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## Intensive care unit admission predicts hospital readmission in pediatric trauma



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## ABSTRACT

**Background:** Hospital readmission in adult trauma is associated with significant morbidity, mortality, and resource utilization. In this study, we examine pediatric intensive care unit (PICU) admission as a risk factor for hospital readmission in pediatric trauma.

**Materials and methods:** This was a retrospective cohort study of patients aged 1 through 19 y in the Pediatric Health Information System database discharged with a trauma diagnosis. Patient and clinical variables included demographics, payer status, length of stay, chronic comorbid conditions, presence of mechanical ventilation, all-patient refined diagnosis-related group and calculated severity of illness, and discharge disposition. The main outcome variable was hospital readmission within 30 d of discharge. Odds ratios (ORs) were calculated in both univariate and multivariate analyses with corresponding 95% confidence intervals (CIs).

**Results:** During the 5-year study period, 90,467 patients were admitted with a trauma diagnosis, of which 16,279 (18.0%) were admitted to the PICU. Hospital readmissions occurred in 3.1% of patients. On univariate analysis, patients admitted to the PICU on the first day of hospital admission (direct PICU admission), and those first admitted to the PICU after the day of hospital admission (delayed PICU admission), had 2-3 times the risk of hospital readmission compared with those never admitted to the PICU (4.8% versus 7.2% versus 2.7%, respectively,  $P < 0.001$ ). On multivariate analysis, controlling for demographic and clinical variables, the adjusted ORs for hospital readmission in patients with direct and delayed PICU admission were 1.34 (95% CI 1.20-1.50) and 1.88 (95% CI 1.50-2.35) versus no PICU admission, respectively.

**Conclusions:** PICU admission, either direct or delayed, during hospitalization for trauma care is an independent risk factor for hospital readmission within 30 d of discharge. Further risk stratification may help focus resources on high-risk patients to improve clinical outcomes and reduce readmissions.

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## Introduction

Early unplanned hospital readmission is a common occurrence that increases strain on health care resources. Although there is a body of literature that has attempted to study and identify risk factors for readmission, studies tend to be based on specific patient populations, making them difficult to apply broadly.

Pediatric general surgery readmissions occur at higher rates in younger patients with the majority associated with chronic comorbid conditions.<sup>1</sup> The system of pediatric post-hospital care consists of family, physicians, nurses, social workers, and case managers, among others. Outcomes for children depend on effective functioning of this system. One way to assess the system is the occurrence of 30-day readmission. There have been few studies to develop predictive models for pediatric readmission and none that the authors found in the realm of pediatric trauma.<sup>2</sup> Studies in adults have demonstrated that risk factors for readmission in general surgical patients can differ from those in the trauma population and may provide opportunities for identifying uniquely high-risk trauma patients.<sup>3,4</sup>

Our experience has suggested that patients with more severe injuries or worse physiological disruption, especially those requiring pediatric intensive care unit (PICU) admission, may be at higher risk for readmission within the pediatric trauma population. In this study, we hypothesize that direct PICU admission is a risk factor for hospital readmission after pediatric trauma care.

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## Materials and methods

This study was approved by the University of Buffalo Institutional Review Board (775891-1). The data were obtained from the Pediatric Health Information System (PHIS), which is an administrative pediatric database containing inpatient demographic, diagnostic, and procedural data from 45 not-for-profit pediatric hospitals in the United States. Data are subjected to a number of reliability and validity checks and processed into data quality reports.

Eligible patients were aged 1-19 y, admitted as inpatients, and discharged with a trauma diagnosis between March 2010 and February 2015. Patients aged younger than 1 year were excluded as they represent a distinct population more likely to present after nonaccidental trauma and to have unique factors affecting readmission and length of stay (LOS) such as social and legal issues. The most recent (July 2014) list of New York State Trauma Registry inclusion International Classification of Diseases, Ninth Revision (ICD-9) diagnoses was used to define a trauma diagnosis.<sup>5</sup> Patients with inadequate clinical information and those who died after admission were excluded. Therefore, the comparison groups were those admitted directly to the PICU (direct PICU admission), those first admitted to the PICU on any subsequent hospital day (delayed PICU admission), and those never admitted to the PICU (ward admission only). Those patients admitted to the PICU on multiple occasions were classified according to the timing of their initial admission. Due to the method by which

level of care is determined, some of the direct PICU admission groups may have been initially admitted to the ward then transferred to the PICU on the day of hospital admission.

Demographic patient variables included age, gender, payer status, presence of any complex chronic condition (CCC), and race and/or ethnicity. Clinical variables included hospital region, payer, transfer from another inpatient or outpatient facility, LOS, use of mechanical ventilation, use of extracorporeal membrane oxygenation, having an operation (receiving any operating room charges), 3M all-patient refined diagnosis-related group (APR-DRG) and severity of illness (SOI), and disposition on discharge. Disposition groups were routine discharge, home under care of an organized home health service organization in anticipation of covered skilled care, inpatient rehabilitation, skilled nursing facility or long-term care hospital, other facility (e.g., federal health care facility, short-term general hospital for inpatient care, intermediate care facility, or inpatient hospice), or other discharge (e.g., to law enforcement, left against medical advice, or home hospice).

The main outcome variable was hospital readmission for any reason within 30 days of discharge. Readmissions that occurred on the same day as discharge were not counted for patients discharged to a facility, discounting 362 readmissions, primarily among transfers to inpatient rehabilitation. This is because it was not possible to distinguish between patients being truly readmitted from another facility and those who were transferred to an independently billed unit within the same hospital or campus, although we reasonably assumed that nearly all these represented transfers.

Diagnosis-related groups (DRGs) are groups of patients related by diagnoses, procedures, comorbidities, and complications. All-patient DRGs are expanded DRGs meant to be more applicable to children. In the APR-DRG scheme, each patient visit is assigned a DRG along with an SOI subclassification meant to reflect the extent of physiological decompensation or organ system loss of function. The SOI for the visit is a variable based on validated algorithms of the 3M Corporation and is also derived from primary and secondary diagnoses as well as procedures and disposition. The SOI is calculated from PHIS data in an automated fashion. SOI categories are 1 through 4, or mild, moderate, severe, and extreme. An SOI in conjunction with an APR-DRG group can be used as a categorical predictor. However, SOI cannot be used as an independent predictor across multiple DRGs as each APR-DRG has a unique algorithm for calculating SOI.

Descriptive statistics and a bivariate comparison of variables between the direct and delayed PICU and ward admission cohorts are presented using t-test, one-way analysis of variance, Fisher exact, and Pearson chi-square tests where appropriate. Odds ratios (ORs) for readmission were calculated in both bivariate and multivariate (as adjusted OR [aOR]) analyses with corresponding 95% confidence intervals (CI).

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## Results

Between March 1, 2010 and February 28, 2015, a total of 91,605 records met inclusion criteria. After exclusions for death (716

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