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The use of whole body computed tomography scans in pediatric trauma patients: Are there differences among adults and pediatric centers?☆,☆☆,☆☆☆

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ABSTRACT

Introduction: Whole body CT (WBCT) scan is known to be associated with significant radiation risk especially in pediatric trauma patients. The aim of this study was to assess the use WBCT scan across trauma centers for the management of pediatric trauma patients.

Methods: We performed a two year (2011–2012) retrospective analysis of the National Trauma Data Bank. Pediatric (age ≤ 18 years) trauma patients managed in level I or II adult or pediatric trauma centers with a head, neck, thoracic, or abdominal CT scan were included. WBCT scan was defined as CT scan of the head, neck, thorax, and abdomen. Patients were stratified into two groups: patients managed in adult centers and patients managed in designated pediatric centers. Outcome measure was use of WBCT. Multivariate logistic regression analysis was performed.

Results: A total of 30,667 pediatric trauma patients were included of which; 38.3% (n = 11,748) were managed in designated pediatric centers. 26.1% (n = 8013) patients received a WBCT. The use of WBCT scan was significantly higher in adult trauma centers in comparison to pediatric centers (31.4% vs. 17.6%, p = 0.001). There was no difference in mortality rate between the two groups (2.2% vs. 2.1%, p = 0.37). After adjusting for all confounding factors, pediatric patients managed in adult centers were 1.8 times more likely to receive a WBCT compared to patients managed in pediatric centers (OR [95% CI]: 1.8 [1.3–2.1], p = 0.001).

Conclusions: Variability exists in the use of WBCT scan across trauma centers with no difference in patient outcomes. Pediatric patients managed in adult trauma centers were more likely to be managed with WBCT, increasing their risk for radiation without a difference in outcomes. Establishing guidelines for minimizing the use of WBCT across centers is warranted.

Trauma remains the leading cause of mortality in patients less than 46 years [1]. In an effort to better identify injuries, the use of computed tomography (CT) has been widely accepted as a key element during their initial assessment. CT scans are widely available, provide fast and accurate diagnoses, and serve as a reliable guide for further management. Moreover, physicians often rely on their use while assessing pediatric trauma patients, since physical examination may be an unreliable tool in identifying injuries.

Despite the advantages, the use of CT scan is associated with significant radiation risks [2], especially in the pediatric population [3–8]. Over the last decades, there has been a fivefold increase in the use of CT scans in pediatric patients who present to the emergency departments (ED), with head injury being one of the most frequent indications that prompts CT scan use [9]. Considering the alarming issue of radiation-induced malignancy, a nationwide trend toward limiting the use of CT scans and using alternative-imaging modalities instead has been observed since 2008 [10,11]. In addition, several dose reduction strategies have been developed, as well as algorithms that help identify the subset of patients who would benefit most from advanced imaging use [12–19]. Contrastingly on the other hand, recent evidence has suggested the survival advantage of utilizing whole body CT scan as a diagnostic procedure in trauma patients with severe blunt injury [20–22] and even in hemodynamically unstable patients or those who require emergency bleeding control. However, the use of whole body CT scan in pediatric patients remains unclear.

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Variations in CT scan utilization exist between pediatric and adult trauma centers. Larson et al. observed an increased CT scan use in children who presented to nonpediatric facilities [9]. Similarly, pediatric trauma patients were twice as likely to undergo a CT scan of the cervical spine at level I adult trauma centers compared to those who presented to designated pediatric trauma centers [23]. Finally, children presenting to a level I trauma center were more likely to receive whole body CT (WBCT) compared to their adult peers [24].

The aim of this study was to compare the use of WBCT in pediatric patients among adult and designated pediatric trauma centers by utilizing the National Trauma Data Bank (NTDB).

1. Materials and methods

We performed a two-year (2011–2012) retrospective analysis using the NTDB, version 7.3. The NTDB is the largest aggregation trauma registry data in the United States and contains more than 5 million patient records contributed by more than 900 trauma centers. It is maintained by the American College of Surgeons (Chicago, IL). In this study, we included patients aged less than 18 years, who underwent a head, chest, or abdominal and pelvic computed tomography, and were managed in a level I or level II trauma center. The trauma center designation (level I or level II) was determined based on the American College of Surgeons (ACS) list of verified trauma centers. Patients transferred from other institutions and patients dead on presentation were excluded from our study.

We abstracted the following data points from the NTDB database: demographics (age, gender, race, and ethnicity), vitals on presentation (heart rate, systolic blood pressure, respiratory rate, and temperature), type of injury (blunt and penetrating), mechanism of injury (motor vehicle collision, falls, pedestrian struck, all-terrain vehicle accidents, stab wound, gun shout wound), Glasgow Coma Scale (GCS) score on presentation, intoxication details, CT scan utilization details (head, chest, abdomen and pelvis), ventilation days, hospital and intensive care unit length of stay, and in-hospital mortality. Patient's injury characteristics were abstracted utilizing the Injury Severity Score (ISS) and the Abbreviated Injury Scale (AIS) score. Patients were stratified into two groups based on the center in which they were managed: adult trauma centers (ATC) or designated pediatric trauma centers (PTC).

Our primary outcome measure was WBCT utilization. CT scan utilization was abstracted from the NTDB utilizing the following ICD 9 procedure codes: head CT (87.03, 87.04), thoracic CT (87.41, 87.42) and abdominal CT (88.01). Patients with a combination of a head, chest, and abdominal CT scan were considered to have undergone a WBCT CT scan. WBCT scan use was compared between ATC and PTC. A subanalysis among adult centers was performed to compare for performance of WHCT between adult level I and level II centers. We also compared the head CT, thoracic CT, and abdominal CT utilization individually between ATC and PTC.

Data are reported as mean ± standard deviation (SD) for continuous variables, median [range] for ordinal variables, and as proportions for categorical variables. We performed Mann–Whitney *U* and student *t* test to explore for differences in the two groups (ACT and PTC) for continuous variables, and chi-square test for categorical variables. Univariate analysis was performed to identify factors predicting WBCT use in pediatric patients. Factors with a p value ≤0.2 on univariate analysis were utilized in a multivariate regression analysis. A p value <0.05 was considered statistically significant. All statistical analyses were performed using Statistical Package for Social Sciences (SPSS, Version 21; IBM, Inc., Armonk, NY).

2. Results

A total of 30,667 patients were included in the study of which, 38.3% (n = 11,748) were managed in designated pediatric centers. The mean age was 11.45 ± 6.2 years, 65.5% (n = 20,092) were male, mean systolic blood pressure was 124.9 ± 20.6 mm of Hg, median GCS was 14 [13–15], and median injury severity score was 10 [4–12]. The majority (89.8%, n = 27,541) had blunt injury and motor vehicle crash was the most common mechanism of injury (44.8%, n = 13,741). Table 1 compares the demographics and injury characteristics of the ATC and PTC groups. Patients managed in PTC were younger and more likely to be hypotensive on admission compared to patients managed in ATC. There was no difference in the admission GCS score, mechanism of injury, severity of head, thoracic, or abdominal injury and total injury severity score between patients managed in ATC and PTC.

Table 2 demonstrates the CT scan performance in the study population. Head CT scans were performed in 88.3% (n = 27,069) of the patients, chest CT scans in 33% (n = 10,103), and abdominal CT scans in 49% (n = 15,043) of the patients. A total of 8008 (26.1%) received a WBCT. Patients managed in ATC were more likely to get a whole body CT scan compared to patients managed in PTC (p = 0.001). Table 3 demonstrates a subanalysis of the CT scan performance in level I and level II ATCs. There was no difference in head CT scan rate however level I adult trauma centers perform more thoracic and abdominal CT scans.

Table 4 demonstrates the outcomes among the study population. Mean hospital length of stay was days 3.65 ± 2.5 days and a total of 30.5% (n = 9347) required ICU admission with a mean ICU length of stay of 1.1 ± 1.2 days. 67.7% (n = 20,763) patients were discharged home from the hospital. There was no difference in the hospital and ICU length of stay as well as the discharge disposition among the

Table 1
Patient Characteristic by Group.

Characteristic	Adult Center (n = 18,919)	Pediatric Center (n = 11,748)	p
Demographics			
Age, years (mean ± SD)	12.9 ± 5.8	9.13 ± 6.1	0.01
≤5 years, %	17%	35%	0.01
6–11 years, %	12%	21.4%	0.001
≥12 years, %	71%	43.6%	0.01
Male, %	65.9%	64.9%	0.09
Race			
Whites, %	67.3%	67%	0.58
Blacks, %	14.4%	13.9%	0.23
Hispanics, %	15.3%	16%	0.13
Intoxication, %	8.1%	7.6%	0.15
Vital Parameters			
GCS, Median [Range]	15 [13–15]	15 [13–15]	0.61
GCS ≤ 8, %	8.3%	7.9%	0.1
ED SBP, (mean ± SD)	127.8 ± 20.5	120.4 ± 19.9	0.8
Hypotensive (SBP ≤ 90), %	**3.1%**	**5.9%**	**0.001**
ED HR, (mean ± SD)	102.1 ± 25.8	109.7 ± 29.3	0.7
Tachycardia (HR > 90), %	50.5%	50.1%	0.96
ED RR, (mean ± SD)	20.16 ± 7.8	22.9 ± 9.1	0.61
ED Temperature, (mean ± SD)	36.1 ± 0.3	36.2 ± 0.1	0.82
Injury Parameters			
Blunt	90%	89.5%	0.16
Mechanism of Injury			0.6
MVC, %	45%	44.2%	0.17
Falls, %	17.6%	18%	0.35
Head AIS, Median [IQR]	2 [2–3]	2 [2–3]	0.45
Head AIS ≥ 3, %	34.7%	35.3%	0.28
Thorax AIS, Median [IQR]	1 [1–2]	1 [1–2]	0.71
Thorax AIS ≥ 3, %	18.3%	18.1%	0.65
Abdomen AIS, Median [IQR]	2 [2–3]	2 [2–3]	0.32
Abdomen AIS ≥ 3, %	16.8%	16.4%	0.17
ISS, Median [IQR]	10 [4–13]	9 [4–12]	0.22
ISS ≥ 25, %	9.8%	9.8%	0.79

Table 2
Computed Tomography Scans.

	Adult Center (n = 18,919)	Pediatric Center (n = 11,748)	p
Whole Body CT Scan, %	**31.4%**	**17.6%**	**0.001**
Head CT Scan, %	88%	88.7%	0.09
Thorax CT Scan, %	**39.8%**	**21.9%**	**0.01**
Abdomen CT Scan, %	**53%**	**42.7%**	**0.01**