HHS Public Access
Author manuscript
Ann Emerg Med. Author manuscript; available in PMC 2026 September 17.

Published in final edited form as:
Ann Emerg Med. 2026 August ; 88(2): 123–131. doi:10.1016/j.annemergmed.2026.02.012.

Emergency Department Observation and Computed Tomography Use in Children with Blunt Abdominal Trauma

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Abstract

Objective: We evaluated the association of observation with computed tomography (CT) use in children with blunt abdominal trauma (BAT).

Author Contributions:
PI, JFH and NK conceived the study. JFH and NK obtained research funding. JFH and NK supervised the conduct of this study and data collection. PI, NSA, KY, ITU, MB, PPC, KAM, NK, and JFH supervised patient recruitment and data collection at participating sites. JSU, DJT and JFH provided analyzed the data. PI drafted the manuscript, and all authors contributed substantially to its revision. PI takes responsibility for the paper as a whole.

Conflict of Interest Disclosures
The authors have no conflicts of interest relevant to this article to disclose.

Meetings:
Abstract presented at Society for Academic Emergency Medicine Annual Meeting, New Orleans, LA, May 2022; and the American Academy of Pediatrics National Conference and Exhibition, Anaheim, CA, October 2022.

Methods: We performed a secondary analysis of a prospective multicenter cohort study of children with BAT. Providers documented Pediatric Emergency Care Applied Research Network (PECARN) abdominal trauma rule variables and whether a period of observation with deferred CT decision-making was performed. Intraabdominal injury undergoing acute intervention (IAIai) was defined as intraabdominal injury (IAI) resulting in surgery, angiography, blood transfusion, or death. We used multivariable logistic regression to examine the association between observation status and CT use, adjusting for age, study site, clinician suspicion of IAI, and PECARN variables.

Results: Among 7,442 children with documented observation status, 2,024 (27.2%, 95% CI 26.2, 28.2%) underwent observation. CT use was less frequent among observed patients 414/2,024 (20.5%) than those not observed 2,011/5,418 (37.1%; difference 16.7%, 95% CI 14.5, 18.8%). IAIai occurred in 8/2,024 (0.4%) of observed versus 137/5,418 (2.5%) of not observed patients (difference 2.1%, 95% CI 1.6, 2.6%). Observation was associated with lower CT use when clinician suspicion of IAI was 1–5% (Odds Ratio [OR] = 0.31, 95% CI 0.25, 0.39), 6–10% (OR = 0.15, 95% CI 0.10, 0.23) and 11–50% (OR = 0.18, 95% CI 0.08, 0.39). 1,610 (79.5%) observed patients were discharged without CT, and none (0%, 95% CI 0, 0.3%) had IAIai.

Conclusions: Observation with deferred CT decision-making was associated with less frequent CT use, particularly in patients with intermediate clinician suspicion, without an increase in missed injuries.

INTRODUCTION

Trauma is a common presentation in children evaluated in the emergency department (ED), accounting for nearly 8 million ED visits in the United States in 2023.[1] Blunt abdominal trauma (BAT) represents a substantial proportion of pediatric trauma patients. Most children sustaining BAT, however, do not have clinically important injuries, and only a small percentage of children with BAT undergo acute intervention.[2]

Computed tomography (CT) is the reference standard for diagnosing intraabdominal injury (IAI) in children who have sustained BAT.[3,4] For some children presenting to the ED, the management plan is straightforward. An asymptomatic, well-appearing patient with a trivial mechanism of injury and a normal abdominal examination is unlikely to require CT imaging. In contrast, an unresponsive child with multisystem trauma and visible abdominal trauma requires a CT or emergent surgical management. A substantial proportion of children, however, fall into an intermediate risk category for whom the decision to obtain (or not obtain) a CT scan is not immediately clear. For these patients, a period of observation may provide additional information prior to CT decision-making.

Importance

While CT is highly accurate in identifying children with IAIs after BAT, this diagnostic modality has several disadvantages. CT imaging requires exposure to ionizing radiation, and this exposure increases the risk of developing malignancies.[5,6] Some children, especially younger children, require pharmacological sedation to tolerate CT imaging. In addition, CT scans frequently detect incidental findings which are infrequently of clinical significance;[7] however, further investigation of these findings requires additional resource use and causes additional stress for patients and their families.[8]

Clinical prediction rules can assist with CT decision-making. A clinical prediction rule developed by a group of investigators in the Pediatric Emergency Care Applied Research Network (PECARN) was recently validated by our group[2,9] and consists of abdominal pain, vomiting, Glasgow Coma Scale score <14, absent/decreased breath sounds, thoracic wall trauma, abdominal wall trauma, and abdominal tenderness. Absence of all these variables identifies patients at very low risk for IAI undergoing acute intervention (IAIai) for whom CT scans can be safely deferred. Many of those who are positive for the rule, however, do not require abdominal CT imaging, and a period of observation may inform imaging decision-making.

Goals of this Investigation

Previous studies in children with blunt head trauma have demonstrated an association between observation before CT decision-making and lower CT scan use without an increase in missed injuries.[10–13] Similar studies investigating the utility of observation in BAT in children, however, have not been conducted. We sought to determine how frequently ED observation prior to the decision to obtain or not obtain abdominal CT is used in children with BAT. We also sought to determine if a period of ED observation is associated with abdominal CT use. We hypothesized that ED observation is commonly performed in children with BAT, and that a period of observation in the ED before CT decision-making is associated with less frequent abdominal CT utilization.

METHODS

Study Design and Setting

We performed a planned secondary analysis of a large, prospective multicenter cohort study conducted at six level-1 pediatric trauma center EDs between December 2016 and September 2021. Eligible patients were those younger than 18 years presenting with BAT. The parent study sought to validate the PECARN prediction rules for head and abdominal injuries. In the parent study, eligible children presenting with BAT or minor blunt head trauma were enrolled using inclusion and exclusion criteria identical to the original PECARN trauma rule derivation studies.[2,14] Clinicians prospectively documented whether the relevant PECARN prediction rule was positive or negative before CT results were known (if CT was obtained), using standardized case report forms. CT imaging was obtained at clinician discretion. Primary outcome of the parent study was IAI undergoing acute intervention (IAIai), determined through imaging review, record abstraction, and structured follow-up of patients discharged from the ED without CT being obtained.[9]

The parent study was approved by the institutional review boards of each study site. The full study protocol has been previously published,[15] and the current subanalysis follows the Strengthening the Reporting of Observational Studies (STROBE) guidelines.

Enrolling clinicians (including emergency medicine, pediatric emergency medicine, and trauma surgery faculty or fellows and advanced practice providers) at all participating study sites underwent standardized training and completed case report forms on all enrolled patients. These forms included demographic information and clinical findings including the presence or absence of the PECARN IAI prediction rule variables as well as the clinician's suspicion of IAI categorized as <1%, 1–5%, 6–10%, 11–50% and > 50%. The PECARN IAI rule variables were written on the case report form, and the clinicians were aware that the parent study was a validation study of the PECARN rule. However, the use of the rule was not mandated, allowing for clinician discretion consistent with real-world practice. Treating clinicians were instructed to complete the case report form prospectively during the ED encounter and were specifically asked whether a period of observation was intentionally chosen before deciding whether to obtain an abdominal CT. Patients whom clinicians chose to observe before CT decision-making were assigned to the "observation" group for the current analysis, and patients who did not undergo such observation (whether or not CT was ordered) were assigned to the "no observation" group. Clinicians were asked why they decided to observe patients before determining the need for abdominal CT at the time they made their observation decisions. They were also asked whether the patient's symptoms worsened, improved, or stayed the same at the conclusion of this observation period. The duration of observation, additional management (including laboratory testing, ultrasound, and medication administration), and the final disposition decisions were left to the discretion of the treating clinician.

Selection of Participants

Study inclusion criteria were any of the following: history or physical examination suggestive of IAI after blunt torso trauma, blunt torso trauma from a significant mechanism of injury, decreased level of consciousness in association with blunt abdominal trauma, or blunt traumatic event associated with extremity paralysis or multiple long bone fractures at multiple sites (e.g., tibia and humerus fracture). Patients were excluded for any of the following: penetrating trauma, pre-existing neurologic disorders significantly compromising assessment, injury occurring >24 hours before ED assessment, transfer of patient to the study ED with prior abdominal CT, strong suspicion for nonaccidental trauma, or known pregnancy. We additionally excluded all patients whose observation status was unknown.

Measurements and Outcomes

The primary outcome of this current subanalysis was the rate of abdominal CT scan use, and secondary outcomes were IAI and IAIai. Study staff reviewed patient medical records to determine rates of CT scan use and the frequency of any IAI and IAIai. An IAI was defined as an injury to the liver, spleen, pancreas, gastrointestinal tract (stomach to sigmoid colon including the mesentery), gallbladder, urinary tract (kidney to bladder), adrenal glands, intraabdominal vascular structure, or fascial defect. IAIai was defined as death from the injury, therapeutic laparotomy, therapeutic angiographic embolization, blood transfusion for intraabdominal hemorrhage, or intravenous fluids for at least two nights in patients with pancreatic or gastrointestinal injuries. For patients who were admitted to the hospital, study staff extracted clinical data from the patient's medical record. For patients who were discharged from the ED, study staff contacted parents and guardians by telephone or text at least one week after the index visit.

Analysis

Simple descriptive statistics were used to analyze demographic variables. Risk differences were calculated as the absolute difference in proportions between groups, with 95% confidence intervals (CI) estimated using the Wald normal approximation. ED length of stay and time to CT are presented as the median with interquartile ranges (IQR) or mean with 95% CIs. To examine the association between observation and CT use we performed multivariable logistic regression analysis using maximum likelihood estimation with the dependent variable being CT use and primary independent variable being observation status. Covariates in the model included the PECARN abdominal injury prediction rule risk variables, patient age, clinician suspicion of IAI, and study site, included as a fixed effect to account for between-site practice variation. The PECARN rule variables (considered present or absent) were selected because they are clinically meaningful markers of IAI. Patient age was included as a continuous variable because clinicians are particularly motivated to avoid CT imaging in the youngest children, who face a higher lifetime risk from radiation exposure. Participating site was included to account for variation in local practice patterns. We hypothesized that the effects of observation may be modified by level of clinician suspicion for IAI, which we assessed by augmenting the model by level of clinician suspicion and its interaction with observation. We report detailed clinical and outcome information on all patients in the observation group who were ultimately diagnosed with IAIai.

RESULTS

Patient Characteristics

7,542 children with BAT were enrolled in the abdominal trauma cohort of the main validation study. Of these, 7,442 (98.7%) had a documented observation status (yes/no), and this group formed the analytic population. 4,228 (56.8%) were male and 3,214 (43.2%) were female, and the mean age for this group was 9.4 ± 5.0 years. Follow-up was attempted for all discharged patients by text or telephone, and follow-up was obtained in 70% of patients. For those patients lost to text or telephone follow-up, a review of the medical record was performed to see if they returned with a missed injury. Previous work has demonstrated that the patients lost to follow-up who ultimately underwent acute intervention were identified by medical record review (as participating sites were the regional pediatric trauma centers and thus would ultimately admit patients with IAI).[2]

Main Results

Within the analytic population, 2,024 (27.2%) were observed before CT decision-making and 5,418 (72.8%) were not observed and had immediate CT decision-making. Three thousand-one hundred and sixty-three (42.5%) patients were admitted to the hospital. Findings categorized by observation and non-observation status are presented in Table 1. Variation in observation usage by site was identified (range 24% to 36% of patients).

In the analytic population, 2,425 (32.6%) underwent abdominal CT in the ED. Of those that were observed 414/2,024 (20.5%, 95% CI 18.7, 22.3%) underwent CT. Of those not observed, 2,011/5,418 (37.1%, 95% CI 35.8, 38.4%) underwent abdominal CT (unadjusted difference in CT rates: −16.7%, 95% CI −14.5, −18.8%). Appendix Tables 1 and 2 provide detailed information on the population by observation status and CT use.

In the observation group, 77 (3.8%, 95% CI 3.0, 4.7) patients ultimately had IAIs identified while eight (0.4%, 95% CI 0.1, 0.7%) had IAIs undergoing acute intervention (Table 2). Conversely, in the no-observation group, 426 (7.9%, 95% CI 7.2, 8.6%) were identified as having IAIs and 137 (2.5%, 95% CI 2.1, 3.0%) had IAIs undergoing acute intervention (difference in IAIai: 2.1%; 95% CI 1.6, 2.6%).

The main reasons for observation cited by the treating clinicians were severe mechanism of injury, abdominal pain, and abdominal tenderness (Table 3). During the observation period, most patients with abdominal tenderness and vomiting had improvement or resolution of their symptoms (Table 4).

The multivariable logistic regression analysis, adjusting for site, patient age, clinician suspicion of IAI, and the seven PECARN abdominal injury prediction rule variables is presented in Table 5 and included 7,399 patients (99%). The effects of ED observation had significant heterogeneity according to level of clinician suspicion. Clinician suspicion and ED observation were each independently associated with CT use. There were significant interactions between ED observation and clinician suspicion, with a stronger association between observation and lower CT use among patients with clinician suspicion between 1–50%, but not among those with suspicion <1% or >50%. These interaction terms have been included in Table 5.

For patients who underwent CT scanning, the median time from ED triage to CT ordering was 23 minutes (interquartile range: 13, 49 minutes) in the no observation group. The median time from ED triage to CT ordering in the observation group (for those who underwent CT) was 119 minutes (IQR 69, 216 minutes).

The mean ED length of stay for observed children (269 minutes, 95% CI 262, 274 minutes) was longer than those not observed (248 minutes, 95% CI 243, 252 minutes). In the subset of children who were observed, the median length of stay was 322 minutes (IQR 220, 447 minutes) in those who underwent CT and 226 minutes (IQR 150, 319 minutes) in those who did not. In those children who were not observed before CT decision-making, the median ED length of stay was 240 minutes (IQR 141, 361 minutes) in those who underwent CT and 200 minutes (IQR 137, 289 minutes) in those who did not.

Eight (0.4%, 95% CI 0.1, 0.7%) of the 2,024 patients who underwent observation were ultimately diagnosed with IAIai. For these patients the median time from triage to ED CT ordering was 39 minutes (IQR 11, 98 minutes), and the longest time of observation prior to CT was 305 minutes. For those identified with any IAI the median time from triage to ED CT ordering was 92 minutes (IQR 70, 138 minutes). One thousand one hundred and sixty-six children were discharged after a period of observation without CT and none (0%, 95% CI 0, 0.3%) were identified as having IAIai at follow-up. One (0.1%, 95% CI 0.0, 0.5%) of these 1,166 patients, however, had an IAI identified. This patient was an eight-year-old male in a motor vehicle collision who had both thoracic wall and abdominal wall trauma. He spent almost 10 hours in the ED before being discharged home. He returned two days later with epigastric pain, and a CT scan demonstrated a duodenal hematoma. He was hospitalized for one night without incident or intervention.

LIMITATIONS

This study has several limitations. First, this study was conducted in six pediatric EDs where clinician experience with injured children may differ from that of non-pediatric EDs. Previous studies, however, show that non-pediatric community hospitals can successfully use pediatric clinical prediction rules.[16,17] Furthermore, the PECARN IAI prediction rule has been successfully used in non-pediatric hospitals.[18] Second, the observation period was unstructured, and the duration of observation, additional diagnostic interventions such as laboratory testing, abdominal ultrasound use, and additional interventions (if any) were left to the discretion of treating clinicians, and we were unable to evaluate how adjunctive diagnostic testing and interventions interacted with observation to influence CT decision-making. Third, study clinicians were not asked how they would have managed these patients if observation were not an option. Left with a binary choice of ED discharge or abdominal CT scan, it is difficult to predict how this would impact study findings. Fourth, this study population was skewed towards older children. In this population certain variables may be easier to assess such as abdominal pain or tenderness, and the results of the study may be different for younger children with BAT. Fifth, we acknowledge that observation decisions can be influenced by site-specific culture, which may result in management actions driven not only by a patient’s clinical characteristics but by local customs. Although ED observation is a cost-effective intervention in children at intermediate risk of important brain injuries after minor blunt head trauma,[19] similar cost-effectiveness analyses have not been conducted for observation in abdominal trauma, and this is an area for future study.[19,20] We recognize that the ‘no observation’ group is heterogeneous, comprising both patients for whom clinicians determined that immediate CT was necessary and patients judged to be at sufficiently low risk to require neither CT nor observation. This heterogeneity reflects real-world decision-making. However, we performed both an adjusted analysis using multivariable regression with clinician suspicion of IAI to address this heterogeneity. The latter part of the enrollment period occurred during COVID lockdowns and sites saw a decline in the number of patients; effects of this on study results are otherwise unknown. Finally, we acknowledge that while the study team regularly reviewed the study protocol with all clinician participants at all sites and instructed on the appropriate use of the case report forms, we cannot exclude the possibility that delayed completion of case report forms may have impacted CT decision-making.

DISCUSSION

We found that clinicians frequently use a period of observation prior to determining whether abdominal CT scans are indicated. In this study, over a fourth of children underwent a period of observation prior to a final decision regarding the use of abdominal CT. Additionally, children who underwent observation had lower rates of CT scanning than patients who had an immediate decision regarding the use of CT. After adjusting for injury severity with the PECARN abdominal prediction rule variables and clinician suspicion, a period of observation was associated with less frequent abdominal CT use in those children considered low to moderate risk. Notably, the observation cohort was more likely than the no-observation cohort to have patients who were positive for any of the PECARN criteria. Despite this, the CT rate was lower in the observation cohort, further supporting an association between observation and lower CT utilization.

In those children who were positive for at least one PECARN prediction rule variable, a decrease in abdominal CT use from 61% in the original derivation study to 49% in the validation study was noted.[2,9] The reasons for this decrease are likely multifactorial. The current study suggests a period of observation may be one factor associated with this decline in CT use. During a period of observation, clinicians may obtain laboratory tests, abdominal ultrasonography and perform serial abdominal examinations.[21–24] The information gathered during this period may inform clinician decision-making regarding abdominal CT use.

Patients who underwent immediate CT had higher rates of IAIai, whereas no patients discharged without CT were later identified with IAIai. For the subset of patients in whom the clinician suspicion of IAI was the lowest (<1%), there was no difference in CT rates in the observation and no observation groups. Similarly, in the subset of patients in whom clinical suspicion for IAI was highest (>50%), there was no difference in CT rates in the observation and no-observation groups. The association between observation and CT use was most evident in the three strata of patients in which clinician uncertainty was high (1–5%, 6–10%, and 11–50%). In each of these three groups, observation was associated with a lower rate for CT utilization compared to no observation.

The number of patients who were observed and eventually identified with an IAI that underwent acute invention was low (0.4%). Most importantly, all children with IAIai who were observed were detected during this period of observation with the longest period just over five hours. Only one patient who was observed and discharged from the ED without a CT was subsequently identified with an IAI. This patient had a duodenal hematoma identified two days after his injury but never received an intervention. Thus, no patient who was discharged after an observation period returned to the ED and was identified with an IAIai. This data are consistent with the safety of observation among children with low to moderate risk for IAI.

Many of the patients in this study had more than one PECARN prediction rule variable documented which removed them from the very-low-risk category. However, the most common reason why patients were observed was because of “severe mechanism of injury”, which is not a PECARN IAI prediction rule variable. The mechanism of injury may have informed the clinician’s overall sense of which patients needed observation, but this factor is not an independent risk factor for IAIai in the PECARN abdominal injury prediction rule.[2] This may provide an opportunity for provider education.

The perception that a period of observation leads to substantially longer stays in the ED was not borne out by the results of this study. While the median length of stay for observed patients was 27 minutes longer than for those not observed, this statistical difference is of questionable clinical relevance. A previous study determining the relationship between duration of observation for children with head trauma and CT rates demonstrated a time-dependent decrease in the rates of head CT.[13] The current study demonstrated that those undergoing observation but ultimately diagnosed with IAIs had short median observation periods. This suggests that although patients were planned to be observed, decisions were quickly made to obtain CT scans in the most injured patients in the observation group.

Importantly, the findings of this study should be interpreted as evaluating the role of observation as a management strategy, rather than as defining a complete diagnostic pathway. In clinical practice, observation often serves as a framework within which clinicians perform serial examinations and integrate adjunctive studies such as laboratory testing and ultrasound. The association between observation and lower CT use among children managed with a period of observation before CT decision-making suggests that this strategy may allow clinicians to safely incorporate evolving clinical information before committing to CT imaging.

In summary, a period of ED observation was associated with lower abdominal CT utilization in children, particularly in children with intermediate clinician suspicion for IAI, without an observed increase in missed injuries and with a minimal increase in the overall ED length of stay. Future research should incorporate implementation science principles to study how local context and adjunctive testing influence observation and imaging decisions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKOWLEDGEMENTS

The authors thank the study participants and their families. We gratefully acknowledge the enrolling clinicians at the sites and the site research coordinators: Kathryn Hollenbach (Rady Children's Hospital, San Diego), Sofronia Ringold (Children's Hospital Los Angeles), Donovan Nielsen (lead study coordinator, UC Davis), Lisa Lavrisha (UCSF Benioff Children's Hospital Oakland), Misha Granado (UT Houston), and Elizabeth Hazel Hernandez (UT Southwestern). The authors acknowledge the outstanding work of the study research manager, Allyson Sage (UC Davis).

Funding/Support:

Research reported in this publication was supported by the Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health under Award Number R01HD084674. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Data Sharing Statement

NA

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Table 1:

Findings in Observation and No Observation Patients

	Observation (n=2,024)	No Observation (n=5,418)	Difference (95% CI)
Age (mean, SD) years	9.0 ± 5.0	9.5 ± 5.0	0.5 (0.2, 0.7)
Sex (male)	1,113 (55.0%)	3,115 (57.5%)	2.5% (0.0, 5.0%)
Mechanism of Injury			
Motor vehicle collision	1,064 (52.6%)	2,725 (50.3%)	2.3% (−0.3, 4.8%)
Auto versus pedestrian	225 (11.1%)	586 (10.8%)	0.3% (−1.3, 1.9%)
Motorized vehicle	181 (8.9%)	530 (9.8%)	−0.8% (−2.3, 0.6%)
Fall (elevation)	232 (11.5%)	690 (12.7%)	−1.2% (−2.9, 0.4%)
Fall (ground) / run into object	40 (2.0%)	132 (2.4%)	−0.5% (−1.1, 0.3%)
Fall (stairs)	27 (1.3%)	60 (1.1%)	0.2% (−0.3, 0.8%)
Bicyclist	111 (5.5%)	300 (5.5%)	0.0% (−1.2, 1.1%)
Assault	42 (2.1%)	100 (1.9%)	0.2% (−0.5, 0.9%)
Object struck abdomen	45 (2.2%)	104 (1.9%)	0.3% (−0.4, 1.0%)
Object struck head	22 (1.1%)	83 (1.5%)	−0.4% (−0.1, 0.1%)
Other	35 (1.7%)	108 (2.0%)	−0.3% (−0.9, 0.4%)
PECARN Risk Variables *			
PECARN Rule Positive	1,187/2,024 (58.7%)	2,818/5,418 (52.0%)	6.5% (4.0, 9.1%)
Abdominal pain	534/2,020 (26.4%)	1,274/5,417 (23.5%)	2.9% (0.7, 5.1%)
Vomiting	166/2,020 (8.2%)	430/5,417 (7.9%)	0.3% (−1.1, 1.7%)
GCS < 14	93/2,021 (4.6%)	589 (10.9%)	−6.3% (−7.5, −5.0%)
Abnormal breath sounds	17/2,019 (0.8%)	114/5,409 (2.1%)	−1.3% (−1.8, −0.7%)
Thoracic wall trauma	354/2,018 (17.5%)	869/5,414 (16.1%)	1.5% (−0.4, 3.4%)
Abdominal wall trauma	390/2,020 (19.3%)	1,087/5,410 (20.1%)	−0.8 (−2.8, 1.2%)
Abdominal tenderness	488/2,020 (24.2%)	1,301/5,410 (24.1%)	0.1% (−2.1, 2.3%)
Hospitalized	717 (35.4%)	2,446 (45.2%)	−9.7% (−12.2, −7.3%)
ED CT scan obtained	414 (20.5%)	2,011 (37.1%)	−16.7% (−18.8, −14.5%)

* Denominator provided for the PECARN risk variables as these were rarely missing.

Table 2:

Intraabdominal Injuries Undergoing Acute Intervention Identified During Observation

Age (years)	Mechanism	Clinical Findings at Presentation	Therapy	Injury
8.5	MVC	Abdominal pain and tenderness, Abdominal wall trauma	Laparotomy	GI
9.1	Fall	Abdominal pain Vomiting	Embolization, Blood transfusion	Liver, Hemoperitoneum
9.8	MVC	Abdominal wall trauma	Laparotomy	GI, Hemoperitoneum
9.9	MVC	Abdominal pain and tenderness, Abdominal wall trauma	Laparotomy, Blood transfusion	GI, Hemoperitoneum
10.9	Bicycle	Abdominal pain and tenderness	Laparotomy	GI
11.6	MVC	Abdominal pain and tenderness, Abdominal wall trauma	Blood transfusion	Liver, Spleen
12.2	MVC	Abdominal pain and tenderness, GCS <14, Abdominal wall trauma, Thoracic wall trauma	Laparotomy, Blood transfusion	GI, Pancreas, Hemoperitoneum
17.5	MVC	Abdominal pain and tenderness, Abdominal wall trauma	NPO for ≥2 days	GI, Hemoperitoneum

GCS = Glasgow Coma Scale

GI = Gastrointestinal

MVC = Motor vehicle crash

NPO = *Nil per os*

Table 3:

Reasons for Observation (n = 2,024)

Reason	Patients (%)
Mechanism of injury	1,116 (55%)
Abdominal pain	361 (18%)
Abdominal tenderness	324 (16%)
Abdominal wall trauma	235 (12%)
Chest wall trauma	161 (8.0%)
GCS score < 15	113 (5.6%)
Vomiting	100 (4.9%)
Awaiting labs/urinalysis	47 (2.3%)
Flank tenderness	39 (1.9%)
Abnormal labs	27 (1.3%)
Femur fracture	26 (1.3%)
Trauma surgery request	22 (1.1%)
Pelvic bone tenderness	20 (1.0%)
Costal margin tenderness	19 (0.9%)
Patient age	16 (0.8%)
Head injury	9 (0.4%)
Abnormal breath sounds	8 (0.4%)
FAST examination abnormal	8 (0.4%)
Fussy	7 (0.4%)
Tachycardia, unexplained	6 (0.3%)
Other	110 (5.4%)

Patients could have more than one reason for observation

GCS = Glasgow Coma Scale

FAST = Focused Assessment with Sonography for Trauma

Table 4:

Clinical Changes During Observation (n = 2,024)

Abdominal Tenderness		Vomiting	
Progression	**Patients**	**Progression**	**Patients**
Never had tenderness	1,312 (64.8%)	Never vomited	1,769 (87.4%)
Stayed the same (no change)	163 (8.1%)	Resolved without medications	75 (3.7%)
Improved but not resolved	150 (7.4%)	Resolved with medications	65 (3.2%)
Resolved with analgesia	115 (5.7%)	No change	25 (1.2%)
Resolved without analgesia	87 (4.3%)	Worsened	24 (1.2%)
Unable to assess (pre/non-verbal)	81 (4.0%)	Did not reassess	7 (0.4%)
Worsened	40 (2.0%)		
Did not reassess	21 (1.0%)		

Patients could have more than one sign/symptom

Table 5:

Multivariable logistic regression model demonstrating factors associated with abdominal CT use with specific patient characteristics (controlled by site)

Patient Characteristics	Odds Ratio	(95% CI)
Age	1.03	(1.02, 1.04)
Abdominal Pain	1.53	(1.26, 1.87)
Abdominal tenderness	5.35	(4.40, 6.50)
Abdominal wall trauma	2.88	(2.48, 3.36)
Chest wall trauma	1.69	(1.44, 1.99)
Decreased breath sounds	2.71	(1.60, 4.61)
GCS score < 14	8.45	(6.92, 10.33)
Vomiting	1.15	(0.93, 1.43)
Observation (Main Effect)		
No	REF	
Yes	1.06	(0.83, 1.35)
Suspicion of intraabdominal injury (Main Effect)		
<1%	REF	
1 – 5%	5.64	(4.72, 6.74)
6 – 10%	23.6	(17.9, 31.2)
11 – 50%	40.0	(26.4, 60.6)
> 50%	23.0	(13.6, 39.0)
Interaction term of suspicion of intraabdominal injury and observation		
1 – 5%	0.29	(0.21, 0.48)
6 – 10%	0.14	(0.09, 0.23)
11 – 50%	0.17	(0.07, 0.38)
> 50%	0.57	(0.13, 2.39)
Contrasts describing observation (Yes vs. No) specific to each level of suspicion of intraabdominal injury		
< 1%	1.06	(0.83, 1.35)
1 – 5%	0.31	(0.25, 0.39)
6 – 10%	0.15	(0.10, 0.23)
11– 50%	0.18	(0.08, 0.39)
> 50%	0.60	(0.15, 2.48)

This multivariable model included 7,399 (99%) patient encounters

The model also included the site as a fixed effect (results not shown)

PECARN = Pediatric Emergency Care Applied Research Network

GCS = Glasgow Coma Scale