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Implementation of clinical effectiveness guidelines for solid organ injury after trauma: 10-year experience at a level 1 pediatric trauma center☆

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ABSTRACT

Background: Diagnostic imaging of pediatric blunt abdominal trauma is evolving in light of increased attention to radiation exposure. We hypothesize that the implementation of imaging guidelines has reduced total CT scans without missing clinically significant injury.
Methods: We retrospectively reviewed blunt trauma patients age 0–17 with solid organ injury who underwent CT scan at our academic level 1 pediatric trauma center between 2005 and 2014. Variables including total annual trauma admissions and CT scans, demographics, injury characteristics, and procedures were recorded. Descriptive statistics, Fisher exact and rank sum testing were performed. $p < 0.05$ defined significance.
Results: Overall percentage of abdominal CT scans decreased significantly after protocol implementation. There were 498 solid organ injuries in 403 subjects. There was a significant decrease in the median percentage of low grade injuries (1.3% versus 0.6%; $p = 0.019$) but no difference in high grade injuries (1.3% versus 1.1%; $p = 0.394$). No patient had death, readmission or delayed diagnosis of injury requiring intervention.
Conclusion: Implementation of imaging guidelines for blunt abdominal trauma decreased the incidence of low grade solid organ injuries at our institution, but did not inhibit diagnosis and safe management of high grade injuries. Selective imaging of trauma patients decreases childhood radiation exposure and does not result in delayed bleeding or death.
Level of evidence: Level III, retrospective study.

Trauma is the leading cause of morbidity and mortality in children and young adults [1,2]. Blunt trauma is the most common mechanism, with motor vehicle collisions and falls representing the most frequent causes of injury. Much work has been done to date in determining the optimal diagnostic and management strategies for injured children after blunt abdominal trauma, driven by a desire to provide quality care and reduce radiation exposure in this vulnerable population. Concerns over radiation exposure are substantiated by data on the attributable risk of future malignancies: one radiation-induced solid cancer is projected to result from every 300 to 700 abdomen/pelvis scans [3–5]. Lifetime attributable risks of solid cancer are highest for those who undergo CT scans of the abdomen/pelvis and for young patients, who have heightened tissue radiosensitivity and many future life years in which cancer may develop.

Several groups have published on the physical exam findings, symptoms, laboratory testing and other factors that predict solid organ injury in order to develop sensitive and specific clinical practice guidelines [6–11]. These efforts and those of other working groups shaped the development of the clinical screening guidelines at our institution. While most centers have adopted a similar protocol with the goals of reducing radiation exposure, there is no data regarding the impact of implementing these guidelines.

1. Methods

We performed a 10 year retrospective review of subjects admitted to our single academic pediatric trauma center between January 1, 2005-December 31, 2014. We queried our institutional trauma database for all pediatric patients who were diagnosed with solid organ injury of the liver, kidney, or spleen after blunt trauma mechanism. Subjects were excluded if transfer from another hospital with diagnosis of solid organ injury based on CT scan from that location, as this study focuses on the impact of imaging guidelines on decision making in our institution. Subjects were also excluded if mechanism was penetrating trauma, or diagnosis of solid organ injury was made at the time of trauma

☆ Conflicts of interest: None.
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laparotomy and no imaging was obtained. The remaining cohort was included in the final analysis.

Solid organ injuries are graded based on AAST comprehensive scaling system [12], where each individual organ is graded according to the magnitude of anatomic disruption: 1 (minimal), 2 (mild), 3 (moderate), 4 (severe), 5 (massive), and 6 (lethal). Our institutional trauma registry is prospectively maintained by a designated trauma registrar and trained data abstractors. These abstractors record an injury grade based on radiologist report. Subjects were divided into high grade (any organ grade ≥3) or low grade (all organs grade ≤2) subgroups.

Time period was categorized as pre (2005–2010) and post (2011–2014) implementation of screening guidelines. Our evidence-based solid organ injury guidelines were determined by expert consensus based on the best available literature at the time [7,9,13–15] (Fig. 1). An abdominal exam and FAST (Focused Assessment with Sonography in Trauma) are performed as part of the secondary survey on all trauma activations [14,16,17]. Trauma activations are run by both Surgery and Emergency Department personnel in our institution. Those with peritonitis proceed to the operating room without imaging ($n = 8$); those with shock but no peritonitis undergo initial resuscitation, and if no improvement proceed to the operating room ($n = 12$). If hemodynamics improves, they become candidates for additional imaging. Hemodynamically normal patients at the time of arrival should be considered for additional abdominal imaging under any one of the following circumstances: evidence of abdominal wall trauma (e.g. seatbelt sign), GCS <13 and concern for abdominal injury, presence of abdominal wall tenderness, complaints of abdominal pain or vomiting, positive FAST exam, evidence of thoracic wall trauma, decreased breath sounds, or laboratory abnormalities (ALT/AST > 200, amylase/lipase >100, hematuria or 100 + red blood cells on urinalysis). At our institution, standard of care is a CT scan of the abdomen and pelvis with IV contrast, plus oral contrast if hollow viscus injury is also suspected. If solid organ injury is identified, patients are admitted to appropriate level of care depending on concomitant injuries. Standard of care includes serial exams, NPO, bedrest, and Hematocrit checks q8h until one (grade1–2) or three (grade 3–5) serial labs is stable; patients are then discharged when pain controlled and tolerating a regular diet. Patients with no pain, minor mechanism, negative FAST and normal labs do not undergo imaging and undergo a trial of oral intake in the ED versus admission for observation depending on their clinical condition.

Variables of interest including basic demographics, trauma level, injury grade, injury mechanism, imaging and procedures were recorded. Trauma level is based on multiple factors, including patient hemodynamics, injury mechanism, presence of specific injuries and provider discretion; activations include level 1 (e.g. intubated, respiratory compromise, neurologic deficit, shock, penetrating injury, spinal cord injury), level 2 (mechanisms without instability, e.g. MVC, pedestrian struck, fall from height) and level 3 (e.g. other injury with patent airway, breathing normally, hemodynamic stability, GCS = 15). Hypotension and tachycardia were calculated using age-adjusted criteria [18]. Hypothermia was defined as admission temperature ≤ 35 °C [19]. An age-adjusted pediatric shock index, which has been validated in blunt solid organ injury, was applied [20]. Interventions including blood transfusion and operative intervention were recorded. Other outcomes

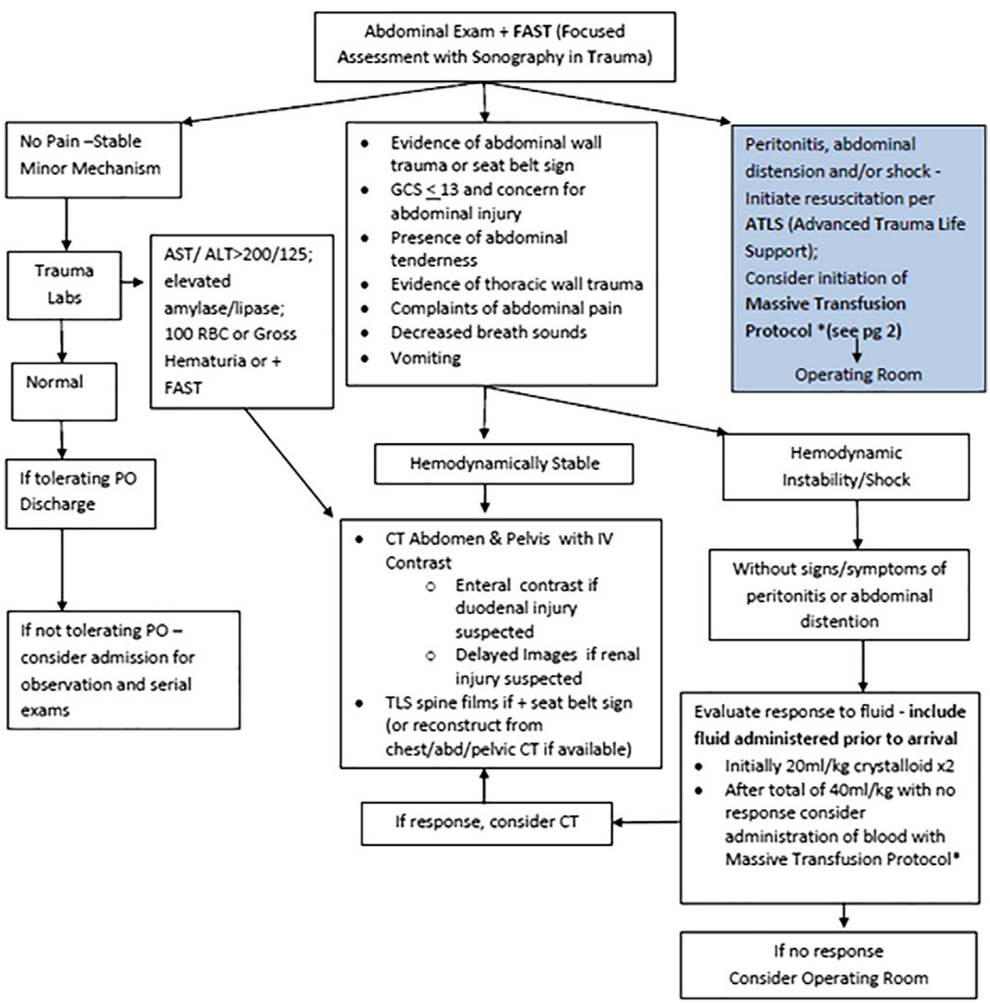

Fig. 1. Clinical Effectiveness Guideline for the imaging and management of pediatric patients with blunt torso trauma.