Accuracy of the Abdominal Examination for Identifying Children with Blunt Intra-Abdominal Injuries

Kathleen M. Adelgais, MD, MPH[1,2], Nathan Kuppermann, MD, MPH[3,4], Joshua Kooistra, DO[5], Madelyn Garcia, MD, MPH[6], David J. Monroe, MD[7], Prashant Mahajan, MD, MPH[8], Jay Menaker, MD[9], Peter Ehrlich, MD[10], Shireen Atabaki, MD, MPH[11], Kent Page, MStat[2], Maria Kwok, MD[12], and James F. Holmes, MD, MPH[3], on behalf of the Intra-Abdominal Injury Study Group of the Pediatric Emergency Care Applied Research Network (PECARN)*

Objective To determine the accuracy of complaints of abdominal pain and findings of abdominal tenderness for identifying children with intra-abdominal injury (IAI) stratified by Glasgow Coma Scale (GCS) score.

Study design This was a prospective, multicenter observational study of children with blunt torso trauma and a GCS score ≥13. We calculated the sensitivity of abdominal findings for IAI with 95% CI stratified by GCS score. We examined the association of isolated abdominal pain or tenderness with IAI and that undergoing acute intervention (therapeutic laparotomy, angiographic embolization, blood transfusion, or ≥2 nights of intravenous fluid therapy).

Results Among the 12 044 patients evaluated, 11 277 (94%) had a GCS score of ≥13 and were included in this analysis. Sensitivity of abdominal pain for IAI was 79% (95% CI, 76%-83%) for patients with a GCS score of 15, 51% (95% CI, 37%-65%) for patients with a GCS score of 14, and 32% (95% CI, 14%-55%) for patients with a GCS score of 13. Sensitivity of abdominal tenderness for IAI also decreased with decreasing GCS score: 79% (95% CI, 75%-82%) for a GCS score of 15, 57% (95% CI, 42%-70%) for a GCS score of 14, and 37% (95% CI, 19%-58%) for a GCS score of 13. Among patients with isolated abdominal pain and/or tenderness, the rate of IAI was 8% (95% CI, 6%-9%) and the rate of IAI undergoing acute intervention was 1% (95% CI, 1%-2%).

Conclusion The sensitivity of abdominal findings for IAI decreases as GCS score decreases. Although abdominal computed tomography is not mandatory, the risk of IAI is sufficiently high that diagnostic evaluation is warranted in children with isolated abdominal pain or tenderness. *(J Pediatr 2014;165:1230-35)*.

Trauma is the leading cause of death and disability in children, and torso trauma is the second most frequent cause of death among children, after head injury.[1] For this reason, identifying children with intra-abdominal injury (IAI) after blunt torso trauma is critical, and clinical prediction rules for identifying children at high risk and low risk for IAI are useful. Overuse of abdominal computed tomography (CT) scans in injured children also caries risk of radiation-induced malignancy, however.[2]

Determining the need for CT often relies on patient history and physical examination findings. The exact characteristics of certain elements of the abdominal examination, such as location of tenderness and degree of pain, are not well understood, particularly in children with varying degrees of alertness from blunt head trauma or other causes.[3,4]

The use of abdominal CT to screen patients for IAI has increased substantially over the last 15 years.[5-8] Because children have a higher lifetime risk for radiation-induced malignancy compared with adults, the indiscriminate use of CT scanning should be avoided.

To date, several small single-center studies have provided estimates of the risk of IAI based on certain abdominal findings.[9-12] These studies are of limited precision because of small sample sizes, however, and cannot provide reliable risk estimates for children with minor head trauma and those with varying Glasgow Coma Scale (GCS) scores.

CT	Computed tomography
ED	Emergency department
GCS	Glasgow Coma Scale
IAI	Intra-abdominal injury
IAI^{AI}	Intra-abdominal injury undergoing acute intervention
PECARN	Pediatric Emergency Care Applied Research Network

From the [1]Department of Pediatrics, University of Colorado Denver, Aurora, CO; [2]Department of Pediatrics, University of Utah, Salt Lake City, UT; Departments of [3]Emergency Medicine and [4]Pediatrics, University of California Davis School of Medicine, Sacramento, CA; [5]Department of Emergency Medicine, Helen DeVos Children's Hospital, Grand Rapids, MI; [6]Department of Emergency Medicine, University of Rochester, Rochester, NY; [7]Department of Pediatrics, Howard County Hospital, Columbia, MD; [8]Department of Pediatrics, Children's Hospital of Michigan, Detroit, MI; [9]Department of Surgery, University of Maryland, Baltimore, MD; [10]Department of Surgery, University of Michigan, Ann Arbor, MI; [11]Department of Emergency Medicine, Children's National Medical Center, Washington, DC; and [12]Department of Pediatrics, Columbia University Medical Center, New York, NY

*A list of members of the Intra-Abdominal Injury Study Group of PECARN is available at www.jpeds.com (**Appendix**).

Supported by the Centers for Disease Control and Injury Prevention (1 R49CE00100201). PECARN is supported by the Health Resources and Services Administration, Maternal and Child Health Bureau, Emergency Medical Services for Children Program (U03MC00001, U03MC00003, U03MC00006, U03MC00007, U03MC00008, U03MC22684, and U03MC22685). The authors declare no conflicts of interest.

Portions of this study were presented at the Pediatric Academic Societies annual meeting, Washington, DC, May 4-7, 2013 and the Society for Academic Emergency Medicine Annual Meeting, Atlanta, GA, May 15-18, 2013.

http://dx.doi.org/10.1016/j.jpeds.2014.08.014

Recently, the Pediatric Emergency Care Applied Research Network (PECARN) derived a clinical prediction rule for children with blunt torso trauma to identify those at low and high risk for IAI.[13] This prediction rule includes complaints of abdominal pain and the presence of abdominal tenderness as variables putting children at risk for IAI.[13] The importance of these variables and how clinicians should treat patients when these variables are present have not been fully described, however.

The main objective of the present study was to determine the accuracy of patient history of abdominal pain and initial abdominal tenderness on examination for diagnosing either IAI or IAI undergoing acute intervention (IAI^{AI}). We also sought to determine the accuracy of these variables with increasing severity of abdominal findings, with the presence of minor head trauma and varying GCS scores, and in those patients with isolated abdominal pain and/or tenderness (ie, without other variables in the PECARN IAI prediction rule). We hypothesized that the sensitivity of abdominal findings for IAI increases with severity of findings and decreases with declining GCS score. Finally, we suspected that the risk of IAI with isolated abdominal findings would be low but nonnegligible, such that further diagnostic evaluation generally would be indicated.

Methods

This was a planned secondary analysis of a large, multicenter, prospective, observational study conducted between May 2008 and January 2010 in 20 PECARN centers. Details of the study design are described elsewhere.[13] The Institutional Review Boards of each participating institution approved the study at all sites. Details of methods specific to the current secondary analysis are provided below.

Patients aged <18 years were eligible for the parent study if they had sustained blunt torso trauma within 24 hours of emergency department (ED) evaluation. Patients were excluded for the following reasons: penetrating trauma, preexisting neurologic disorder preventing reliable examination, known pregnancy, or transfer from another hospital after a previous abdominal CT scan and/or diagnostic peritoneal lavage. In addition, patients with an initial GCS score of <13 were excluded from the present analysis.

Patient history and physical examination findings were documented on a standardized data collection form by the treating physician before laboratory tests or radiographic evaluation (if performed). Patients aged ≥2 years were asked about the presence/absence of abdominal pain. If pain was reported, then the patient was further questioned about the degree of pain, as mild (pain score 1-3), moderate (pain score 4-6), or severe (pain score 7-10), using the pain scale in place at each institution. If the degree of pain could not be determined, then the clinician graded pain severity as unknown. The location of abdominal pain was categorized as diffuse, localized, or unknown.

Clinicians determined the presence, location, and degree of abdominal tenderness on physical examination. The severity of tenderness, if present, was quantified as mild (1-3), moderate (4-6), or severe (7-10). If the degree of tenderness could not be determined, then clinicians graded the tenderness as of unknown severity. The location of abdominal tenderness was categorized as diffuse, above the umbilicus, below the umbilicus, periumbilical, or unknown. Patients were examined for peritoneal irritation, which was defined as rebound or cough tenderness. In addition, the abdomen was examined for distention and the presence or absence of bowel sounds. Finally, results of the rectal examination, if performed, were documented. A rectal examination was categorized as positive for blood if gross blood was present or if the stool was hemoccult-positive.

The decision to obtain an abdominal CT scan was made by the treating physician, not by the study protocol. In approximately 5% of patients, a second examiner independently completed a separate standardized data collection form,[14] blinded to and within 60 minutes of that of the first clinician, to determine the interrater reliability for the foregoing abdominal findings.

Outcome Measures

The primary outcome measure was IAI, defined as any injury to the spleen, liver, urinary tract (from the kidney to the urinary bladder), gastrointestinal tract (including the bowel or associated mesentery from the stomach to the sigmoid colon), pancreas, gallbladder, adrenal gland, intra-abdominal vascular structure, or traumatic fascial defect. The secondary outcome measure was IAI^{AI}, defined as death attributed to the IAI, a therapeutic intervention at laparotomy, angiographic embolization owing to bleeding from the IAI, blood transfusion for anemia secondary to abdominal hemorrhage, or administration of intravenous fluids for at least 2 nights in patients with pancreatic or gastrointestinal injuries.

Data Analyses

For the complaint of abdominal pain, as well as the presence and degree of abdominal tenderness on examination, we calculated the sensitivity and relative risk with 95% CIs for the analyses of IAI and IAI^{AI}, stratified by GCS score. We compared the proportion of patients with additional abdominal examination findings, including abdominal distention, absence of bowel sounds, peritoneal irritation, and blood on rectal examination for their association with IAI. We analyzed the clinical importance of "isolated" abdominal pain and/or tenderness (ie, presence of 1 or both of these variables without any of the other variables in the PECARN IAI prediction rule) for the presence of both IAI and IAI^{AI}. The prediction rule variables, in the order of appearance in the prediction tree, include evidence of abdominal wall trauma or "seat belt" sign, GCS score <14, abdominal tenderness, evidence of thoracic wall trauma, complaints of abdominal pain, decreased breath sounds, and history of vomiting after the injury. We also examined the types of IAIs sustained among patients with isolated abdominal pain and/or tenderness.

Finally, we calculated the aORs for IAI and IAI^{AI} for increasing severity of abdominal pain (by history) and