Identifying Children at Very Low Risk for Blunt Intra-Abdominal Injury in Whom CT of the Abdomen Can Be Avoided Safely

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BACKGROUND: Computed tomography is commonly used to rule out intra-abdominal injury (IAI) in children, despite associated cost and radiation exposure. Our purpose was to derive a prediction rule to identify children at very low risk for IAI after blunt abdominal trauma (BAT) for whom a CT scan of the abdomen would be unnecessary.

STUDY DESIGN: We prospectively enrolled children younger than 16 years of age who presented after BAT at 14 Level I pediatric trauma centers during 1 year. We excluded patients who presented more than 6 hours after injury or underwent abdominal CT before transfer. We used binary recursive partitioning to derive a prediction rule identifying children at very low risk of IAI and IAI requiring acute intervention (IAI-I) using clinical information available in the trauma bay.

RESULTS: We included 2,188 children with a median age of 8 years. There were 261 patients with IAI (11.9%) and 62 patients with IAI-I (2.8%). The prediction rule consisted of (in descending order of significance): aspartate aminotransferase >200 U/L, abnormal abdominal examination, abnormal chest x-ray, report of abdominal pain, and abnormal pancreatic enzymes. The rule had a negative predictive value of 99.4% for IAI and 100.0% for IAI-I in patients with none of the prediction rule variables present. The very-low-risk population consisted of 34% of the patients and 23% received a CT scan. Computed tomography frequency ranged from 4% to 96% by center.

CONCLUSIONS: A prediction rule using history and physical examination, chest x-ray, and laboratory evaluation at the time of presentation after BAT identifies children at very low risk for IAI for whom CT can be avoided. (J Am Coll Surg 2017;224:449–460. © 2017 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

Unintentional injury is the leading cause of mortality in children older than age 1 year and more than 90% of injuries after blunt mechanism.[1] Computed tomography is currently the gold standard for the evaluation of suspected intra-abdominal injury (IAI) after blunt abdominal trauma (BAT) in adults.[2] The vast majority of injured children present to adult trauma centers and more than half of children undergo a CT scan as part of their trauma evaluation.[3,4] Use of CT has increased dramatically in the past 20 years and it is now estimated that CT of the

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Abbreviations and Acronyms

AST = aspartate aminotransferase
BAT = blunt abdominal trauma
BP = blood pressure
ED = emergency department
IAI = intra-abdominal injury
IAI-I = intra-abdominal injury receiving acute intervention
PECARN = Pediatric Emergency Care Applied Research Network

abdomen and pelvis is performed in children at a rate >9 per 1,000 individuals in the US each year.[5-7] Potentially fueling additional increases in abdominal CT use in children are 2 recent studies that have suggested than "pan" CT is superior to selective CT in adults after blunt trauma.[8,9]

Although CT provides important information that can be used to make management decisions in patients with IAI, the modality has important drawbacks in children. Pediatric patients, particularly those that receive CT scans based on adult protocols, are exposed to relatively large doses of radiation, placing them at potential risk for future radiation-induced malignancy.[10-14] Along with the concept of "gentle imaging" protocols, strategies to reduce use of abdominal CT when there is very low risk for IAI are important to improve the care of pediatric patients.

Several retrospective reviews have suggested that a combination of clinical variables available in the trauma bay, including plain films and laboratory values, might be used to risk stratify children for IAI.[15-20] A recent prediction rule developed by the Pediatric Emergency Care Applied Research Network (PECARN) used history and physical examination alone to identify children at very low risk of IAI requiring acute interventions (IAI-I) like blood transfusion, surgery or angiographic embolization.[21] Although the rule has an excellent negative predictive value for IAI-I, it fails to identify a number of clinically important IAIs and did not include laboratory testing, plain films, or abdominal ultrasound, clinical variables readily available in the trauma bay, which might prove beneficial in evaluating for all IAIs.

Our purpose was to derive a clinical prediction rule using data available in the trauma bay to identify children at very low risk for IAI after BAT for whom a CT scan of the abdomen would be unnecessary.

METHODS

We conducted a prospective, observational study of children with BAT within the Pediatric Surgery Research Collaborative. Institutional Review Board approval was obtained at all participating sites before study enrollment. Children younger than 16 years of age with BAT were evaluated at 14 Level I pediatric trauma centers across the US during a 1-year period that concluded in July 2015. Patients were included who presented after blunt mechanism of injury to the torso as a trauma activation (highest 2 tiers) or as a consult to the trauma service for abdominal pain. Patients were excluded if they presented more than 6 hours after injury, had earlier abdominal CT imaging, or had a mechanism with isolated force to the head or extremity.

Data were initially collected in the trauma bay and a second follow-up form was completed within 30 days of discharge. The trauma bay data collection included demographic data (age, race, mechanism of injury), level of trauma activation (I, II, or consult), initial emergency department (ED) vital signs (systolic blood pressure [BP], heart rate, and Glasgow Coma Scale), subjective information (report of abdominal pain, history of emesis, need for intubation), pertinent abdominal and thoracic physical examination findings, presence of femur fracture or pelvic instability on physical examination, laboratory data (hematocrit, base deficit, aspartate aminotransferase [AST], amylase, lipase), chest x-ray and pelvic x-ray findings, findings from the focused assessment with sonography for trauma, abdominal CT timing, and disposition from the trauma bay. Trauma activation criteria were not standardized between centers and activation level was at the discretion of the receiving institution. Abdominal CT scans were performed at the discretion of the treating physician team and the final interpretation of the CT scan was by the site's attending radiologist. Follow-up data were obtained by reviewing the medical record and the trauma registry. The follow-up data included additional laboratory studies drawn after disposition from the trauma bay but within 4 hours of arrival, abdominal CT findings, interventions for IAI (angiographic embolization, laparoscopy, laparotomy, transfusion), intraoperative data related to organ injury and treatment, other injuries (traumatic brain injury, skull fracture, facial fracture, spine injury, thoracic injury, or rib, clavicle, pelvic, femur, or extremity fracture), length of stay, Injury Severity Score, delay in diagnosis, and mortality. Patient data were entered by each site into a central REDCap (Research Electronic Data Capture) database in a de-identified fashion.

The primary purpose of the study was to develop a clinical prediction model to determine which patients were at very low risk for IAI after BAT. The primary end point was any IAI. Intra-abdominal injury was defined as any injury apparent on abdominal CT scan or identified in surgery to one of the following: spleen, liver, kidney, mesentery,