comatose patient and a score of 3 indicates complete unresponsiveness. The ISS rates the overall severity of injury sustained by each patient. A score of 1-8 indicates a minor injury severity, 9-15 indicates a moderate severity, and >15 indicates a severe injury severity.

Medical record numbers, names, and dates of birth from the Trauma Registry were used to identify children in the electronic medical record and extract services, diagnoses, and prescribed psychotropic medications 12 months pre- and post-injury. The Partners For Kids billing database was used to verify that each patient was insured at admission and for 1 visit in the 12 months pre-injury. Both databases were used to identify the *International Classification of Diseases, Ninth Revision* diagnoses and prescribed medications associated with each healthcare visit in the 12 months pre- and post-injury. Mental health diagnoses were categorized into 14 categories: adjustment disorders, anxiety disorders, attention-deficit/hyperactivity disorders (ADHDs), bipolar disorders, disruptive behavior disorders, eating disorders, learning/cognitive disorders, nonbipolar depressive disorders, pervasive developmental disorders, psychotic disorders, sleep disorders, somatoform disorders, substance use disorders, and other disorders. Similarly, psychotropic prescriptions in the hospital's formulary were reviewed and grouped into 8 categories: ADHD, anti-anxiety, anticonvulsant, antidepressant, antipsychotic, bipolar, hypnotics/sedatives, and stimulants. Anticonvulsants prescribed to patients with seizure disorder or intracranial hemorrhage *International Classification of Diseases, Ninth Revision* diagnosis codes were excluded due to the overlap of treatment for neurologic and mental health diagnoses.

STEPP Screening. Social workers in the ED respond to all trauma-alert activations and initiate the screen during their assessment and intake process. If the STEPP cannot be completed in the ED, a hand-off is given to the inpatient social worker to complete the tool during the 24-hour trauma follow-up assessment. Efforts are made to complete the tool if the child is discharged home from the ED. Completed tools are collected by the Trauma Social Work Program Coordinator. We entered completed STEPP screens collected from 2010 to 2016 into a database. This dataset was merged with the primary analysis described above. The STEPP consists of 4 questions for the parent, 4 for the child, and 4 to be obtained from the medical record. Questions for the child include whether others were injured or killed in the accident, if there was a time the child could not find his/her parents, if the child felt afraid during the accident, and if the child thought he/she might die during the accident. Questions for the parent include whether he/she witnessed the event, if the parent accompanied the child to the hospital, if the parent felt helpless during/immediately after the accident, and whether the child has any pre-existing behavioral concerns. The latter is the only parental response that is incorporated into the child screen. The child screen accounts for suspected extremity fracture, child's pulse, and sex and the parent screen accounts for suspected extremity fracture and age; this information can be found in the ED medical record. Once scored, a child's score ≥4 and a parent's score ≥3 are both considered positive screens. A positive screen is associated with later PTSS and general anxiety symptoms.[19]

Data Analyses

Descriptive statistics were used to characterize the study population, including median and quartiles for continuous variables and counts and frequencies for categorical variables. Child STEPP scores and parent STEPP scores were grouped by positive screen (child scores ≥4, parent scores ≥3) or negative (child score<4, parent score <3). Among children without a prior indication of a mental health diagnosis or a prior psychotropic medication history, the sensitivity, specificity, positive and negative predictive values, and exact 2-sided 95% CIs were calculated for the child and the parent STEPP screens. All data management and analyses were performed with the use of SAS software v 9.4 (SAS Institute, Cary Inc, North Carolina).

Human Subjects Protection

The institutional review board at Nationwide Children's Hospital approved this study to be conducted with the Health Insurance Portability and Accountability Act and written informed consent waivers.

Results

Study Population Characteristics

The **Figure** illustrates the inclusion and exclusion criteria resulting in the 85 children with STEPP scores that were analyzed for this study. The median age of this population was 12.9 years (IQR 10.4, 15.6), and the majority of children were identified as male (63.5%) (**Table I**). Children's race was classified as 50.6% white, 36.5% black, and 12.9% other; 94% of children were non-Hispanic.

The most common type of trauma was blunt force (83.5%), followed by penetrating point force (11.8%), and burn injury (4.7%). Using the AIS region, children most commonly had an external body injury (70.6%), head injury (31.8%), abdominal injury (17.7%), and leg injury (14.1%). Injuries to the arms, chest, cervical spine, lumbar spine, and neck each accounted for less than 7% of injuries, respectively.

Most children were classified as minor ISS (78.8%) and normal GCS (97.6%). Sixty-two percent of children had 1-day length of stay, 36.5% stayed 2-7 days, and only 1 (1.2 %) patient was admitted longer than 7 days. Only 4 (4.7%) children were admitted to the pediatric intensive care unit for 1 or more days; 92% of children did not have a pre-existing mental health diagnosis and 80% of children were not prescribed psychotropic mediations prior to the injury admission.

New Mental Health Diagnoses and Prescribed Psychotropic Medication Post-injury Admission

Of the 78 children without previous mental health diagnoses, 12 (15.4%) had new post-injury mental health diagnoses. Nine (11.5%) children were diagnosed with learning or cognitive disorders. 4 other diagnoses (5.1%) included anxiety disorder, ADHD, bipolar disorder, and substance use disorder. Of the 68 children without previous

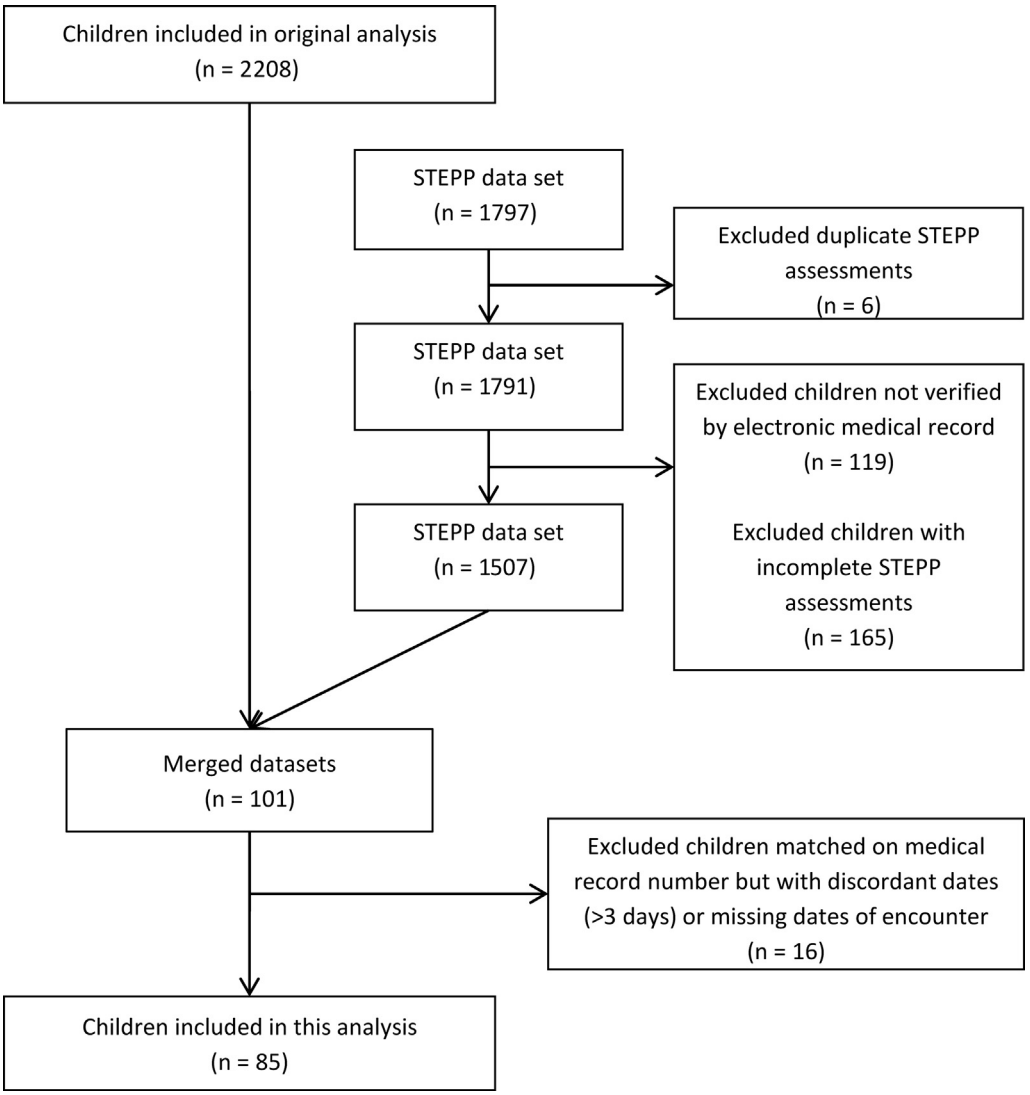

Figure. Study cohort inclusion and exclusion diagram.

psychotropic medication use, 10 (14.7%) had new psychotropic medications prescribed post-injury. 4 (5.9%) children had anticonvulsants; 8 (11.8%) children had antidepressants, antipsychotics, stimulants, or ADHD medications.

STEPP Performance

Results and performance of the STEPP screening are described in Table II and Table III. The child STEPP sensitivity was 8.3% for mental health diagnoses (95% CI 0.2, 38.5) and 10% sensitivity for psychotropic medications (95% CI 0.3, 44.5). In comparison, the parent STEPP had 58.3% sensitivity for mental health diagnoses (95% CI 27.7, 84.8) and 50% sensitivity for psychotropic medications (95% CI 18.7, 81.3). The child STEPP specificity was 77.3% for mental health diagnoses (95% CI 65.3, 86.7) and 75.9% for psychotropic medication (95% CI 62.8, 86.1). The parent STEPP specificity was 52.3% for mental health diagnoses (95% CI 39.5, 64.9) and 55.2% for psychotropic medications (95% CI 41.5, 68.3). Positive and negative predictive values are also reported.

Discussion

Our analysis found that the STEPP, when administered in the acute care setting, did not accurately identify children who received new mental health diagnoses and new psychotropic prescriptions within 12 months following injury. Several other studies have examined STEPP test accuracy in predicting PTSD or a related mental health condition post-injury.[6,19,20] Our analysis builds on these prior studies by evaluating the tool when administered in the acute care

Table I. Demographics and injury characteristics (n = 85)

Characteristics of injured children	Median (Q1, Q3)
Age in years	12.9 (10.4, 15.6)
	N (%)
Sex	
Female	31 (36.5)
Male	54 (63.5)
Race/ethnicity	
White	43 (50.6)
Black	31 (36.5)
Other	11 (12.9)
Ethnicity	
Hispanic	5 (6.0)
Non-Hispanic	78 (94.0)
Trauma type	
Blunt force	71 (83.5)
Burn injury	4 (4.7)
Penetrating point force	10 (11.8)
GCS in the ED	
Normal (15)	82 (97.6)
Abnormal (<15)	2 (2.4)
ISS	
Minor (1-8)	63 (78.8)
Moderate (9-15)	14 (17.5)
Severe (>15)	3 (3.7)
AIS region	
Abdominal injury	15 (17.7)
Arm injury	5 (5.9)
Chest injury	6 (7.1)
Spine injury	6 (7.1)
External body injury	60 (70.6)
Head or neck injury	29 (34.1)
Leg injury	12 (14.1)
Hospital length of stay	
1 d	53 (62.3)
>1 d	32 (37.6)
Length of intensive care unit stay	
0 d	81 (95.3)
1 or more d	4 (4.7)
Mental health diagnosis	
Pre-existing	7 (8.2)
No pre-existing	78 (91.8)
Mental health medications	
Pre-existing	17 (20.0)
No pre-existing	68 (80.0)

Table II. STEPP test performance for predicting new mental health diagnoses 1 year post-injury

	n = 78			
	Child		Parent	
Performance measures	Positive STEPP	Negative STEPP	Positive STEPP	Negative STEPP
Mental health diagnosis	1	11	7	5
No mental health diagnosis	15	51	31	34
Sensitivity, % (95% CI)	8.3% (0.2%, 38.5%)		58.3% (27.7%, 84.8%)	
Specificity, % (95% CI)	77.3% (65.3%, 86.7%)		52.3% (39.5%, 64.9%)	
Positive predictive value, % (95% CI)	6.3% (0.2%, 30.2%)		18.4% (7.7%, 34.3%)	
Negative predictive value, % (95% CI)	82.3% (70.5%, 90.8%)		87.2% (72.6%, 95.7%)	

setting immediately following the traumatic injury and by evaluating test accuracy in predicting new psychotropic prescriptions post-injury.

As trauma-related stress is not limited to the injured patient, we analyzed the test accuracies of both the child STEPP and the parent STEPP in predicting new mental health diagnoses and new psychotropic prescriptions. Although parent STEPP questions were derived to assess PTSD risk for the parents, the parent score had a higher sensitivity and higher positive predictive value than the child score for predicting both mental health diagnosis and psychotropic prescriptions in the child, supporting the relationship between parent and child stress. The positive relationship found between positive parent STEPP scores and new mental illness diagnoses and psychotropic prescriptions in children, support other study findings that child and parent PTSD are not entirely independent events.[1,21-29] Trauma is a family experience. Children are more likely to develop PTSD when their parents have PTSD, even more so if the parent was present at the injury.[1,21-29] When parents are present in the ED, they are encouraged to remain at their child's bedside to provide support and to receive immediate medical updates. This time spent awaiting assessment from the medical team can be stressful. Parents can experience feelings of confusion, anger, anxiety, and shock, intensifying their stress response. In addition, the child is influenced by his/her interpretation of his parent's stress response.[30] As the immediate threat of danger subsides, coping skills, social support, and intervention from the psychosocial team can facilitate a return to a more manageable state for both parents and child.

The *Diagnostic and Statistical Manual of Mental Disorders* (DSM) criteria defining PTSD have changed with the publication of the DSM-V in 2013.[31] In the DSM-IV, PTSD criteria for traumatic exposure included emotional responses to traumatic events, such as fear, helplessness, and horror. These are no longer included as diagnostic criteria in DSM-V.[31,32] The STEPP was developed in 2003, when DSM-IV diagnostic criteria were still used for PTSD, and includes multiple fear-based questions, particularly in the child tool. DSM PTSD criteria A is the only criteria that is assessable in an acute care setting, or any setting immediately following injury.[31]

Criteria B-H of the DSM-V diagnostic criteria for PTSD include the following: intrusion symptoms, persistent avoidance of stimuli associated with the traumatic event, negative alterations in cognitions and mood associated with the traumatic event, marked alterations in arousal and reactivity associated with the traumatic event, duration of the disturbance of more than 1 month, clinically significant distress or impairment in social, occupational, or other areas of functioning, and the disturbance not being attributable to physiological effects of a substance.[31] These criteria are not assessable in the acute care setting, as these symptoms take time to manifest. Questions regarding these criteria are not included in the STEPP.

The STEPP-AUS shows promise as an effective PTSD screening tool to be administered in the acute care setting, as questions are geared toward past mental health history,

Table III. STEPP test performance for predicting new psychotropic medications 1 year post-injury

	n = 68			
	Child		Parent	
Performance measures	Positive STEPP	Negative STEPP	Positive STEPP	Negative STEPP
Psychotropic medication	1	9	5	5
No psychotropic medication	14	44	26	32
Sensitivity, % (95% CI)	10.0% (0.3%, 44.5%)		50.0% (18.7%, 81.3%)	
Specificity, % (95% CI)	75.9% (62.8%, 86.1%)		55.2% (41.5%, 68.3%)	
Positive predictive value, % (95% CI)	6.7% (0.2%, 32.0%)		16.1% (5.5%, 33.7%)	
Negative predictive value, % (95% CI)	83.0% (70.2%, 91.9%)		86.5% (71.2%, 95.5%)	

the actual injury event, and current feelings.[16] Instead of assessing 8 PTSD risk factors like the STEPP, the STEPP-AUS assesses 5 PTSD risk factors, 2 disassociation symptoms at the time of injury, and 1 acute stress symptom.[33] STEPP-AUS questions for the parent include if the child has had behavior or attention problems for a while, if the child has been sad/depressed/worried for a while, if someone close to the child has had a serious injury before, and if they heard the child crying or asking for help when they were injured.[16] STEPP-AUS questions for the child include whether they have ever had trouble with being really sad or really worried, if they felt extra "hyper" when they were injured, if they felt really "spacey" when they were injured, and if they are currently feeling upset or scared.[16] The STEPP-AUS was implemented within 4 weeks after injury in children suffering from traffic accidents, falls/assaults/burns, sports injuries, and other injuries. They assessed for PTSD 3 and 6 months after injury and found the original STEPP to not accurately predict PTSD in their patient population, but that the STEPP-AUS did accurately predict positive PTSD screens 6 months after injury.[16] Because STEPP-AUS only includes 1 fear-based question, unlike the STEPP, it may be more accurate in determining PTSD risk immediately following an injury event.

Other tools developed to screen for PTSD in children following a traumatic event were developed to be administered a significant amount of time following the injury event and to focus on DSM criteria B-H. Further, most were developed prior to the newest DSM revision. Many show successes in identifying those at risk for PTSD, however, they are not feasible to administer in the acute care setting. Psychological Simple Triage and Rapid Treatment (PsySTART) is a tool initially developed to screen for mental health needs after a mass disaster such as a hurricane. It contains questions similar to the STEPP but it also includes additional questions regarding the traumatic experience itself.[34] Data collection for the PsySTART and STEPP are similar with information obtained by the child, a parent, a family member, a friend, scene response personnel, or the medical record. However, all questions are aimed at predicting mental health needs in the child; no questions are focused on assessing mental health needs of the parent.[34] In theory, PsySTART should be a better predictor of mental health needs following injury because of its more extensive analysis of criterion A of the DSM-V. An additional feasibility issue of STEPP use in the acute care setting is the use of a multistep screening process; electronic medical record review, parent self-report, and child self-report. Automated electronic medical record screenings have proven efficient for PTSD screening following injury.[35] With tools such as PsySTART that focus on DSM-V criteria A, there is more potential for an automated PTSD screen.

Healthcare systems vary in the accessibility of follow-up services for low income populations, which is mitigated through the implementation of Accountable Care Organizations. Nationwide Children's Hospital's Accountable Care Organization, Partners For Kids, serves as the medical home for over 330 000 low income children and Ohio's 5 Medical Managed Care Plans. Through care navigation programs, access to post-injury care including mental health services is facilitated. Other healthcare systems may lack or differ in their Accountable Care Organization.[36] Follow-up care is essential to diagnosing and preventing the entrenchment of PTSD symptoms.[37] Yet in many healthcare systems, the transition from acute care to primary and specialty care follow-up is often lacking.[38] This may decrease the likelihood that low income children will receive the mental health services that they need, compared with those whose medical care is fully managed.[39]

There were several limitations to this study. Our data was collected from 1 pediatric hospital and contains a small sample size. Given this small sample size, the majority of estimates are highly variable and there is limited power to detect differences. However, our sample of children is comparable with other published samples of children at-risk for PTSD, and is likely representative of this population. Further, our sample of children in managed-Medicaid programs may not be representative of the larger pediatric trauma population. We have access to records of all healthcare received through our hospital system or paid through our managed-Medicaid program, but may have missed information for care paid for by other sources. The STEPP was initially developed to only assess risk for PTSD, however, we investigated all subsequent mental health diagnoses in our analysis. The focus on admitted children may limit generalizability to the overall population of traumatically injured children; however, this is consistent with the population in which the STEPP was originally derived and validated.[19,20] Finally, as a children's hospital, we did not have records to analyze the STEPP test accuracy for predicting new mental health diagnoses and psychotropic prescriptions in the parents of the injured children.

The STEPP, in its current form, does not accurately assess risk for PTSD. It may be of benefit to injured patients to find a tool, such as PsySTART, with greater focus on trauma exposure, pursuant to DSM-V criteria. Our study demonstrates the need for a tool that more accurately assesses risk of PTSD and other mental health disorders after traumatic injury when administered in the acute care setting. Such a

tool could be used to facilitate mental health services referral and earlier mitigation of PTSS. ■

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