Pediatric Trauma Assessment and Management Database: Leveraging Existing Data Systems to Predict Mortality and Functional Status after Pediatric Injury

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BACKGROUND: Efforts to improve pediatric trauma outcomes need detailed data, optimally collected at lowest cost, to assess processes of care. We developed a novel database by merging 2 national data systems for 5 pediatric trauma centers to provide benchmarking metrics for mortality and non-mortality outcomes and to assess care provided throughout the care continuum.

STUDY DESIGN: Trauma registry and Virtual Pediatric Systems, LLC (VPS) from 5 pediatric trauma centers were merged for children younger than 18 years discharged in 2013 from a pediatric ICU after traumatic injury. For inpatient mortality, we compared risk-adjusted models for trauma registry only, VPS only, and a combination of trauma registry and VPS variables (trauma registry+VPS). To estimate risk-adjusted functional status, we created a prediction model de novo through purposeful covariate selection using dichotomized Pediatric Overall Performance Category scale.

RESULTS: Of 688 children included, 77.3% were discharged from the ICU with good performance or mild overall disability and 17.6% with moderate or severe overall disability or coma. Inpatient mortality was 5.1%. The combined dataset provided the best-performing risk-adjusted model for predicting mortality, as measured by the C-statistic, pseudo-R^2, and Akaike Information Criterion, when compared with the trauma registry-only model. The final Pediatric Overall Performance Category model demonstrated adequate discrimination (C-statistic = 0.896) and calibration (Hosmer-Lemeshow goodness-of-fit $p = 0.65$). The probability of poor outcomes varied significantly by site ($p < 0.0001$).

CONCLUSIONS: Merging 2 data systems allowed for improved risk-adjusted modeling for mortality and functional status. The merged database allowed for patient evaluation throughout the care continuum on a multi-institutional level. Merging existing data is feasible, innovative, and has potential to impact care with minimal new resources. (J Am Coll Surg 2017;224:933–944. © 2017 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

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Abbreviations and Acronyms

AIC = Akaike Information Criterion
GCS = Glasgow Coma Scale
NTDB = National Trauma Data Bank
PELOD = Pediatric Logistic Organ Dysfunction
PICU = pediatric ICU
PIM2 = Pediatric Index of Mortality
POPC = Pediatric Overall Performance Category
PRISM3 = Pediatric Risk of Mortality
PTAM = Pediatric Trauma Assessment and Management Database
REDCap = Research Electronic Data Capture
TQIP = Trauma Quality Improvement Program
VPS = Virtual Pediatric Systems, LLC

Injury is the leading cause of death and disability in children.[1] During the past 3 decades, the American College of Surgeons Committee on Trauma has fostered the creation of trauma systems nationally, and has worked to improve patient care through organized data systems, including the National Trauma Data Bank (NTDB) and the Trauma Quality Improvement Program (TQIP). These allow for hospital benchmarking and they establish a platform for institutional performance improvement.[2-5] These data systems do not capture important non-mortality outcomes, such as functional status or quality of life outcomes. These outcomes are arguably more important in pediatric trauma than adult trauma due to significantly lower mortality after traumatic injury in the pediatric population (11.39 vs 75.97 per 100,000).[1] Morbidity, as measured by functional status impairment and reduced health-related quality of life, is especially important in the evaluation of pediatric trauma care because of the high burden of traumatic brain injury and risk for neurologic sequela leading to lifelong disabilities. Functional status has been studied in small populations of injured children,[6,7] however, it has not been adopted and integrated into national registries and data systems, limiting multi- and intra-institutional assessment, risk-adjusted benchmarking, and national quality-improvement efforts.

Additional data sources exist outside of the American College of Surgeons Committee on Trauma, but they either lack the ability to appropriately risk adjust for injury severity or are limited to specific hospitals or subpopulations. For example, the Pediatric Health Information System is a database with clinical and resource use data, however, it is limited to fewer than 50 children's hospitals, uses only administrative claims data, and lacks data elements critical for risk adjustment in trauma, including the Abbreviated Injury Scale and Glasgow Coma Scale (GCS) scores.[8] The Healthcare Cost and Utilization Project is a comprehensive source of hospital data involving hundreds of hospitals nationally. It is also based on administrative data and lacks essential risk-adjustment variables. Finally, and most importantly, the Pediatric Health Information System and the Healthcare Cost and Utilization Project family of databases lack non-mortality functional outcomes data, which limits their ability to effectively evaluate the quality of pediatric trauma care.[9]

The Pediatric NSQIP captures detailed process of care data, but also lacks critical trauma-specific variables, including injury type, intent, and mechanism, pre-arrival and arrival physiologic data, and anatomical Injury Severity Scores. Also, NSQIP is procedure-based, and a significant portion of trauma care is nonoperative. Finally, NSQIP is a sample only, and with the heterogeneity of pediatric trauma, arguably fails at capturing the majority of the pediatric trauma population.

The Virtual Pediatric Systems, LLC (VPS) database is a collaborative involving more than 140 hospitals and includes comprehensive data from the pediatric ICU (PICU) phase of care.[10] The VPS database includes detailed physiologic and laboratory data, functional status outcomes at PICU discharge, and 3 validated scores for mortality prediction in critically ill children (Pediatric Index of Mortality [PIM2], Pediatric Risk of Mortality [PRISM3], and the Pediatric Logistic Organ Dysfunction [PELOD]).[11-14] The non-mortality outcomes collected at PICU discharge include the Pediatric Overall Performance Category (POPC) and the Pediatric Cerebral Performance Category, modeled after the traditional Glasgow Outcomes Scale, and have been shown to correlate to more-specific neuropsychological tests and also to post-discharge long-term outcomes.[15]

Under the guidance of the Institute for Healthcare Improvement's Triple Aim—calling for improving the health of populations (injured children) and the patient experience of care (targeting functional status optimization), all while reducing costs—we created the Pediatric Trauma Assessment and Management (PTAM) database. The PTAM is a novel database created through the merging of 2 independent data systems, capitalizing on both systems' specific strengths, infrastructure, and investment, to improve assessment of care quality provided to critically injured children throughout their hospitalization and to, for the first time, create multi-institutional risk-adjusted models for functional status impairment in the pediatric trauma population.

The primary objectives of this study were to prove the feasibility of a multi-institutional merger of existing data with improved ability to assess care metrics across the care continuum, test the utility of PTAM to improve

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