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Intra-abdominal injury following blunt trauma becomes clinically apparent within 9 hours

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Abstract

Background—The diagnosis of blunt abdominal trauma can be challenging and resource intensive. Observation with serial clinical assessments plays a major role in the evaluation of these patients, but the time required for intra-abdominal injury to become clinically apparent is unknown. The purpose of this study was to determine the amount of time required for an intra-abdominal injury to become clinically apparent after blunt abdominal trauma via physical examination or commonly followed clinical values.

Methods—A retrospective review of patients who sustained blunt trauma resulting in intra-abdominal injury between June 2010 and June 2012 at a Level 1 academic trauma center was performed. Patient demographics, injuries, and the amount of time from emergency department admission to sign or symptom development and subsequent diagnosis were recorded. All diagnoses were made by computed tomography or at the time of surgery. Patient transfers from other hospitals were excluded.

Results—Of 3,574 blunt trauma patients admitted to the hospital, 285 (8%) experienced intra-abdominal injuries. The mean (SD) age was 36(17) years, the majority were male (194 patients, 68%) and the mean (SD) Injury Severity Score (ISS) was 21 (14). The mean (SD) time from admission to diagnosis via computed tomography or surgery was 74 (55) minutes. Eighty patients (28%) required either surgery (78 patients, 17%) or radiographic embolization (2 patients, 0.7%) for their injury. All patients who required intervention demonstrated a sign or symptom of their intra-abdominal injury within 60 minutes of arrival, although two patients were intervened upon in a delayed fashion. All patients with a blunt intra-abdominal injury manifested a clinical sign or symptom of their intra-abdominal injury, resulting in their diagnosis within 8 hours 25 minutes of arrival to the hospital.

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Authorship: E.L.J. and R.T.S. designed this study. E.L.J., R.T.S., and T.S.J. collected the data, and all authors contributed to the data analysis and interpretation. E.L.J., R.T.S., and T.S.J. prepared the manuscript, which was critically reviewed by D.D.B., C.C.B., J.L.J., G.J.J., C.C.B., and E.E.M.

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Conclusion—All diagnosed intra-abdominal injuries from blunt trauma manifested clinical signs or symptoms that could prompt imaging or intervention, leading to their diagnosis within 8 hours 25 minutes of arrival to the hospital. All patients who required an intervention for their injury manifested a sign or symptom of their injury within 60 minutes of arrival.

Level of Evidence—Therapeutic study, level IV Epidemiologic study, level III.

Keywords

Blunt trauma; intra-abdominal injury; 8 hours; 60 minutes; clinically apparent

The accurate and timely diagnosis of blunt intra-abdominal injury (IAI) is a common dilemma. The accuracy of physical examination has been questioned by multiple previous studies,^{1,2} while others have suggested that the optimal method of diagnosis is via serial examination by an experienced trauma surgeon.^{3,4} Unfortunately, these studies do not define the period that is needed for IAIs to become clinically apparent.

Differing periods of observation both in the emergency department and as an inpatient have been proposed in the literature to identify clinically relevant injuries after trauma.^{5–8} The largest study by Poletti et al. arbitrarily used a 23-hour period of observation and, in retrospect, identified a missed injury rate of just 0.5%, suggesting that this is not warranted in all trauma patients. However, we could find no data in the literature that described the time frame necessary for an IAI to manifest itself. The period of observation chosen by previous studies was determined solely by expert opinion. This duration, if known, could be used to define the optimal period of observation required to identify clinically significant injuries following blunt abdominal trauma.

The purpose of this study was to determine the length of time necessary for an IAI to become apparent after blunt abdominal trauma based on commonly followed clinical findings. Our hypothesis is that an IAI in a patient after blunt trauma will become clinically evident via a commonly followed sign or symptom within 12 hours of presentation to the hospital.

Patients and Methods

The Denver Health Medical Center (DHMC) Trauma Registry was queried for all blunt trauma patients with an IAI from June 2010 to June 2012. DHMC is a state-certified and American College of Surgeons-verified level I regional trauma center and an intergral teaching facility of the University of Colorado School of Medicine. These records were reviewed for general patient demographics, mechanism of injury, Injury Severity Score (ISS), timing and results of initial and subsequent physical examinations, Focused Abdominal Sonogram for Trauma (FAST) results, complete blood count and urinalysis, imaging and operative intervention for the abdominal injury, and overall survival. Patient transfers from other facilities were excluded.

At DHMC, all trauma patients immediately undergo full physical assessment as per the Advanced Trauma and Life Support protocol.⁹ Besides FAST, cervical-spine, chest, and pelvis x-rays are performed when indicated, and an initial laboratory panel is drawn, which

includes a complete blood cell (CBC) count, basic metabolic panel, and coagulation studies. Blunt abdominal trauma patients who are mentally intact (Glasgow Coma Scale [GCS] score of 15 and oriented to person, place, and time) with an initially normal physical examination finding, a negative FAST result, and normal laboratory results do not undergo initial computed tomography (CT) and are observed in the emergency department. This common practice of observation includes serial physical and FAST examinations as well as a repeat CBC count at 8 hours to 12 hours after arrival.¹⁰ However, this practice has varied in the past and can be altered at the trauma surgeon's discretion.^{3,8,11}

The amount of time required for an IAI to manifest was defined as the time from emergency department arrival to the first documentation of a sign or symptom commonly associated with IAIs (Table 1). For ease of categorization, these were arbitrarily prioritized based on the authors' experience as follows: (1) vital signs; (2) unevaluable patient (intubated and sedated or GCS < 15 who is not oriented, intoxicated, or combative); (3) abdominal examination findings such as peritonitis, significant pain, abrasions, or a seat belt sign; (4) other concerning examination findings commonly associated with an IAI including lower chest wall, flank, or lumbar spine tenderness; (5) positive FAST result with stable vital signs; (6) distracting or severe associated injuries, for example, pelvic, femur, spinal, multiple lower rib fractures, or multiple long bone fractures; (7) unexplained, altered white blood cell count, hemoglobin, gross hematuria, or microscopic red blood cell count greater than 100 cells/mL; and (8) high-energy mechanism or attending discretion (when no other indicator was identified before imaging or intervention).^{2,8,12-19} When two or more clinical indicators were apparent at the same time, the higher priority sign or symptom was recorded as the prompting sign or symptom. All diagnoses were made by CT or surgery. The University of Colorado Multi-Institutional Review Board approved this study (COMIRB #13-0244).

Results

During a 2-year period 3,574 blunt trauma patients were admitted to the DHMC, and 285 (8%) were diagnosed with IAIs. Of those 285 patients with an IAI, the mean (SD) age was 36 (17) years, the majority was male (68%), and the mean (SD) ISS was 21 (14). The most common mechanism of injury was a motor vehicle collision in 127 patients (45%), followed by motorcycle crashes (40 patients, 14%), and auto pedestrian collisions (41 patients, 14%) (Table 2). The majority of the injuries included isolated liver or spleen injuries (139 patients, 49%), followed by patients with multiple solid organ injuries (60 patients, 21%). Just 9 patients (3.2%) experienced isolated hollow viscus injuries, although an additional 14 patients (5.0%) had concomitant solid organ injuries, for a total of 25 hollow viscus injuries (8.8%) (Table 3).

Of the 285 patients with IAIs diagnosed at our facility, 52 (18%) underwent immediate CT or intervention because they were deemed unevaluable owing to altered mental status or endotracheal intubation with sedation. The remaining 233 patients (82%) exhibited specific clinical abnormalities prompting CT or intervention, resulting in the diagnosis (and management in the case of surgery) of their injury (Fig. 1). The two patients (0.7%) who were found to have a severe mechanism as an indication for diagnosis were involved in

high-speed (>55 mph) motor vehicle accidents with significant vehicular damage and/or a death at the scene; both patients also exhibited a sign or symptom of their injury within 6 hours of arrival.

Of the 285 patients with an IAI, 80 (28%) required either surgery (78 patients, 17%) or radiographic embolization (2 patients, 0.7%) for their injury (Table 3 and 4). Of these 80 patients, 78 (98%) proceeded directly to the operating room or radiology suite within 1 hour of arrival. Two patients underwent a delay in the diagnosis and subsequent intervention owing to initial inappropriate triage as nontrauma. However, both demonstrated signs or symptoms of their injury within 1 hour of arrival. Despite the delay, neither patient experienced additional complications following exploration for their hollow viscus or splenic injury.

Two hundred sixty patients (91%) were diagnosed within this first 60 minutes of arrival, while the remaining 25 patients underwent serial examinations and a repeat CBC count 6 hours to 12 hours after arrival, resulting in their diagnosis. All 285 patients demonstrated a sign or symptom prompting diagnosis by either CT or intervention within 8 hours 25 minutes of arrival, with a mean (SD) time to diagnosis of 74 (55) minutes (Fig. 2). All patients with an IAI that required an intervention demonstrated a sign or symptom of their injury within 60 minutes of arrival.

Discussion

We reviewed our experience with more than 3,500 blunt trauma admissions, resulting in 285 IAIs diagnosed at our facility during a 2-year period to determine the length of time required for patients with IAIs to manifest via commonly measured clinical variables. Interestingly, all patients who ultimately required an intervention for their IAI developed a clinical sign or symptom within 1 hour of arrival to the hospital. For the entire population, all patients with blunt IAIs demonstrated a sign or symptom of their injury within 8 hours 25 minutes of arrival to the DHMC.

A consistent, evidence-based duration for serial clinical assessments or a time course for the clinical presentation of IAIs is lacking. Differing periods of observation have been proposed to reasonably exclude additional traumatic injuries.⁵⁻⁸ Direct comparison of these studies is challenging because each apply a different management algorithm. An earlier study from our institution by Kendall et al. most closely follows our current system and found that just 6% of blunt trauma patients required admission with an IAI rate of 0.4% after observation for a median 9.5 hours in the emergency department. Our study differs from this and previous studies in that we are not evaluating a blunt abdominal trauma protocol. Rather, we sought to define the time interval required for known IAIs to manifest themselves through commonly followed clinical signs or symptoms. This information can then be used to determine the optimal duration for observation of patients after blunt abdominal trauma.

Our study is not without limitations. The retrospective identification of specific clinical variables prompting the imaging or intervention is prone to error because there is no way to confirm the actual indication or constellation of signs and symptoms considered by the

bedside clinician. In addition, the hierarchy of clinical signs and symptoms was designed for ease of categorization based on the authors' experience but may not be applicable in all situations. The specific signs and symptoms we evaluated are supported by the literature.^{2,12-15} While the intent of this study does not include the evaluation of our blunt abdominal trauma protocol, it is impossible to describe the natural course of an IAI without chronicling our management algorithm. Thus, more or less frequent examinations, laboratory evaluations, or imaging may have resulted in more efficient or cost-effective management of these patients and warrant further study.

Conclusion

Of the 3,574 blunt trauma patients admitted to the DHMC during the 2-year study period, all diagnosed IAIs exhibited clinical signs or symptoms that could prompt imaging or intervention within 8 hours 25 minutes of arrival to the hospital. All patients who required intervention for their IAI demonstrated a clinical sign or symptom of their injury within 60 minutes of arrival. These periods should be considered when establishing protocols for the management of blunt abdominal trauma.

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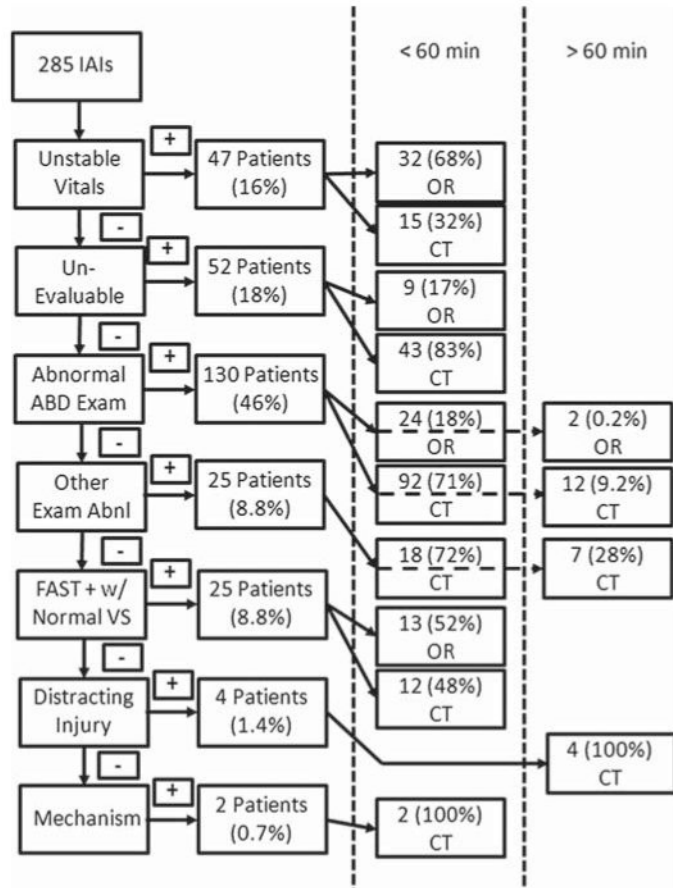


Figure 1. The pathway to diagnosis after blunt abdominal trauma. Unstable vitals are considered to be a systolic blood pressure less than 90 mmHg and/or new or delayed onset tachycardia of greater than 100 beats per minute. Unevaluable patients are those with a CCS score of less than 15 and/or clinical intoxication or combativeness. Abnormal abdominal examination findings included peritonitis, significant tenderness, or a seat belt sign. Other examination abnormalities indicative of an IAI included significant lower chest wall, flank, or lumbar spine tenderness. Distracting injuries include multiple lower rib fractures, pelvic fractures, or long bone fractures. A severe mechanism includes motor vehicle collisions at faster than 55 mph or a death at the scene. *ABD*, abdominal; *Abnl*, abnormal; *OR*, operating room; *IR*, interventional radiology.

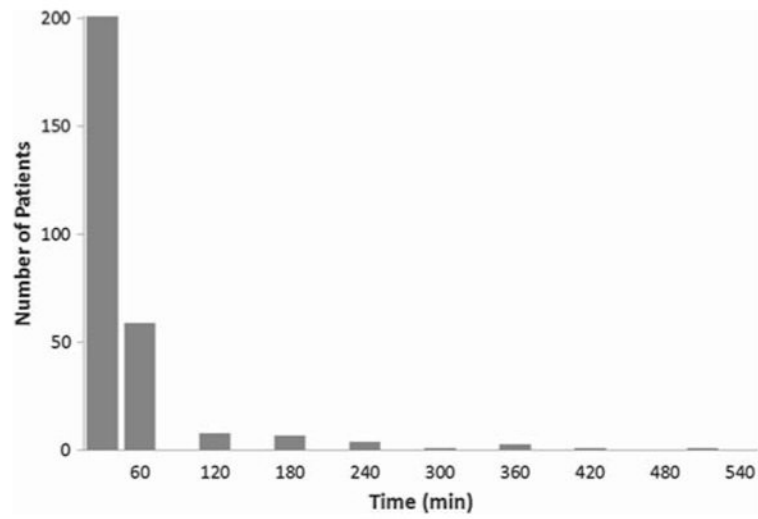


Figure 2. The number of patients diagnosed at 30-minute intervals after arrival. The majority of patients were diagnosed within 60 minutes of arrival by physical examination alone, although one patient required 8 hours 25 minutes to manifest symptoms of their injury.

Table 1
Definition of Signs or Symptoms Prompting the Diagnosis

Vital signs	Hypotension (SBP < 90 mm Hg) or delayed tachycardia
Unevaluable patient	Intubated and sedated, altered mental status
Abdominal examination findings	Abdominal pain, peritonitis or significant tenderness, seat belt sign, significant abrasions
Other examination findings	Flank, spine, pelvic, lower chest wall tenderness
Distracting injuries	Pelvic or femur fractures, multiple long bone fractures, multiple lower rib fractures, sternal fracture
Unexplained abnormal laboratory values	CBC count, UA
Severe mechanism	When none of the above identified before diagnosis

Patients with a GCS score of less than 15 were considered to have an altered mental status. CBC count was considered abnormal with when either the white blood cell count or hemoglobin was out of the normal range. UA was considered abnormal if there was evidence of hematuria.

SBP, systolic blood pressure; UA, urinalysis.

Table 2
Mechanisms of Injury

Mechanism	Patients (n = 285), n (%)
Motor vehicle crash	127 (45)
Motorcycle crash	40 (14)
Auto pedestrian collision	41 (14)
Falls	27 (9.5)
Bicycle crash	18 (6.3)
Assault	17 (6.0)
Sports/all-terrain vehicle/miscellaneous	15 (5.3)

The most common mechanism in patients diagnosed with an IAI was motor vehicle crashes.

Table 3
Distribution of IAIs and Interventions

Injury	Patients	Patients Requiring Intervention, n (%)
Multiple IAIs	74	31 (42)
Isolated liver injury	70	10 (14)
Isolated spleen injury	69	12 (17)
Isolated genitourinary	33	15(45)
Isolated hollow viscus	9	6 (6.7)
Other	30	6 (20)
Total	285	80 (28)

Fourteen of the patients with multiple IAIs included both hollow viscus and solid organs; the remaining 60 experienced multiple solid organ injuries. "Other" injuries included retroperitoneal and/or vascular injuries.

Table 4
Signs or Symptoms Leading to the Diagnosis via Imaging or Intervention

Clinical Indicator	Total (n = 285)	Intervention for Abdominal Injury (n = 80)
Vital signs	47	32
Unevaluable	52	9
Abdominal examination	130	26
Other examination	25	0
FAST+ (hemodynamically normal)	25	13
Distracting injury	4	0
Mechanism	2	0

The majority of patients had an abnormal physical examination finding, which prompted the diagnosis in both groups. Patients included in the FAST+ group all demonstrated at least one quadrant with free fluid on the FAST examination but had normal vitals.