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Trauma experts versus pediatric experts: comparison of outcomes in pediatric penetrating injuries

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ABSTRACT

Background: While pediatric trauma centers (PTCs) can uniquely care for pediatric patients, adult trauma centers (ATCs) may be more accessible. Evidence is scarce regarding outcomes of pediatric patients with penetrating trauma treated at PTCs versus ATCs.

Materials and methods: We performed a retrospective study using the National Trauma Data Bank to identify pediatric patients aged ≤ 18 y with penetrating injuries from 2007 to 2012, treated at stand-alone PTCs or ATCs. We excluded patients treated at combined PTC or ATC, transferred between hospitals, with gunshot wounds (GSW) to the head, or dead on arrival. Eligible patients numbered 26,276 (PTC, $n = 3737$; ATC, $n = 22,539$). The primary outcome was in-hospital mortality. The secondary outcome was discharge location as a potential surrogate for functional outcome. Univariate and multivariate analyses assessed trauma center type as an independent risk factor for outcomes.

Results: Patients treated at ATCs were more likely to have Injury Severity Score >15 , Glasgow Coma Scale <9 , GSW, cardiovascular injuries, and emergent operations ($P < 0.001$). Adjusted odds ratios (ORs) for mortality favored PTCs but without statistical significance (OR, 0.592; $P = 0.054$). In subgroup analyses, children with aged ≤ 12 y, those with GSW injury mechanism, and those who underwent emergent operations at PTCs were more frequently discharged home versus elsewhere (OR, 0.327, 0.483, and 0.394; P values <0.001 , <0.001 , and 0.004, respectively).

Conclusions: Children with penetrating injuries demonstrated equivalent survival outcomes whether they were treated at PTCs or ATCs. Younger pediatric patients may have superior functional outcomes when treated at PTCs.

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Introduction

Penetrating injuries are generally associated with higher mortality rates and are more likely to require operative intervention when compared with blunt injuries.^{1,2} Because of their potential complexity, penetrating injuries require readily available operating rooms, experienced trauma surgeons, and staff. Injured pediatric patients pose additional challenges because of their variable anatomy, physiology, and concomitant specialized requirements for ventilator, inotropic, fluids, and other forms of management. In current trauma systems, injured children are triaged to pediatric or adult trauma centers (ATCs), which may have different levels of American College of Surgeons verification or state designation. Triage of pediatric penetrating injuries may consider a multitude of variables from patient age and physiology to center proximity, experience, and perceived quality of care. To date, there are limited data to differentiate trauma centers purely on the basis of patient outcomes.

All mechanisms of injury combined, previous studies that examined trauma center type and associated mortality had mixed results.³⁻⁵ Studies at the state-level suggest that adolescents with blunt or penetrating injuries treated at pediatric trauma centers (PTCs) have mortality rates equivalent to patients with similar injuries treated at ATCs.⁶⁻⁹ At the national level, Osler *et al.*¹⁰ compared the survival rates at PTCs and ATCs in pediatric trauma with all mechanisms of injury and also demonstrated no difference in mortality between different types of trauma centers. However, many existing studies demonstrate higher mortality rates among injured children treated at ATCs *versus* PTCs.¹¹⁻¹⁵ Recently, Sathya *et al.* studied children in different age groups with all mechanisms of injury who were treated at PTCs, ATCs, and mixed trauma centers, and found superior survival rates at PTCs as compared with other centers.¹⁶

However, no study has specifically compared the outcomes of pediatric patients sustaining penetrating injuries who were treated at PTCs and ATCs. Furthermore, no study has yet specifically focused on functional outcome in the setting of pediatric penetrating injuries. We hypothesized that PTCs have equivalent outcomes as compared with ATCs in the treatment of overall pediatric population with penetrating injuries and superior outcomes with the younger pediatric population.

Material and methods

This study was approved by the institutional review board at Children's Hospital Los Angeles. This is a retrospective study using data from the National Trauma Data Bank from 2007 to 2012. We analyzed data elements from the cohort of patients 18 y of age or younger whose primary mechanism of injury was penetrating trauma, treated in either stand-alone PTCs or stand-alone ATCs. For the purpose of examining pure examples of adult and pediatric care, patients treated at American College of Surgeons verified or state-designated trauma centers for both adult and pediatric centers were excluded. To minimize selection bias and different thresholds in

performing emergency room thoracotomy, patients transferred between hospitals and those who were dead or with no signs of life on arrival were excluded. Patients with gunshot wounds (GSW) to the head were also excluded, as this injury carries a unique clinical course with extremely high mortality. We collected standard demographic, descriptive, and outcome elements including age, gender, race, comorbidities, initial systolic blood pressure, initial Glasgow Coma Scale (GCS), Injury Severity Score (ISS), mechanism of injury (stab wound and GSW), the presence or absence of cardiovascular injury, and any required surgical procedures. Initial systolic blood pressure was further categorized as hypotension based on the following definitions: (a) less than $70 + 2 \times \text{age}$ in years if age < 10 y or (b) less than 90 if age > 10 y. Procedures were queried using procedure codes in the database. Procedures queried include "emergent operation," which was defined as laparotomy, thoracotomy, operative vascular intervention, or median sternotomy for cardiac repair within the first 24 h.

The primary outcome for this study was in-hospital mortality. The secondary outcome was discharge location (home *versus* nonhome, such as rehabilitation center or skilled nursing facility) as a potential surrogate for functional outcome. Descriptive statistics were calculated for all variables. Kolmogorov-Smirnov test was performed to confirm normal distribution in the continuous data. Univariate analysis was performed to compare study groups using Student's *t*-test or Mann-Whitney *U* test for continuous variables and chi-square or Fisher's exact tests for categorical variables, as appropriate. Variables with *P* values < 0.2 in univariate analysis were included for adjustment in multivariate analysis, which was performed for each outcome by using logistic regression. Odds ratio (OR) and 95% confidence interval (CI) were calculated.

We subsequently performed analyses in the following subgroups: (a) adolescents (13-18 y); (b) nonadolescents (≤ 12 y); (c) ISS > 15 ; (d) GSW; (e) stab wounds; and (f) patients who underwent "emergent operation." A multiple logistic regression model was created to explore the potential risk factors for mortality and "nonhome" discharge. To evaluate the performance of both types of trauma centers specifically in younger pediatric patients, the subgroup analyses were repeated within nonadolescents. There was no multicollinearity among the variables in any of the above analyses. Statistical significance was defined as $P < 0.05$. All analyses were performed using IBM SPSS Statistics for Windows version 22.0 (IBM Corp, Armonk, NY).

Results

Figure 1 shows the patient selection: 26,276 patients were ultimately eligible for inclusion (PTC, $n = 3737$; ATC, $n = 22,539$). The clinical characteristics, the number of trauma centers, and the average annual pediatric penetrating trauma case volumes in each group are summarized in Table 1. Notably, patients treated at ATCs were more likely to have ISS > 15 , GCS < 9 , GSW, cardiovascular injury, and received emergent operations ($P < 0.001$). PTC group had more annual pediatric

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