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A Comparison of Pediatric Trauma Patients Presenting to a Pediatric vs Adult Trauma Center: When Do Kids Become Adults?

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INTRODUCTION: There are few pediatric trauma centers (PTC), resulting in frequent treatment of pediatric patients at adult trauma centers (ATC). Locally, a level 2 PTC and level 1 ATC without pediatric specific trauma designation share the care of pediatric trauma patients. We compared characteristics and outcomes of pediatric patients (< 19 years) presenting at a PTC vs ATC.

METHODS: The trauma databases of the University of Nebraska Medical Center and Children's Nebraska, respectively an ATC and PTC, were examined from January 2015 to June 2022. Demographics, patient characteristics, and outcomes were analyzed using appropriate non-parametric tests.

RESULTS: 4818 PTC and 2259 ATC patients were evaluated. Blunt mechanisms predominated, but the PTC saw fewer penetrating injuries (4.4% vs 10.1%). Male gender predominated, while PTC patients were younger. The PTC saw a lower percentage of moderate, serious, and severe injuries and admitted a lower percentage of patients with shorter length of stay (LOS). The PTC had fewer admissions to the ICU, but had similar ICU LOS. Fewer patients at the PTC were ventilated but had more ventilator days per patient. Overall mortality was lower at the PTC. Examining only severely injured patients, there was no difference in mortality. Patients with minor injuries had shorter LOS at the PTC.

CONCLUSIONS: The PTC saw more patients and those with minor injuries were discharged faster. The ATC saw older patients with higher Injury Severity Score (ISS). However, mortality was similar between the two centers. Older, more severely injured pediatric trauma patients may benefit from care at an ATC, while less severely injured patients may receive more efficient care at a PTC.

Keywords: Pediatric Trauma, Trauma Center, Pediatric Trauma Center, Adult Trauma Center, Injury Severity Score, Trauma Outcomes.

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INTRODUCTION

Deaths due to injury are the leading cause of mortality in the pediatric and young adult population.¹ It has been demonstrated that outcomes for patients suffering from traumatic injuries are improved with direct pre-hospital transportation to a trauma center.² However, outside of large metropolitan areas, the availability of pediatric specific trauma (PTCs) centers is limited leading to many pediatric trauma patients being cared for at designated adult trauma centers (ATCs). While a recent review and meta-analysis of pediatric trauma patients demonstrated an overall lower risk of mortality when treated at a PTC, this effect was not apparent in older children and was associated with a very low certainty based on the evidence.³ Locally, a level 2 PTC and an level 1 ATC are in close proximity and share the responsibility of treating pediatric victims of trauma. Our goal was to compare outcomes of pediatric trauma patients treated at our local ATC and PTC.

METHODS

This study was reviewed and approved by the Institutional Review Board of the University of Nebraska Medical Center under protocol 0543-22-EP. Pediatric patients (age <19) were identified from the institutional trauma databases of the University of Nebraska Medical Center (ATC) and Children's Nebraska (PTC) from January 1st, 2015 to June 30th, 2022. Information collected included demographics (age, gender), mechanism of injury, pre-hospital transport information (scene, private transport, interfacility transport), injury characteristics (injury severity score [ISS] and abbreviated injury scores [AIS]), admission characteristics (length of stay, intensive care use, ventilator use), in-patient mortality, and disposition. All records for the specified time-period in the trauma databases were included, even if significant missing data was identified in the patients' records.

Statistical analysis was performed using the R Statistical Package (version 4.2.2, R Foundation for Statistical Computing, Vienna, Austria). Statistical analysis included descriptive statistics as well as parametric and non-parametric methods including Student's t-tests, Wilcoxon-Mann-Whitney tests, Pearson's chi-square and Fisher's exact tests. Statistical significance was set at $p < 0.05$.

RESULTS

Over the study period, the PTC evaluated and treated 4818 patients while the ATC treated 2259 pediatric patients. The demographics are summarized in (Table 1).

	PTC	ATC	p-value
Patients, n	4818	2259	
Median Age, n [25-75% IQR]	6 [3-11]	13 [7-16]	<0.001
Male Gender, n (%)	2964 (61.5%)	1402 (62.1%)	0.656
Median ISS, n [25-75% IQR]	4 [4-6]	5 [4-13]	<0.001
Severity Grouping			<0.001
Minor (ISS 1-9), n (%)	4220 (89.0%)	1437 (67.7%)	
Moderate (ISS 10-15), n (%)	249 (5.3%)	205 (9.7%)	
Serious (ISS 16-24), n (%)	144 (3.0%)	271 (12.8%)	
Severe (ISS 25-75), n (%)	129 (2.7%)	209 (9.8%)	
Mechanism of Injury			<0.001
Blunt, n (%)	4505 (93.5%)	1883 (83.4%)	
Penetrating, n (%)	213 (4.4%)	227 (10.1%)	

Table 1. Summary of Patient characteristics between PTC and ATC.

The median patient age was significantly lower at the PTC (6 [IQR 3-11] vs 13 [7-16] years, $p < 0.001$), with a significant trend towards older pediatric patients at the ATC (Figure 1).

Gender distribution was similar between the centers with male patients numbering 2694 (61.5%) at the PTC vs 1402 (62.1%) at the ATC ($p = 0.656$).

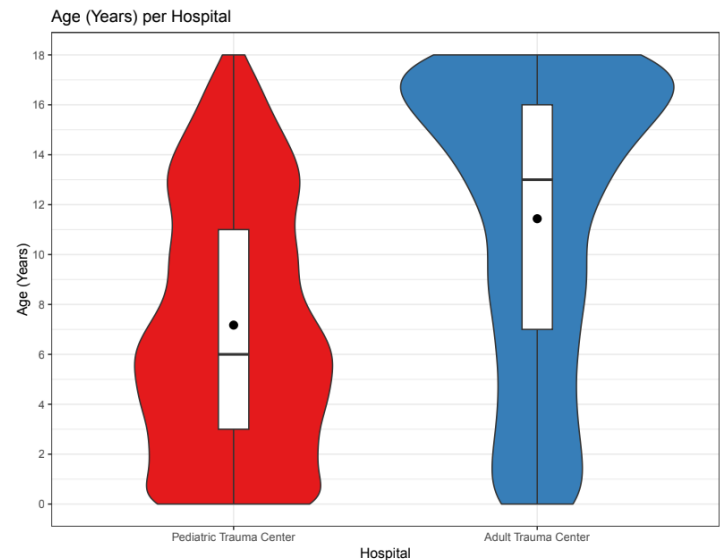


Figure 1. Distribution of ages between the PTC and ATC.

Examining injury mechanisms, both facilities saw predominately blunt trauma (4505 [93.3%] at the PTC vs 1183 [83.4%] at the ATC). However, the rate of penetrating injuries was significantly higher at the ATC seeing more than double the rate of penetrating injuries than the PTC (227 [10.1%] at the ATC vs 213 [4.4%] at the PTC; $p < 0.001$). Burn injuries were also more frequent at the ATC (43 [1.9%] ATC vs 34 [0.7%] PTC; $p < 0.001$). Overall injury severity score (ISS) was higher at the ATC with a PTC median ISS of 4 [IQR 4, 6] vs an ATC median of 5 [IQR 4, 13]. Looking closer into the distribution, more minor injuries (ISS 1-9) were seen at the PTC 4220 (89.0%) vs ATC 1437 (67.7%). At the ATC, higher injury severity was more common with about double the rates of moderate injury severity (ISS 10-15) [PTC 249 (5.3%) vs ATC 205 (9.7%); $p < 0.001$], four time the rate of serious injury severity (ISS 16-24) [PTC 144 (3.0%) vs ATC 271 (12.8%); $p < 0.001$], and three time the rate of severe injury severity (ISS 25-75) [PTC 129 (2.7%) vs ATC 209 (9.8%); $p < 0.001$].

Modes of prehospital transportation also differed significantly between the centers with more patients arriving at the PTC by private vehicle (3862 [81.2%]) vs the ATC (614 [27.8%]) and the reverse being true for ambulance transport (PTC 863 [18.1%] vs ATC 1456 [65.9%]; $p < 0.001$). Total patients transferred from a referring hospital differed significantly between the facilities; 2145 (44.2%) transfers to the PTC vs 741 (32.8%) transfers to the ATC ($p < 0.001$). Interestingly, 32 (0.7%) patients were transferred from the PTC to the ATC and 31 (1.4%) from the ATC to the PTC for definitive care over the study period.

Patient outcomes are detailed in (Table 2). Overall, the PTC admitted a lower percentage of patients after initial evaluation [PTC 4042 (83.9%) vs ATC 2106 (93.2%); $p < 0.001$]. Of those admitted, patients at the PTC had an overall shorter hospital LOS [PTC median 1 day (IQR 1, 1) vs ATC 1 day (IQR 1, 3); $p < 0.001$]. Furthermore, the PTC had a significantly lower percentage of patients admitted to the intensive care unit (ICU) [292 (7.2%) vs 758 (36.0%); $p < 0.001$], but the median ICU LOS was similar [PTC 2 days (IQR 2, 5) vs ATC 2 days (IQR 2, 3);

$p=0.125$]. Mechanical ventilation was used less often at the PTC [124 patients (3.1%) vs 250 patients (11.9%)], but when ventilated, the median days on the ventilator were higher at the PTC [3 days (IQR 2, 9) vs ATC 2 days (IQR 2, 7); $p=0.01$]. For the total patient population, the PTC had a lower in-patient mortality [105 patients (1.5%) vs the ATC of 68 patients (3.0%); $p<0.001$].

	PTC	ATC	p-value
Patients, n	4818	2259	
Hospital Admissions, n (%)	4042 (83.9%)	2106 (93.2%)	<0.001
Median Hospital Length of Stay	1 [1-1]	1 [1-3]	<0.001
ICU Admissions, n (%)	292 (7.2%)	758 (36.0%)	<0.001
Median ICU Stay	2 [2-5]	2 [2-3]	0.125
Ventilated, n (%)	124 (3.1%)	250 (11.9%)	<0.001
Median Ventilator Days	3 [2-9]	2 [2-7]	0.01
Overall In-Hospital Mortality, n (%)	105 (1.5%)	68 (3.0%)	<0.001

Table 2. PTC vs ATC Admission and Outcome Characteristics Over Study Period.

To enhance our understanding of care and care process differences between the PTC and ATC, subgroup analysis was performed for the minor and severely injured cohorts of patients. Of the 5619 patients identified with minor injuries, median patient ages remained significantly lower at the PTC [7 years (IQR 4, 11) vs ATC 13 years (IQR 7, 16); $p<0.001$]. No significant differences in median ISS existed [PTC 4 (IQR 2, 4) vs ATC 4 (IQR 1, 50); $p=0.096$]. Distribution of injury mechanisms were similar to the overall group with more blunt injuries at the PTC (93.5%) than the ATC (82.4%) and fewer penetrating injuries at the PTC (4.7%) vs the ATC (11.3%) ($p<0.001$). Admission rates after trauma evaluation were significantly lower at the PTC 3478 (83.2%) vs the ATC 1322 (92.0%) ($p<0.001$), as were the median days of inpatient length of stay for those patients who were admitted [1 days (IQR 1, 1) at the PTC vs 1 day (IQR 1, 2) at the ATC ($p<0.001$)]. Mortality for those with minor injuries did not differ significantly between centers [PTC 0 (0.0%) vs ATC 2 (0.1%); $p=0.102$].

In the most severely injured cohort of 338 patients, other differences were apparent. Severely injured patients presenting to the PTC remained significantly younger with a median age of 3 years (IQR 0,10) vs 14 years (IQR 6, 17) at the ATC ($p<0.001$). A trend existed toward a lower percentage of male patients presenting to the PTC, but this did not reach statistical significance [71 (55.3%) males at the PTC vs 135 (64.6%) at the ATC ($p=0.102$)]. Blunt trauma predominated at the PTC [112 (86.8%) vs 162 (77.5%); $p=0.048$] and the PTC had significantly fewer patients with penetrating trauma [4 (3.1%) PTC vs 24 (11.5%) ATC; $p=0.012$]. Injury severity in this most severely injured cohort was significantly lower at the PTC with a median ISS of 26 (IQR 25, 30) vs the ATC ISS of 30 (IQR 25, 41) ($p<0.001$). Despite the lower injury severity at the PTC, overall mortality was not significantly different between centers [35 (27.3%) PTC vs 64 (30.6%) ATC; $p=0.604$]. Other care characteristics, including admission rate, hospital LOS, ICU admission rate, ICU LOS, mechanical ventilation rate, and length of mechanical ventilation did not demonstrate statistical differences in this cohort.

DISCUSSION

Generalizing the experiences from wartime injuries, by the mid 1960s the need for specialization in the treatment of patients presenting with major injuries was identified, and by 1966 the first

adult trauma centers were established in the United States.⁴ Recognizing the differences in pediatric physiology, the development of pediatric specific trauma programs began in the 1970s and continues today.⁵ As of 2025, the American College of Surgeons list 586 verified trauma centers – 189 Adult Level 1 Centers, 70 Pediatric Level 1 Centers, 215 Adult Level 2 Centers, 58 Pediatric Level 2 Centers, and 135 Adult Level 3 Centers, each meeting the rigorous verifications guidelines established in the ACS Resources for Optimal Care of the Injured Patient.⁶

While studies have long established the utility of transporting severely injured patients to a trauma specific facility, the relative scarcity of pediatric specific trauma centers often leads to pediatric patients being treated in adult trauma centers. A recent meta-analysis identified children (≤ 18 years old) treated at a pediatric trauma center after injury demonstrated lower mortality, lower use of computed tomography imaging, and lower risk of operative management for blunt solid organ injury.³ In this study, these effects did not persist for older adolescents leading the authors to conclude “the advantage of PTCs may not hold for this population.”³ However, the authors were unable to define an optimal age cutoff and noted that the risk of bias in their evaluation was generally high and the certainty of the evidence very low.

Locally, this Adult Level 1 trauma center and the Pediatric Level 2 trauma center are in close geographic proximity – less than 4 miles apart. Decisions on transport facility by pre-hospital care providers are made independently, following local policies and procedures. Decisions regarding destination for inter-facility transfers are made exclusively by the referring facilities. Catchment area for our centers involves a large geographic area including eastern to central Nebraska, as well as parts of western Iowa and Missouri, northern Kansas and southern South Dakota.

As our results describe, significant differences exist in the pediatric population treated at our local PTC and ATC. Patients at the PTC tend to be younger, somewhat less severely injured, less likely to suffer from penetrating trauma, less likely to be admitted, and less likely to require ICU care including mechanical ventilation. When admitted to the ICU and ventilated, ICU LOS is similar, but PTC patients had an overall longer duration of mechanical ventilation. This may be secondary to the nature of the PTC ICU being a closed unit model, managed by non-surgical pediatric intensivists, whereas the surgical ICU of the ATC is overseen by surgeons boarded in critical care. Overall, PTC patients have a shorter length of stay when admitted. For patients identified with only minor injuries, these findings are amplified, suggesting very efficient pediatric care at the PTC.

Our data suggests that the local ATC essentially sees a different population of children and adolescents. Pediatric patients evaluated and treated at the ATC tend to be significantly older and more seriously injured with a significantly higher proportion of penetrating trauma. These patients are more likely to require ICU care, more likely to require mechanical ventilation, and have an overall longer LOS and a higher mortality. However, when examining only the cohort of only severely injured patients, some of these differences dissipate. Most importantly the severely injured patients at the ATC demonstrated similar mortality to the PTC despite significantly higher injury severity, suggesting that the ATC might have better outcomes in this older, more seriously injured cohort.

One important consideration is the methods used to triage, evaluate, and treat pediatric trauma patients at other non-trauma centers. Empirically, multiple triage methods exist when pediatric trauma patients are encountered in the pre-hospital setting depending in part on PTC availability. The authors have observed multiple different

strategies including; all pediatric patients going to a PTC, all pediatric patients being initially evaluated at an ATC with subsequent transfer to a PTC after the initial evaluation and management, all pediatric patients evaluated at an ATC with patients above a certain age threshold (as young as 12) remaining at the ATC for definitive care, PTC vs ATC prehospital transport based on age cutoffs, and PTC vs ATC prehospital transport based on prehospital assessment of injury severity. If a PTC is not locally available, it is highly likely that transport or transfer to an ATC will occur. Given the heterogeneity of transport and admission assessments in use, results of studies comparing PTC vs ATC outcomes may be extremely difficult to interpret.

Our study does have several limitations. As a retrospective review of database information, we are unable to dive into specific detail into patient differences not captured by the database. Furthermore, our analysis can only be as good as the quality of the data. In past reviews, error rates in clinical research databases have been demonstrated to vary widely, and even small errors have the potential to skew results.⁷ Even with data audits and the validation methods which are mandated for institutional trauma databases, one study demonstrated error rates from individual trauma centers to vary between 0.4 – 5.2%.⁸ As this is a study of our local institutions, we cannot account for differences in the local pre-hospital care environment or referring hospital transfer patterns which might account for some of the differences noted and limit the generalizability of our findings. Also, we cannot account for difference in the protocols for evaluation and treatment of pediatric trauma patients at other institutions. Additionally, we recognize the fortunate geographic setup with close proximity of our PTC and ATC facilities, and acknowledge that the unique structure that has allowed us to evaluate pediatric trauma care from a fresh perspective is not available in many other locations. Furthermore, as many parameters of pediatric care hinge on a weight-based approach, future analysis may benefit from identifying a size cutoff for the treatment of pediatric trauma patients at an ATC vs PTC, rather than a specific age.

CONCLUSION

Our results demonstrate significant differences in the patient population and outcomes in pediatric patients presenting to a level 2 pediatric trauma center vs a level 1 adult trauma center without a pediatric specific designation. Based on our findings, patient's presenting with minor severity injuries may receive faster and more efficient care at a pediatric trauma center while older more severely injured patients may benefit from care at an adult trauma center. More research is needed to better define appropriate roles in the care of traumatically injured children.

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Abbreviations: abbreviated injury score, AIS, adult trauma center, ATC, American College of Surgeons, ACS, injury severity score, ISS, intensive care unit, ICU, interquartile range, IQR, length of stay, LOS, pediatric trauma center, PTC.

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