

**American College of Radiology  
ACR Appropriateness Criteria®**

**Clinical Condition:** Blunt Abdominal Trauma

**Variant 1:** Stable patient.

Radiologic Procedure	Rating	Comments	<a href="#">RRL*</a>
X-ray abdomen supine and upright	8	CT and radiographs may be appropriate. See text for details.	Med
CT abdomen and pelvis	8	MDCT is preferable. CT and radiographs may be appropriate. See text for details.	High
INV angiography embolization abdomen and pelvis	8	Not a screening procedure. Angiography is indicated to delineate and treat active bleeding or other lesions amenable to angiographic therapy, but only when this type of lesion is first detected or suspected, either by CT or by some other means.	High
X-ray chest	8	CT and radiographs may be appropriate. See text for details.	Min
US screen for hemoperitoneum	4	Low sensitivity of US to injuries that require surgery (active hemorrhage, viscus perforation) and its inability to exclude injuries that require in-hospital observation lessen its usefulness for key triage decisions.	None
US organ	3		None
MRI organ evaluation	2		None
MRI diaphragm evaluation	2		None
<b>Rating Scale:</b> 1=Least appropriate, 9=Most appropriate			<b>*Relative Radiation Level</b>

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**Clinical Condition: Blunt Abdominal Trauma****Variant 2: Unstable patient.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	7		Min
US screen for hemoperitoneum	7		None
X-ray abdomen supine and upright	6		Med
US organ	4		None
INV angiography embolization abdomen and pelvis	4		High
CT abdomen and pelvis	4	MDCT is preferable. Clinical judgment needed on stability of patient versus need for diagnostic information.	High
MRI organ evaluation	2		None
MRI diaphragm evaluation	2		None
<b>Rating Scale:</b> 1=Least appropriate, 9=Most appropriate			<b>*Relative Radiation Level</b>

**Variant 3: Hematuria >35 RBC/HPF (stable).**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	8	CT and radiographs may be appropriate. See text for details.	Min
X-ray abdomen supine and upright	8	CT and radiographs may be appropriate. See text for details.	Med
CT abdomen and pelvis	8	MDCT is preferable. CT and radiographs may be appropriate. See text for details.	High
CT cystography	7		High
X-ray retrograde urethrography	7	If urethral injury is suspected.	Med
X-ray intravenous urography	4		Med
X-ray cystography	4		Med
INV arteriography kidney	4		Med
US organ	3		None
US pelvis (bladder)	3		None
MRI kidneys and bladder	2		None
<b>Rating Scale:</b> 1=Least appropriate, 9=Most appropriate			<b>*Relative Radiation Level</b>

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# BLUNT ABDOMINAL TRAUMA

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## Summary of Literature Review

This review considers only the issue of blunt abdominal trauma in adults. Penetrating trauma and pediatric cases are not considered. Since the original summaries of literature in 1996 and 1999, a continued trend is noted in which imaging is used less for mere detection of intraperitoneal fluid (which correlates with injury but does not predict the need for therapeutic surgery) and more for detection of specific findings that do predict the need for therapeutic surgery or for angiographic embolization or that predict a period of close observation is needed for an injured patient. This trend in imaging parallels a strong trend in trauma therapy toward nonoperative management of injuries of the spleen, liver, and kidney even when hemoperitoneum is present. This new approach decreases the frequency of nontherapeutic surgery [1-9].

### Category A

*Hemodynamically unstable* patients presenting to the emergency room with clinically obvious major abdominal trauma and with unresponsive profound hypotension need rapid clinical evaluation and immediate resuscitation with volume replacement. If such unstable patients do not respond to resuscitation (become hemodynamically stable), *and* if they have clear clinical evidence of abdominal injury, they should go immediately to the operating room without imaging [10,11]. During resuscitative efforts if time and circumstances permit, conventional radiographs of the chest and abdomen are often obtained as part of trauma protocols. This may help identify a pneumothorax, pneumoperitoneum or significant bone injury. Ultrasound (US) performed by an experienced sonologist to check for intraperitoneal free fluid may quickly provide information that can support a decision to operate immediately, with the caveat that the false negative rate is at least 15% [12,13]. More detailed

US to check for organ injury takes too long in this setting and suffers from poor sensitivity [12]. There is now general agreement that routine diagnostic peritoneal lavage (DPL) is obsolete because of its invasive nature, lack of specificity, and inability to predict the need for therapeutic surgery [12,14,15].

### Category B

*Hemodynamically stable* patients, patients with mild to moderate responsive hypotension presenting to the emergency room after blunt abdominal trauma, and unstable patients who stabilize after initial resuscitation are in a separate category. These patients typically have a history of significant trauma and have at least moderate suspicion of intra-abdominal injury based on clinical signs and symptoms. For these patients, two decisions need to be made: (1) Is urgent therapeutic surgery or angiography needed? (2) If surgery is not needed, is a period of close observation warranted? If computed tomography (CT) is to be performed, radiographs will offer little if any incremental help with those questions. Rather, the decision to proceed with urgent surgery depends on the identification of specific CT criteria that predict that the surgery will be therapeutic: active hemorrhage, parenchymal “blush” or pseudoaneurysm in the spleen, or perforation of a hollow viscus (including the pancreatic duct) [16-27]. In patients with active hemorrhage or pseudoaneurysm of the spleen, angiographic embolization may also be therapeutic [16,17,28,29]. The decision to operate urgently does not solely depend on the identification of hemoperitoneum or the identification of parenchymal injury to the liver or spleen, because most patients in this category ultimately do not need surgery [2,3,30]. However, accurate identification of hemoperitoneum or organ injury is important [19,31,32] because patients with these findings require at least a period of close observation. Patients with multiple organ injury or significant active bleeding may need surgery even if they are hemodynamically stable [11,33,34]. Conversely, stable patients with isolated organ injury may not need surgery (or may need only angiography plus embolization) even with a large amount of hemoperitoneum [35,36].

Either way, time is available in such patients to obtain chest and abdominal radiographs, a hematocrit plus blood chemistries, and a urinalysis. If a reliable abdominal exam can be performed (the patient is conscious and does not need prolonged anesthesia for other procedures) and all the above preliminary tests are unremarkable, a period of close observation may be all that is needed. However, if a reliable abdominal exam cannot be performed (patient is unconscious or prolonged nonabdominal surgery is anticipated) or if a clinical evaluation suggests organ

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injury, hemoperitoneum, or peritonitis, further imaging is needed.

At this point, US is not a good modality for further imaging because it misses up to 25% of liver and spleen injuries, most renal injuries, and virtually all pancreatic, mesenteric, and gut injuries [10,37-47]. It also misses a high proportion of retroperitoneal hemorrhage and of bladder rupture. Combining the results for US in 1535 abdominal trauma patients from eight published series yields an average US sensitivity for hemoperitoneum of 88% and for organ injury of 74% [37,39,41,48-51]. Unfortunately, a negative US (absence of hemoperitoneum) does not rule out significant organ or viscus injury that might require surgery or observation [10,37,38,40,44,52-57].

Although US is 63% sensitive to moderate amounts of free intraperitoneal fluid (compared with CT), 400-600 cc are needed for US detection of fluid in the trauma setting [13,58]. Almost regardless of volume, an US diagnosis of free fluid alone does not predict that surgery is needed nor that surgery will be therapeutic [30,59]. In addition, in the best of hands, there is at least a 15% false negative rate for detecting hemoperitoneum with US [32]. Further, US is quite insensitive in detecting organ injury: 62% of spleen and 14% of liver injuries are missed compared with CT and operative findings [13,15,59]. US poorly identifies active hemorrhage and also does not accurately predict the need for surgery in splenic injuries [59,60].

US is also insensitive to perforation of gut and to pancreatic injury [32,60]. For these reasons, it is not very useful in deciding when a patient needs urgent therapeutic surgery or angiography [31,60,61]. For the same reasons, US is not an accurate modality to determine whether a patient needs a period of close observation; thus, if a negative US is the sole imaging modality used to triage a patient, for safety reasons it must be followed by a 12-24 hour period of in-hospital observation [62,63]. It should be noted that 96% of trauma centers perform fewer than two trauma US exams per month, so there is currently little national experience with or teaching of trauma US [64].

In contrast, for category B trauma patients, CT accurately predicts if therapeutic surgery is urgently needed by identifying active hemorrhage, splenic injury (either parenchymal contrast blush or pseudoaneurysm), gut perforation, and pancreatic injury [16-23]. For these reasons, it is an excellent modality for deciding whether a patient needs urgent therapeutic surgery or is a candidate for therapeutic angiography [4,5,16,17,20,23-25,28,65]. Because CT is sensitive in detecting both hemoperitoneum [19,21,23,65-67] and injury to the liver (sensitivity 93%) and spleen (sensitivity 95%), it is an accurate modality for deciding if a patient needs a period of close observation. The trend toward placing helical CT scanners close to or in emergency departments has

substantially diminished the delay in getting patients to the CT scanner and has decreased actual scan time to less than 40 seconds [23,66]. In most circumstances, results from a helical CT of the abdomen and pelvis can be obtained faster than results from a detailed US that includes evaluation of abdominal organs and gut [14].

If multidetector CT (MDCT) with rapid image display capability is available in or next to an emergency department, abdominal CT can be performed in about 2 minutes—excluding time needed for patient transport, CT scan setup, and archiving of images. Including all time requirements, patient turnaround with rapid-process MDCT CT can be less 10 minutes for a trauma patient. For single-slice incremental CT, turnaround time is somewhat longer, usually 20 minutes. Scanning multiple body regions increases these times variably.

An experienced radiologist should carefully examine images on film, PACS, or at the CT console, where images can be altered to seek bone injury, pneumoperitoneum, or subtle organ injury. Particular care should be taken to find minimal injury of the spleen because these patients may need observation for potential delayed hemorrhage [11,33,52,68]. In some instances, stable patients with more severe injuries of the liver or spleen plus hemoperitoneum may be managed conservatively with only close observation [11,34-36,52,53,69-74]. It should be noted, however, that various schemes for using CT to grade liver or spleen lacerations are not helpful in deciding whether a patient needs surgery. This decision must be based on the clinical status of the patient in combination with the image findings. If evidence of active hemorrhage is discovered on CT exams, the patient may be taken to the operating room or undergo arteriography plus embolization to control the hemorrhage [24,25,36,75-77].

The CT exam should be carefully examined for subtle signs of pancreatic injury because these patients may need immediate surgery or close observation for signs of complication [44]. Duodenal perforation produces subtle but frequent findings on CT, e.g., typically extraluminal air or contrast in the retroperitoneum or elsewhere; these findings mandate surgical intervention [78]. Duodenal hematoma may not require surgery but does need close observation. Other gut injury or perforation produces direct or indirect findings on CT in 50% to 94% of cases [26,27,54,79,80]. However, if the CT is negative for gut injury in the face of a high clinical suspicion, DPL, laparoscopy, or a period of observation plus repeat CT may be used to further evaluate the patient [81].

There may be a rationale for creating a subcategory of stable patients with trivial trauma, a low clinical index of suspicion, and no signs or symptoms of intra-abdominal injury. In such patients, a negative US alone may be adequate to release the patient from observation at a lower

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cost than if CT had been used [32,60]. CT is necessary, however, if there are any positive findings on US.

It may also be reasonable to use CT, in conjunction with the clinical information, to decide whether to observe patients in the hospital for a day or send them home promptly at the completion of their investigation in the emergency department. The high sensitivity of CT in detecting injuries that require observation in the hospital means that a negative CT may be adequate to release the patient to home in selected cases. US has a substantially lower sensitivity to the kind of injuries that must be observed in the hospital. For this reason, a negative US is not adequate to safely release the patient to home. This weakness of US is reflected in the design of many outcomes-based investigations on the use of US in trauma: all keep patients with a negative US in the hospital for a period of observation of 12- 48 hours before release [31,62,63].

### Category C

*Patients with hematuria* require some modification to the imaging workup. Patients with microscopic hematuria (less than 35 RBC per HPF) do not need specific urinary tract imaging. All patients with microscopic hematuria greater than 35 RBCs per HPF, with macroscopic hematuria, or with fracture/diastasis of the symphysis pubis and its rami plus any hematuria need imaging of the urinary tract [8,9,45,46,82-85]. If the urethral meatus has gross blood, if there is a floating prostate, or if a Foley catheter cannot be passed, a retrograde urethrogram should first be performed to rule out urethral injury [86,87]. However, if clinical evaluation or the urethrogram indicates no urethral injury, a CT cystogram should be added to the abdominal CT (see appendix). CT images should be examined carefully for evidence of renal perfusion, hemorrhage, or extravasation of contrast or urine from the kidney or bladder. Two studies have documented the poor ability of US to detect injuries of the kidney [13,88]. All but the worst renal injuries are treated with observation; intraperitoneal bladder rupture is usually treated with surgical repair.

Several new issues in the imaging of blunt abdominal trauma will certainly be investigated soon. Does magnetic resonance imaging (MRI) have any role in evaluating trauma patients? Might MR be more sensitive in detecting subtle organ injury that should lead to close observation of the patient for a period [89,90]? The advent of rapid MDCT placed in or very near to emergency departments may change the treatment of some unstable patients [91-93]. It is possible that information from a quick helical CT or MDCT, which localizes injury or hemorrhage in an unstable patient, will enable surgeons to directly approach a specific injury, rather than use the traditional techniques of surgical exploration. This might facilitate more rapid control of the patient in the operating room, improving outcome. Angiography with embolization of active

hemorrhage has shown great capability for stopping bleeding while preserving organs [4,5,94]. Color Doppler US may ultimately prove useful, although ready availability and expertise of the sonologist/interpreter will be necessary [51,95].

### Appendix

#### CT Technique

Good CT technique requires the use of water-soluble oral contrast when time is available (500 cc PO or per NG tube 20 minutes before scanning, 250 cc on the CT table) [54,69,78]. In unstable patients, administration of oral contrast should not delay scanning, but oral contrast often can be administered during transportation of the patient or during scan setup in the CT suite. Scanning without oral contrast or with water as the oral contrast agent has also been proposed [96,97]. Intravenous contrast is necessary, usually 140 to 180 cc administered at 3 to 5 cc per second 70-80 seconds before to starting MDCT. For single-slice CT, injection rate and delay may be modified to 2 cc per second and 50 seconds. Scanning should include the interior lung fields to the inferior aspect of the ischia at 2.5 mm to 10 mm intervals using 2.5 mm to 7 mm thick slice reconstructions. High-detector-count CT scanners (16, 32, and 64 slice) may make practical rapid single pass whole body CT with quick 3D image review [98].

For a CT cystogram, a Foley catheter is placed and 200 to 300 cc of 15% contrast is instilled before the abdomen and pelvic CT exam [71,83]. At the conclusion of the CT exam, the bladder should be drained through the Foley and repeat CT cuts obtained through the low pelvis to complete the CT cystogram.

#### Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations	
Relative Radiation Level	Effective Dose Estimate Range
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv

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