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Original Contributions

PREDICTORS OF INTRATHORACIC INJURY AFTER BLUNT TORSO TRAUMA IN CHILDREN PRESENTING TO AN EMERGENCY DEPARTMENT AS TRAUMA ACTIVATIONS

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☐ **Abstract—Background: Thoracic injuries are a major cause of death associated with blunt trauma in children. Screening for injury with chest x-ray study, compared with chest computed tomography (CT) scan, has been controversial, weighing the benefits of specificity with the detriment of radiation exposure. Objective: To identify predictors of thoracic injury in children presenting as trauma activations to a Level I trauma center after blunt torso trauma, and to compare these predictors with those previously reported in the literature. Methods: We performed a retrospective chart review of pediatric patients (<18 years of age) who presented to the Emergency Department of a Level I trauma center between June 2010 and June 2013 as a trauma activation after sustaining a blunt torso trauma and who received diagnostic imaging of the chest as part of their initial evaluation. Results: Data analysis was performed on 166 patients. There were 33 patients (20%) with 45 abnormalities detected on diagnostic imaging of the chest, with the most common abnormalities being lung contusion (36%), pneumothorax (22%), and rib fracture (13%). Statistically significant predictors of abnormal diagnostic imaging of the chest included Glasgow Coma Scale score (GCS) < 15 (27% with abnormality vs. 13% without abnormality), hypoxia (22% vs. 5%), syncope/loss of consciousness (55% vs. 35%), cervical spine tenderness (12% vs. 3%), thoraco-lumbar-sacral spine tenderness (41% vs. 17%), and abdominal/pelvic tenderness (12% vs. 3%). Conclusions: Based on our data, predictors of thoracic injury in children after blunt torso trauma include GCS < 15, hypoxia, syncope/dizziness, cervical spine tenderness, thoraco-lumbar-sacral spine tenderness, and abdominal/pelvic tenderness.**

☐ **Keywords—trauma; blunt; torso; chest; thoracic; imaging; chest x-ray; CT scan**

INTRODUCTION

Thoracic injuries are second only to head injuries as the cause of death associated with blunt trauma in children (1). The addition of thoracic injury in a child who sustains multisystem trauma increases the mortality 20-fold (2). However, the incidence of thoracic injury in children is unclear, with some authors citing 0–13% (3,4).

Chest radiographs are rather inexpensive first-line diagnostic tests that have relatively low exposure to radiation, whereas chest computed tomography (CT) scans are more costly, with 100–500 times more radiation exposure. Published studies have shown that chest radiographs are sufficient to detect thoracic injury associated with blunt trauma, and that chest CT scans should be reserved for abnormal initial imaging, concerning physical examinations, or high-risk mechanisms of injury (3,5–10). Furthermore, abnormal findings detected on chest CT scans rarely led to changes in the acute

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management of the injured child, other than closer or prolonged observation periods (8,9).

In an effort to decrease the cost and the exposure to radiation in children who sustain blunt thoracic trauma, several studies have been published delineating specific predictors of thoracic injury (3,11). In a prospective study, Holmes et al. found that predictors of thoracic injury included low systolic blood pressure, elevated respiratory rate, abnormal thoracic physical examination findings, abnormal chest auscultation findings, femur fracture, and a Glasgow Coma Scale score (GCS) < 15 (3). In a retrospective study, Gittelman et al. found that abnormal age-appropriate respiratory rate, chest wall tenderness, and back abrasions were associated with abnormal chest radiographs (11). Due to the lack of consensus associated with these publications, we conducted a study at our institution with the objective of 1) identifying predictors of thoracic injury in children presenting as trauma activations after blunt torso trauma and 2) comparing these predictors to those previously reported in the literature.

MATERIALS AND METHODS

We performed a retrospective chart review of pediatric patients, aged 2 to 18 years of age, who presented to a emergency department (ED) of a Level I trauma center between June 2011 and June 2013 as a trauma activation after sustaining a blunt torso trauma and who received diagnostic imaging of the chest (chest radiograph or CT scan) as part of their initial evaluation. Patients who were designated Level I trauma activations or who were transferred to our facility after initial evaluation at an outside ED were excluded (12). Patients who were younger than 2 years of age were excluded due to the difficulties associated with their initial assessment and to the conservative nature of most trauma surgeons to order diagnostic imaging. Abstracted data from electronic medical records (including electronically generated pediatric trauma surgery and nursing documentation, scanned nursing trauma flow sheet, radiology reports, and daily electronic progress notes) of identified patients were collected and analyzed. The specific data points included demographics (age, sex, mechanism of injury), review of systems (syncope/loss of consciousness, chest pain, shortness of breath, cough, abdominal pain), physical examination findings (initial vital signs, altered mental status [defined as Glasgow Coma Score < 15], cervical spine abnormalities [defined as tenderness, ecchymosis, crepitus, malalignment, or step-off], thoraco-lumbar-sacral spine abnormalities, abnormal breath sounds [decreased or absent, or presence of crackles/rales/wheezes on auscultation], thoracic crepitus, thoracic ecchymosis, "seat belt sign," abdominal ecchymosis, abdominal/pelvic tenderness, extremity injury with deformity), and hospital course (acute interventions in the ED, final radiology attending reports, disposition, length of hospitalization).

The Penn State Hershey Medical Center is a Level I pediatric trauma center, located in a rural setting, serving an immediate population of approximately 65,000 people and a large catchment area of central Pennsylvania, and caring for approximately 2600 activated traumas per year, of which 650 are pediatric patients.

Mechanism of injury was defined as either motor vehicle collision (where patient was a passenger), high-risk fall (defined as ≥ 3 feet), low-risk fall (defined as fall from standing or < 3 feet), and other (injuries that did not fit into any of the above-mentioned categories). Review of systems data points were considered "positive" only if they were documented specifically in the electronic medical records. Abnormal vital signs (heart rate, systolic blood pressure, respiratory rate, and pulse oximetry) were those outside the normal range based on age (13). Physical examination findings were considered "positive" or "present" only if they were documented in the electronic medical records; we considered a lack of documentation as a "negative" or "absent" finding.

The results of the pelvic examination were considered abnormal if erythema, abrasions, contusions, lacerations, or tenderness were identified in the area of the pelvis. Obvious concomitant fractures were noted if the physician documented open fracture or visible bone deformity that was related to the traumatic incident.

Data entry and analysis was performed using the Resource Electronic Data Capture system (REDCap; Vanderbilt University, Nashville, TN). All variables were summarized with frequencies and percentages for categorical variables or with means, medians, and standard deviations for continuous variables. Binomial logistic regression was used to make bivariate comparisons to search for significant associations between the dependent variable, abnormal chest radiograph or CT scan, and independent variables and covariates. Odds ratios with 95% confidence limits were used to quantify the magnitude and direction of any significant associations. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC). The Institutional Review Board at Penn State Hershey Medical Center approved the study as expedited status.

RESULTS

During the study period, 543 pediatric trauma activations presented to the Penn State Hershey Medical Center ED. A total of 370 patients were excluded (246 patients were transferred from another institution, 99 patients were < 2 years of age, 46 patients were considered a Level I trauma activation, 25 patients did not receive chest