American College of Radiology
ACR Appropriateness Criteria®
Major Blunt Trauma

<u>Variant: 1</u> Adult. Major blunt trauma. Hemodynamically unstable. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography trauma series	Usually Appropriate	☢☢☢
CT whole body with IV contrast	May Be Appropriate	☢☢☢☢
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
CT whole body without IV contrast	Usually Not Appropriate	☢☢☢☢

<u>Variant: 2</u> Adult. Major blunt trauma. Hemodynamically stable. Not otherwise specified. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography trauma series	Usually Appropriate	☢☢☢
CT whole body with IV contrast	Usually Appropriate	☢☢☢☢
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
CT whole body without IV contrast	Usually Not Appropriate	☢☢☢☢

<u>Variant: 3</u> Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography trauma series	Usually Appropriate	☢☢☢
CT maxillofacial without IV contrast	Usually Appropriate	☢☢
CT head without IV contrast	Usually Appropriate	☢☢☢
CTA head and neck with IV contrast	Usually Appropriate	☢☢☢
CT whole body with IV contrast	Usually Appropriate	☢☢☢☢
CT whole body without IV contrast	May Be Appropriate	☢☢☢☢
MRI head without IV contrast abbreviated	Usually Not Appropriate	O
CT maxillofacial with IV contrast	Usually Not Appropriate	☢☢
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CT maxillofacial without and with IV contrast	Usually Not Appropriate	☢☢☢

<u>Variant: 4</u> Adult. Major blunt trauma. Hemodynamically stable. Suspected extremity trauma. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography trauma series	Usually Appropriate	☢☢☢
Radiography extremity area of interest	Usually Appropriate	Varies
CT whole body with IV contrast	Usually Appropriate	☢☢☢☢
CTA extremity area of interest with IV contrast	May Be Appropriate	Varies
US duplex Doppler extremity area of interest	Usually Not Appropriate	O

CT whole body without IV contrast	Usually Not Appropriate	☢☢☢☢
CT extremity area of interest with IV contrast	Usually Not Appropriate	Varies
CT extremity area of interest without and with IV contrast	Usually Not Appropriate	Varies
CT extremity area of interest without IV contrast	Usually Not Appropriate	Varies

Variant: 5 Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or mesenteric trauma. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography trauma series	Usually Appropriate	☢☢☢
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT whole body with IV contrast	Usually Appropriate	☢☢☢☢
CTA abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
CT whole body without IV contrast	May Be Appropriate	☢☢☢☢
US abdomen	Usually Not Appropriate	O
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 6 Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography trauma series	Usually Appropriate	☢☢☢
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT whole body with IV contrast	Usually Appropriate	☢☢☢☢
CT pelvis with bladder contrast (CT cystography)	May Be Appropriate (Disagreement)	☢☢☢☢
CTA abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢☢
US abdomen and pelvis	Usually Not Appropriate	O
Fluoroscopy cystography	Usually Not Appropriate	☢☢☢
Fluoroscopy retrograde urethrography	Usually Not Appropriate	☢☢☢
Radiography intravenous urography	Usually Not Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
MRU without and with IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT whole body without IV contrast	Usually Not Appropriate	☢☢☢☢
CTU without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 7 Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography trauma series	Usually Appropriate	☢☢☢
CT chest with IV contrast	Usually Appropriate	☢☢☢

CTA chest with IV contrast	Usually Appropriate	☢☢☢
CT whole body with IV contrast	Usually Appropriate	☢☢☢☢
CT whole body without IV contrast	May Be Appropriate	☢☢☢☢
US chest	Usually Not Appropriate	O
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢
CT chest without IV contrast	Usually Not Appropriate	☢☢☢

<u>Variant: 8</u> Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US pregnant uterus	Usually Appropriate	O
Radiography trauma series	Usually Appropriate	☢☢☢
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CTA chest with IV contrast	May Be Appropriate (Disagreement)	☢☢☢
CT whole body with IV contrast	May Be Appropriate	☢☢☢☢
CTA abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢☢
US abdomen and pelvis	Usually Not Appropriate	O
US pelvis	Usually Not Appropriate	O
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT whole body without IV contrast	Usually Not Appropriate	☢☢☢☢

Panel Members

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Summary of Literature Review

Introduction/Background

Trauma remains the leading cause of mortality for people in the United States who are <45 years of age, and it is the fourth leading cause of death overall [1]. Polytrauma can be defined as an injury to at least 2 body parts, including the head, neck, chest, abdomen, pelvis, or an extremity, with any one or a combination of these injuries being potentially fatal.

This document covers imaging of major blunt trauma or polytrauma resulting in multiple organ injuries. Burn injuries and injuries to pediatric patients are excluded. Separate ACR Appropriateness Criteria® topics are available for injuries that relate to "Penetrating Torso Trauma" [2], "Head Trauma" [3], and "Acute Spinal Trauma" [4].

Special Imaging Considerations

The ACR defines practice parameters and technical standards for ultrasound (US) examinations. These US examinations are ordered by clinicians and performed in radiology departments with interpretation by radiologists. For the purposes of this document, the examination, listed on the variant tables and described in the variants below, is the US procedure as defined by the ACR practice parameters and technical standards.

Deviations from these examinations include but are not limited to targeted Point-of-Care US (POCUS), Focused Assessment with Sonography (FAST), and extended-FAST (E-FAST). These examinations are often performed at bedside as part of a clinical examination, are fundamentally different from comprehensive diagnostic US examinations, and are not performed in the radiology department or interpreted by radiologists.

FAST has been used as a triage tool in the trauma bay or prehospital setting. An alternative version of the traditional FAST examination, called E-FAST, includes US images of the chest as well as the abdomen to assess not only for free fluid in the abdomen but also for traumatic hemothorax and pneumothorax. Although FAST and E-FAST have been proven to have a high specificity for the aforementioned sequela of blunt traumatic injury, they demonstrate fairly low sensitivity of 42.9% and thus are not adequate imaging modalities to exclude significant traumatic injury to the chest or abdomen [5-7].

The acquisition speed of CT has enabled protocols for whole body trauma, considered as “CT whole body” in several variants and referred to as whole body CT (WBCT) in this document. The acquisition entails CT imaging of the head and cervical spine without and/or with intravenous (IV) contrast, concurrently or followed by CT imaging of the chest, abdomen, and pelvis either with or without IV contrast depending on the variant procedure listed. CT of the chest, abdomen, and pelvis with IV contrast images typically includes 1 bolus of contrast material. CT protocols vary depending upon both institutional protocols and clinical presentation. Multiphasic protocols that include an arterial phase may improve the identification and characterization of vascular injuries, whereas the assessment of solid organs in the abdomen and pelvis is best performed during the portal venous phase [6]. The American Association for the Surgery of Trauma recommends dual-phase CT (arterial and venous phases) for accurate diagnosis of vascular injuries of the solid organs including the spleen, liver, or kidney [8]. Throughout this document, CT angiography (CTA) will presuppose at least 2 postcontrast phases of imaging in addition to the angiography phase. When there is suspicion or knowledge of renal injury, delayed excretory phase imaging should be acquired [9].

For the purposes of distinguishing between CT and CTA, ACR Appropriateness Criteria topics use the definition in the ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA) [10]:

“CTA uses a thin-section CT acquisition that is timed to coincide with peak arterial and/or venous enhancement, depending on the vascular structures to be analyzed. The resultant volumetric data set is interpreted using primary transverse reconstructions as well as multiplanar reformations and 3-D renderings.”

All elements are essential: 1) timing, 2) reconstructions/reformats, and 3) 3-D renderings. Standard

CTs with contrast also include timing issues and reconstructions/reformats. Only in CTA, however, is 3-D rendering a **required** element. This corresponds to the definitions that the CMS has applied to the Current Procedural Terminology codes.

CT urography (CTU) is an imaging study that is tailored to improve visualization of both the upper and lower urinary tracts. Although specific parameters and timing of image acquisition may vary, CTU with and without IV contrast should include, at the very least, unenhanced images followed by contrast-enhanced images in the nephrographic and excretory phases acquired at least 5 minutes after contrast injection. Reconstruction methods commonly include maximum intensity projection or 3-D volume rendering. For the purposes of this document, we make a distinction between CTU and CT abdomen and pelvis without and with IV contrast. CT abdomen and pelvis without and with IV contrast is defined as any protocol not specifically tailored for evaluation of the upper and lower urinary tracts and without both the precontrast and excretory phases.

MR urography (MRU) is tailored to improve imaging of the urinary system. Although specific parameters and timing of image acquisition may vary, MRU without and with IV contrast should include T2-weighted images as well as precontrast and postcontrast-enhanced T1-weighted series with images acquired during the corticomedullary, nephrographic, and excretory phase. MRU without IV contrast relies upon heavily T2-weighted imaging of the intrinsic high signal intensity from urine for evaluation of the urinary tract. For the purposes of this document, we make a distinction between MRU and MRI abdomen and pelvis without and with IV contrast. MRI abdomen and pelvis without and with IV contrast is defined as any protocol not specifically tailored for evaluation of the upper and lower urinary tracts, without both the precontrast and excretory phases, and without heavily T2-weighted images of the urinary tract.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (i.e., only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care)

OR

- There are complementary procedures (i.e., more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient’s care).

Discussion of Procedures by Variant

Variant 1: Adult. Major blunt trauma. Hemodynamically unstable. Initial imaging.

It is important to evaluate the patient for hemodynamic stability before deciding on an appropriate imaging modality. If the patient is hemodynamically stable, defined as having a systolic blood pressure ≥90 and a heart rate of 50 to 110 beats per minute, the constellation of imaging modalities that can be safely used for the detection of traumatic injuries will differ from those that are safe for a hemodynamically unstable patient [8]. Appropriate imaging in the case of hemodynamic instability secondary to major blunt trauma will aid in the detection of traumatic injuries and reduce the delay in appropriate treatment to decrease morbidity and/or length of stay.

FAST or E-FAST is often used as a triage tool in the trauma bay or prehospital setting. The high specificity for early detection of free fluid in the abdomen, pneumothorax, hemothorax, and pericardial effusion make it an essential part of the primary trauma survey. However, its relatively low sensitivity make FAST an inadequate imaging modality to exclude significant injury to the chest or abdomen [5,6].

Variant 1: Adult. Major blunt trauma. Hemodynamically unstable. Initial imaging.
A. CT whole body with IV contrast

Patients who remain hemodynamically unstable despite initial attempts at resuscitation and who have positive signs of chest or abdominal trauma (eg, a positive FAST examination) have, in the past, been recommended to proceed directly to exploratory laparotomy, with CT imaging deferred until after operative intervention. Although limited, new literature suggests that imaging of hemodynamically unstable patients in the appropriate clinical context and in a practice environment that allows rapid transport, with continued resuscitation to and from the scanner, may provide additional information about injured viscera while not delaying care in a manner leading to significantly worse outcomes, although further studies are needed [9,11].

Variant 1: Adult. Major blunt trauma. Hemodynamically unstable. Initial imaging.
B. CT whole body without IV contrast

There is no relevant literature to support the use of WBCT without IV contrast in the initial evaluation of the unstable trauma patient. WBCT without IV contrast has a low sensitivity for detecting visceral organ and vascular injury compared with WBCT with IV contrast [12].

Variant 1: Adult. Major blunt trauma. Hemodynamically unstable. Initial imaging.
C. MRI abdomen and pelvis without and with IV contrast

There is no relevant literature to support the use of MRI abdomen and pelvis without and with IV contrast in the initial evaluation of the unstable trauma patient. It is not routinely performed because of the time required in the emergent setting. The use of MRI is mainly reserved for problem-solving of findings identified on initial imaging studies.

Variant 1: Adult. Major blunt trauma. Hemodynamically unstable. Initial imaging.
D. MRI abdomen and pelvis without IV contrast

There is no relevant literature to support the use of MRI abdomen and pelvis without IV contrast in the initial evaluation of the unstable trauma patient. It is not routinely performed because of the time required in the emergent setting. The use of MRI is mainly reserved for problem-solving of findings identified on initial imaging studies.

Variant 1: Adult. Major blunt trauma. Hemodynamically unstable. Initial imaging.
E. Radiography trauma series

Trauma series radiographs in the unstable patient consist of portable radiographs of the chest and pelvis. A portable anteroposterior (AP) chest radiograph helps screen for immediately life-threatening findings, such as tension pneumothorax, hemothorax, and significant mediastinal injury, as well as confirms line placement. However, radiographs have a low sensitivity for injuries such as pneumothorax (39.1%) compared with CT [13]. A portable radiograph of the pelvis can evaluate for unstable pelvic injuries and dislocations that may predispose patients to expanding hemorrhage that may require placement of an external binding device or divert the patient for intravascular embolization procedures [14].

Variant 2: Adult. Major blunt trauma. Hemodynamically stable. Not otherwise specified. Initial imaging.

In the case of nonspecific major blunt polytrauma, the information provided by imaging will allow for the detection of injuries that may be occult on physical examination. Proper imaging will reduce the delay of appropriate interventions and treatment plans and help decrease morbidity and/or length of stay.

FAST is often used as a triage tool in the trauma bay or prehospital setting. Although it can be useful for early detection of free fluid in the abdomen, pneumothorax, hemothorax, and pericardial effusion in the hemodynamically unstable population, its low sensitivity makes it an inadequate imaging modality to exclude significant injury to the chest or abdomen [5,6]. The usefulness of FAST in the hemodynamically stable population remains unclear [15,16].

Variant 2: Adult. Major blunt trauma. Hemodynamically stable. Not otherwise specified. Initial imaging.
A. CT whole body with IV contrast

There remains no practice consensus or validated decision rules for deciding which patients should receive WBCT versus selective CT imaging for blunt trauma. Some studies have found no survival benefit [17]. Meta-analyses have yielded conflicting results concerning improvements in mortality [17-20]. Therefore, clinical judgement remains vital for determining which patients should obtain WBCT versus selective CT.

Indications that may warrant WBCT imaging, as defined above, include high-velocity (>35 mph) motor vehicle collision (MVC), MVC resulting in rollover or passenger ejection, motorcycle trauma, bicycle injury, MVC-pedestrian collision, and a fall from a height of >15 feet. Additional considerations include patient age and functional status, hemodynamic stability, neurological status, physical examination or primary survey, and results of initial imaging from portable radiographs of the chest and pelvis and/or FAST. Patients who have an abnormal chest radiograph in the setting of trauma have clinically significant rates of major injury on the CT chest [20]. CT of the chest, abdomen, and pelvis with IV contrast has a greater sensitivity for detecting visceral organ and vascular injury compared with noncontrast CT [9].

Variant 2: Adult. Major blunt trauma. Hemodynamically stable. Not otherwise specified. Initial imaging.
B. CT whole body without IV contrast

In circumstances in which WBCT is deemed clinically necessary, there is no relevant literature to support the use of WBCT without IV contrast given its relatively low sensitivity for detecting visceral organ and vascular injury compared with WBCT with IV contrast [9].

Variant 2: Adult. Major blunt trauma. Hemodynamically stable. Not otherwise specified. Initial imaging.
C. MRI abdomen and pelvis without and with IV contrast

There is no relevant literature to support the use of MRI abdomen and pelvis without and with IV contrast as initial imaging in patients who are hemodynamically stable, not otherwise specified.

Variant 2: Adult. Major blunt trauma. Hemodynamically stable. Not otherwise specified. Initial imaging.

D. MRI abdomen and pelvis without IV contrast

There is no relevant literature to support the use of MRI abdomen and pelvis without IV contrast as initial imaging in patients who are hemodynamically stable, not otherwise specified. It is not routinely performed because of the time required in the emergent setting. The use of MRI is mainly reserved for problem-solving of findings identified on initial imaging studies.

Variant 2: Adult. Major blunt trauma. Hemodynamically stable. Not otherwise specified. Initial imaging.
E. Radiography trauma series

In the initial workup of a stable patient, trauma series radiographs include portable AP radiographs of the chest and pelvis. A portable AP chest radiograph helps screen for immediately life-threatening findings, such as tension pneumothorax, hemothorax, and significant mediastinal injury, as well as confirms line placement. However, radiographs have a low sensitivity for injuries such as pneumothorax (39.1%) compared with CT [13]. A portable radiograph of the pelvis can evaluate for unstable pelvic injuries and dislocations that may predispose patients to expanding hemorrhage that may require placement of an external binding device or divert the patient for intravascular embolization procedures [14].

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.

In the case of suspected major blunt trauma to the face, the information provided by imaging will allow for the effective detection of facial injuries. Proper imaging will reduce the delay in appropriate interventions and treatment plans.

FAST is often used as a triage tool in the trauma bay or prehospital setting. Although it can be useful for early detection of free fluid in the abdomen, pneumothorax, hemothorax, and pericardial effusion in the hemodynamically unstable population, its low sensitivity makes it an inadequate imaging modality to exclude significant injury to the chest or abdomen [5,6]. The usefulness of FAST in the hemodynamically stable population remains unclear [15,16].

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.
A. CT head with IV contrast

There is no relevant literature to support the use of CT head with IV contrast as initial imaging in patients who are hemodynamically stable with suspected facial injury.

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.
B. CT head without and with IV contrast

There is no relevant literature to support the use of CT head without and with IV contrast as initial imaging in patients who are hemodynamically stable with suspected facial injury.

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.
C. CT head without IV contrast

Intracranial injury can coexist with a facial injury, and the ACR Appropriateness Criteria® topic on "Head Trauma" [3] should be reviewed for further information. For those who meet the criteria for imaging based on mechanism and patients with a Glasgow Coma Score <13, a noncontrast CT of the head is a first-line imaging test in the initial clinical setting. CT imaging allows for the detection of hemorrhage, cerebral edema, and intracranial mass effect, with multiplanar reformation adding greater sensitivity for hemorrhage detection. CT bone algorithm reconstructions provide greater sensitivity for detecting skull fractures.

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.
D. CT maxillofacial with IV contrast

There is no relevant literature to support the use of CT maxillofacial with IV contrast for initial imaging in patients with blunt trauma and expected facial trauma.

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.
E. CT maxillofacial without and with IV contrast

There is no relevant literature to support the use of CT maxillofacial without and with IV contrast for patients with blunt trauma and expected facial trauma.

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.
F. CT maxillofacial without IV contrast

In patients who have suspected osseous or soft tissue maxillofacial injuries as well as skull base injuries, a noncontrast CT through the maxillofacial region has a higher sensitivity and specificity for detecting facial fractures than skull radiographs. Often, these images can be reconstructed from the head and cervical spine source data.

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.
G. CT whole body with IV contrast

The decision regarding which patients should receive WBCT versus selective CT imaging for blunt trauma will depend on factors beyond facial injury. There remains no practice consensus or validated decision rules for deciding which patients should receive WBCT versus selective CT imaging for blunt trauma. Some studies have found no survival benefit [17]. Meta-analyses have yielded conflicting results concerning improvements in mortality [17-20]. Therefore, clinical judgement remains vital for determining which patients should obtain WBCT versus selective CT.

Indications that may warrant WBCT imaging, as defined above, include high-velocity (>35 mph) MVC, MVC resulting in rollover or passenger ejection, motorcycle trauma, bicycle injury, MVC-pedestrian collision, and a fall from a height of >15 feet. Additional considerations include patient age and functional status, hemodynamic stability, neurological status, and results of initial imaging from portable radiographs of the chest and pelvis and/or FAST. CT of the chest, abdomen, and pelvis with IV contrast has a greater sensitivity for detecting visceral organ and vascular injury compared with noncontrast CT [9]. Patients who have an abnormal chest radiograph in the setting of trauma have clinically significant rates of major injury on the CT chest [20].

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.
H. CT whole body without IV contrast

The decision regarding which patients should receive WBCT with IV contrast versus selective CT imaging for blunt trauma will depend on factors beyond facial injury, but in circumstances in which WBCT is deemed clinically necessary, WBCT without IV contrast has a low sensitivity for detecting visceral organ and vascular injury compared with WBCT with IV contrast [9].

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.
I. CTA head and neck with IV contrast

Although rare, undiagnosed blunt cerebral vascular injury (BCVI) may have catastrophic sequalae [21,22]. Facial injuries, as described in several clinical screening algorithms, are among the known risk factors for BCVI. Injuries may occur throughout the cervical and cerebrovascular system but are most commonly identified in the carotid and vertebral arteries. CTA of the head and neck are effective examinations for detecting BCVI.

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.
J. MRI head without IV contrast abbreviated

There is no relevant literature to support the use of MRI head without and with IV contrast abbreviated as initial imaging. It is not routinely performed first because of the time required in the emergent setting and the ease of acute hemorrhage diagnosis on CT.

Variant 3: Adult. Major blunt trauma. Hemodynamically stable. Suspected facial injury. Initial imaging.
K. Radiography trauma series

In the setting of blunt facial trauma, facial and cervical lateral radiographs may also be part of the initial trauma series radiographs, which also typically consists of portable radiographs of the chest and pelvis. A single cervical radiograph can rapidly evaluate for severe fracture, abnormal alignment, and prevertebral swelling, but it lacks sensitivity for nondisplaced fractures when compared with CT. A portable AP chest radiograph helps screen for immediately life-threatening findings, such as tension pneumothorax, hemothorax, and significant mediastinal injury, as well as confirms line placement. However, radiographs have a low sensitivity for injuries such as pneumothorax (39.1%) compared with CT [13]. A portable radiograph of the pelvis can evaluate for unstable pelvic injuries and hip dislocation [14].

Variant 4: Adult. Major blunt trauma. Hemodynamically stable. Suspected extremity trauma. Initial imaging.

In the case of suspected major blunt trauma to an extremity, the information provided by imaging will allow for the effective detection of specific extremity injuries. Proper imaging will reduce the delay in appropriate interventions and treatment plans.

FAST is often used as a triage tool in the trauma bay or prehospital setting. Although it can be useful for early detection of free fluid in the abdomen, pneumothorax, hemothorax, and pericardial effusion, its low sensitivity makes it an inadequate imaging modality to exclude significant injury to the chest or abdomen [5,6].

Variant 4: Adult. Major blunt trauma. Hemodynamically stable. Suspected extremity trauma. Initial imaging.
A. CT extremity area of interest with IV contrast

Routine CT of an extremity of interest with IV contrast can elucidate vascular injury to a better advantage than noncontrast CT, but if an arterial injury is suspected, it is not as sensitive or specific as CTA of the extremity of interest [9,23]. Routine CT of the extremity with IV contrast in the absence of suspected vascular injury is not supported in the literature.

Variant 4: Adult. Major blunt trauma. Hemodynamically stable. Suspected extremity trauma. Initial imaging.
B. CT extremity area of interest without and with IV contrast

There is no relevant literature to support the use of CT of an extremity of interest without and with IV contrast in the setting of major blunt trauma with expected extremity trauma.

Variant 4: Adult. Major blunt trauma. Hemodynamically stable. Suspected extremity trauma. Initial imaging.
C. CT extremity area of interest without IV contrast

CT of an extremity of interest without IV contrast can be used for fracture characterization, detection of radiographically occult fractures, or operative planning but is not useful in the case of suspected vascular injury. Furthermore, CT as the initial imaging procedure for extremity injuries is not supported in the literature.

Variant 4: Adult. Major blunt trauma. Hemodynamically stable. Suspected extremity trauma. Initial imaging.
D. CT whole body with IV contrast

The decision regarding which patients should receive WBCT with IV contrast versus selective CT imaging for blunt trauma will depend on factors beyond extremity injury. There remains no practice consensus or validated decision rules for deciding which patients should receive WBCT versus selective CT imaging for blunt trauma. Some studies have found no survival benefit [17]. Meta-analyses have yielded conflicting results concerning improvements in mortality [17-20]. Therefore, clinical judgement remains vital for determining which patients should obtain WBCT versus selective CT.

Indications that may warrant WBCT imaging, as defined above, include high-velocity (>35 mph) MVC, MVC resulting in rollover or passenger ejection, motorcycle trauma, bicycle injury, MVC-pedestrian collision, and a fall from a height of >15 feet. Additional considerations include patient age and functional status, hemodynamic stability, neurological status, and results of initial imaging from portable radiographs of the chest and pelvis and/or FAST. CT of the chest, abdomen, and pelvis with IV contrast has a greater sensitivity for detecting visceral organ and vascular injury compared with noncontrast CT [9]. Patients who have an abnormal chest radiograph in the setting of trauma have clinically significant rates of major injury on the CT chest [20].

Variant 4: Adult. Major blunt trauma. Hemodynamically stable. Suspected extremity trauma. Initial imaging.
E. CT whole body without IV contrast

The decision regarding which patients should receive WBCT with IV contrast versus selective CT imaging for blunt trauma will depend on factors beyond extremity injury, but in circumstances in which WBCT is deemed clinically necessary, WBCT without IV contrast has a low sensitivity for detecting visceral organ and vascular injury compared with WBCT with IV contrast [9,12,24].

Variant 4: Adult. Major blunt trauma. Hemodynamically stable. Suspected extremity trauma. Initial imaging.
F. CTA extremity area of interest with IV contrast

In circumstances in which extremity arterial injury is suspected, CTA of an upper or lower extremity injury is sensitive and specific for detecting arterial injury [9,12,23,24].

Variant 4: Adult. Major blunt trauma. Hemodynamically stable. Suspected extremity trauma.

Initial imaging.
G. Radiography extremity area of interest

Single-view radiographs of an extremity of interest take little time in the trauma bay and can often detect acute fractures. When possible, multiview radiographs of the extremity of interest are more sensitive and specific for acute fracture than single-view.

Variant 4: Adult. Major blunt trauma. Hemodynamically stable. Suspected extremity trauma. Initial imaging.
H. Radiography trauma series

In the initial workup of a stable patient, trauma series radiographs include portable AP radiographs of the chest and pelvis. A portable AP chest radiograph helps screen for immediately life-threatening findings, such as tension pneumothorax, hemothorax, and significant mediastinal injury, as well as confirms line placement. However, radiographs have a low sensitivity for injuries such as pneumothorax (39.1%) compared with CT [13]. A portable radiograph of the pelvis can evaluate for unstable pelvic injuries and hip dislocation [14].

Variant 4: Adult. Major blunt trauma. Hemodynamically stable. Suspected extremity trauma. Initial imaging.
I. US duplex Doppler extremity area of interest

There is no relevant literature to support the use of duplex Doppler US of an extremity as initial imaging in the case of major blunt trauma with expected extremity injury. This examination should not be confused with bedside, nonimaged based Doppler examinations.

Variant 5: Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or mesenteric trauma. Initial imaging.

In the case of suspected major blunt trauma to the bowel, the information provided by imaging will allow for the effective detection of bowel injury. Proper imaging will reduce the delay in appropriate interventions and treatment plans.

FAST is often used as a triage tool in the trauma bay or prehospital setting. Although it can be useful for early detection of free fluid in the abdomen, pneumothorax, hemothorax, and pericardial effusion, its low sensitivity makes it an inadequate imaging modality to exclude significant injury to the chest or abdomen [5,6].

Variant 5: Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or mesenteric trauma. Initial imaging.
A. CT abdomen and pelvis with IV contrast

For blunt trauma, CT of the abdomen and pelvis with IV contrast is most often obtained in the portal venous phase 70 seconds after contrast administration and has a high sensitivity and specificity for characterization of solid organ injury. The administration of oral contrast material has not been found to alter the sensitivity or specificity for blunt abdominal injuries, and its administration can delay the definitive diagnosis of other injuries [25-27].

Variant 5: Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or mesenteric trauma. Initial imaging.
B. CT abdomen and pelvis without and with IV contrast

There is no relevant literature to support the use of CT abdomen and pelvis without and with IV contrast as initial imaging in patients major blunt trauma and suspected bowel injury.

Variant 5: Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or mesenteric trauma. Initial imaging.
C. CT abdomen and pelvis without IV contrast

CT abdomen and pelvis without IV contrast has a low sensitivity for detecting visceral organ and vascular injury compared with WBCT with IV contrast [9].

Variant 5: Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or mesenteric trauma. Initial imaging.
D. CT whole body with IV contrast

There remains no practice consensus or validated decision rules for deciding which patients should receive WBCT versus selective CT imaging for blunt trauma. Some studies have found no survival benefit [17]. Meta-analyses have yielded conflicting results concerning improvements in mortality [17-20]. Therefore, clinical judgement remains vital for determining which patients should obtain WBCT versus selective CT.

Indications that may warrant WBCT imaging, as defined above, include high-velocity (>35 mph) MVC, MVC resulting in rollover or passenger ejection, motorcycle trauma, bicycle injury, MVC-pedestrian collision, and a fall from a height of >15 feet. Additional considerations include patient age and functional status, hemodynamic stability, neurological status, and results of initial imaging from portable radiographs of the chest and pelvis and/or FAST. CT of the chest, abdomen, and pelvis with IV contrast has a greater sensitivity for detecting visceral organ and vascular injury compared with noncontrast CT [9]. Patients who have an abnormal chest radiograph in the setting of trauma have clinically significant rates of major injury on the CT chest [20]. The administration of oral contrast material has not been found to alter the sensitivity or specificity for blunt abdominal injuries, and its administration can delay the definitive diagnosis of other injuries [25-27].

Variant 5: Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or mesenteric trauma. Initial imaging.
E. CT whole body without IV contrast

WBCT without IV contrast has a low sensitivity for detecting visceral organ and vascular injury compared with WBCT with IV contrast [9].

Variant 5: Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or mesenteric trauma. Initial imaging.
F. CTA abdomen and pelvis with IV contrast

CT in the arterial phase may be carried through the abdomen and pelvis to assess for active arterial bleeding or injury to abdominopelvic viscera and soft tissues. If 3-D reconstructions are included, then it is considered a CTA study to more closely evaluate for findings such as pseudoaneurysm, segmental hypoenhancement, arterial beading, or cutoff [26,27]. CTA of the abdomen has been shown to detect more splenic vascular injuries than CT of the abdomen in the portal venous phase alone [24,26,27].

Variant 5: Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or mesenteric trauma. Initial imaging.
G. MRI abdomen and pelvis without and with IV contrast

There is no relevant literature to support the use of MRI of the abdomen and pelvis without and with IV contrast as initial imaging in patients with major blunt trauma and suspected bowel injury.

Variant 5: Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or

mesenteric trauma. Initial imaging.
H. MRI abdomen and pelvis without IV contrast

There is no relevant literature to support the use of MRI of the abdomen and pelvis without IV contrast as initial imaging in patients with major blunt trauma and suspected bowel injury.

Variant 5: Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or mesenteric trauma. Initial imaging.
I. Radiography trauma series

In the initial workup of a stable patient, trauma series radiographs include portable AP radiographs of the chest and pelvis. A portable AP chest radiograph helps screen for immediately life-threatening findings, such as tension pneumothorax, hemothorax, and significant mediastinal injury, as well as confirms line placement. However, radiographs have a low sensitivity for injuries such as pneumothorax (39.1%) compared with CT [13]. A portable radiograph of the pelvis can evaluate for unstable pelvic injuries and hip dislocation [14].

Variant 5: Adult. Major blunt trauma. Hemodynamically stable. Suspected bowel or mesenteric trauma. Initial imaging.
J. US abdomen

Although US may be able to diagnose certain abdominal injuries, it has a lower specificity and sensitivity for diagnosing visceral organ injury when compared with CT [28]. Bowel injury is a specific setting for which US is limited because of bowel gas. This examination should not be confused with bedside FAST or E-FAST.

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.

In the case of suspected major blunt trauma to the urinary system, the information provided by imaging will allow for the effective detection of injuries to the urinary system, including urethra trauma. Proper imaging will reduce the delay in appropriate interventions [29].

FAST is often used as a triage tool in the trauma bay or prehospital setting. Although it can be useful for early detection of free fluid in the abdomen, pneumothorax, hemothorax, and pericardial effusion, its low sensitivity makes it an inadequate imaging modality to exclude significant injury to the chest or abdomen [5,6].

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
A. CT abdomen and pelvis with IV contrast

For blunt trauma, CT of the abdomen and pelvis with IV contrast is most often obtained in the portal venous phase 70 seconds after contrast administration for ideal characterization of solid organ injury, including the genitourinary system. This may be obtained in conjunction with CTA if there is a concern for renal infarction or arterial injury, as well as delayed imaging of the abdomen and pelvis if perinephric fluid suggests renal pelvis or ureteral trauma [12,24]. The administration of oral contrast material has not been found to alter the sensitivity or specificity for blunt abdominal injuries, and its administration can delay the definitive diagnosis of other injuries [25].

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
B. CT abdomen and pelvis without and with IV contrast

There is no relevant literature to support the use of CT abdomen and pelvis without and with IV contrast in the setting of major blunt trauma in a hemodynamically stable patient with suspected urinary system trauma.

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
C. CT abdomen and pelvis without IV contrast

CT abdomen and pelvis without IV contrast has a low sensitivity for detecting visceral organ and vascular injury compared with WBCT with IV contrast [9].

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
D. CT Whole Body With IV Contrast

There remains no practice consensus or validated decision rules for deciding which patients should receive WBCT versus selective CT imaging for blunt trauma. Some studies have found no survival benefit [17]. Meta-analyses have yielded conflicting results concerning improvements in mortality [17-20].Therefore, clinical judgement remains vital for determining which patients should obtain WBCT versus selective CT.

Indications that may warrant WBCT imaging, as defined above, include high-velocity (>35 mph) MVC, MVC resulting in rollover or passenger ejection, motorcycle trauma, bicycle injury, MVC-pedestrian collision, and a fall from a height of >15 feet. Additional considerations include patient age and functional status, hemodynamic stability, neurological status, and results of initial imaging from portable radiographs of the chest and pelvis and/or FAST. CT of the chest, abdomen, and pelvis with IV contrast has a greater sensitivity for detecting visceral organ and vascular injury compared with noncontrast CT [9]. Patients who have an abnormal chest radiograph in the setting of trauma have clinically significant rates of major injury on the CT chest [20]. The administration of oral contrast material has not been found to alter the sensitivity or specificity for blunt abdominal injuries, and its administration can delay the definitive diagnosis of other injuries [25].

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
E. CT Whole Body Without IV Contrast

WBCT without IV contrast has a low sensitivity for detecting visceral organ and vascular injury compared with WBCT with IV contrast [9,11].

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
F. CTA Abdomen And Pelvis With IV Contrast

CTA of the abdomen and pelvis may be performed to assess for active arterial bleeding. CTA of the abdomen has been shown to detect vascular injuries more often than CT of the abdomen without IV contrast or in the portal venous phase alone [9,12,23,24]. However, arterial phase imaging without 3-D reformations can also detect bleeding.

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
G. CTU Without And With IV Contrast

There is no relevant literature to support the use of CTU in the initial evaluation of patients who are hemodynamically stable with suspected urinary system or urethral trauma; however, it can be useful as adjunct imaging to better elucidate the trauma to the urinary system after initial imaging.

Some studies have shown longer delayed postcontrast imaging in CTU correlates with increased detection of urinary system injuries causing urinary extravasation of contrast [30,31].

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
H. CT Pelvis with Bladder Contrast (CT Cystography)

CT cystography has become the first-line imaging technique to evaluate for suspected bladder injury because it is both sensitive and specific and can provide the key anatomic location of the bladder injury (ie, intraperitoneal versus extraperitoneal). Active filling of the bladder through gravity instillation is recommended, because passive filling may be inadequate to identify injuries [29].

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
I. Fluoroscopy Retrograde Urethrography

In a male patient, gross blood at the urethral meatus may indicate a urethral injury, for which a retrograde urethrogram (RUG) is often used to evaluate urethral integrity [31]. RUG identify the presence and location of injuries to guide management, but it is usually not part of the initial imaging workup.

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
J. Fluoroscopy Cystography

Conventional cystography was previously widely used as an imaging technique to evaluate for suspected bladder injury because it is both sensitive and specific and can provide the key anatomic location of the bladder injury (ie, intraperitoneal versus extraperitoneal). Active filling of the bladder through gravity instillation is recommended, because passive filling may be inadequate to identify injuries. CT cystography has largely replaced conventional cystography because it can be performed at the same time as whole body imaging and does not require transporting the patient to the fluoroscopy suite [29].

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
K. MRI abdomen and pelvis without and with IV contrast

There is no relevant literature to support the use of MRI of the abdomen and pelvis without and with IV contrast in the initial evaluation of patients who are hemodynamically stable with suspected urinary system or urethral trauma.

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
L. MRI abdomen and pelvis without IV contrast

There is no relevant literature to support the use of MRI of the abdomen and pelvis without IV contrast in the initial evaluation of patients who are hemodynamically stable with suspected urinary system or urethral trauma.

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
M. MRU without and with IV contrast

There is no relevant literature to support the use of MRU without and with IV contrast in the initial evaluation of patients who are hemodynamically stable with suspected urinary system or urethral trauma. MRU is generally reserved as a problem-solving tool or examination.

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
N. Radiography intravenous urography

There is no relevant literature to support the use of IV urography in patients who are hemodynamically stable with suspected urinary system or urethral trauma.

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
O. Radiography trauma series

In the initial workup of a stable patient, trauma series radiographs include portable AP radiographs of the chest and pelvis. A portable AP chest radiograph helps screen for immediately life-threatening findings, such as tension pneumothorax, hemothorax, and significant mediastinal injury, as well as confirms line placement. However, radiographs have a low sensitivity for injuries such as pneumothorax (39.1%) compared with CT [13]. A portable radiograph of the pelvis can evaluate for unstable pelvic injuries and hip dislocation [14].

Variant 6: Adult. Major blunt trauma. Hemodynamically stable. Suspected urinary system trauma. Initial imaging.
P. US abdomen and pelvis

Although US may be able to diagnose certain abdominal injuries, it has a lower sensitivity when diagnosing visceral and vascular injuries compared with CT [28]. This examination should not be confused with bedside FAST or E-FAST.

Variant 7: Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.

In the case of suspected major blunt trauma to the chest, the information provided by imaging will allow for the effective detection of thoracic injuries. Proper imaging will reduce the delay in appropriate interventions and treatment plans.

FAST is often used as a triage tool in the trauma bay or prehospital setting. Although it can be useful for early detection of free fluid in the abdomen, pneumothorax, hemothorax, and pericardial effusion, its low sensitivity makes it an inadequate imaging modality to exclude significant injury to the chest or abdomen [5,6].

Variant 7: Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.
A. CT chest with IV contrast

Although noncontrast CT of the chest can detect most injuries, including rib fractures, pneumothorax, hemothorax, and pulmonary contusion, contrast-enhanced CT of the chest has a higher sensitivity for detecting vascular injuries in patients with major blunt trauma and suspected chest trauma [9]. Regardless of contrast administration, CT is more sensitive and specific for chest trauma than conventional radiographs or US [13,28]. Patients who have an abnormal chest radiograph in the setting of trauma have clinically significant rates of major injury on the CT chest [20].

Variant 7: Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.

B. CT chest without and with IV contrast

There is no relevant literature to support the use of CT chest without and with IV contrast in the setting of major blunt trauma in a hemodynamically stable patient with suspected chest trauma.

Variant 7: Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.
C. CT chest without IV contrast

Although CT chest without IV contrast can detect most injuries in the chest such as pneumothorax, hemothorax, pulmonary contusion, and rib fractures, CT without IV contrast has a low sensitivity for detecting vascular injury compared with WBCT with IV contrast [9].

Variant 7: Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.
D. CT whole body with IV contrast

There remains no practice consensus or validated decision rules for deciding which patients should receive WBCT versus selective CT imaging for blunt trauma. Some studies have found no survival benefit [17]. Meta-analyses have yielded conflicting results concerning improvements in mortality [17-20]. Therefore, clinical judgement remains vital for determining which patients should obtain WBCT versus selective CT.

Indications that may warrant WBCT imaging, as defined above, include high-velocity (>35 mph) MVC, MVC resulting in rollover or passenger ejection, motorcycle trauma, bicycle injury, MVC-pedestrian collision, and a fall from a height of >15 feet. Additional considerations include patient age and functional status, hemodynamic stability, neurological status, and results of initial imaging from portable radiographs of the chest and pelvis and/or FAST. CT of the chest, abdomen, and pelvis with IV contrast has a greater sensitivity for detecting visceral organ and vascular injury compared with noncontrast CT [9]. Patients who have an abnormal chest radiograph in the setting of trauma have clinically significant rates of major injury on the CT chest [20]. The administration of oral contrast material has not been found to alter the sensitivity or specificity for blunt abdominal injuries, and its administration can delay the definitive diagnosis of other injuries [25].

Variant 7: Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.
E. CT whole body without IV contrast

WBCT without IV contrast has a low sensitivity for detecting visceral organ and vascular injury compared with WBCT with IV contrast [9].

Variant 7: Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.
F. CTA chest with IV contrast

CTA of the chest is warranted in the arterial phase primarily when there is a concern for aortic or other major vessel injury [12].

Variant 7: Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.
G. MRI chest without and with IV contrast

There is no relevant literature to support the use of MRI chest without and with IV contrast for the initial evaluation of blunt chest trauma. It is not routinely performed because of the time required in the emergent setting. The use of MRI is mainly reserved for problem-solving of findings identified on initial imaging studies.

Variant 7: Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.
H. MRI chest without IV contrast

There is no relevant literature to support the use of MRI chest without IV contrast for the initial evaluation of blunt chest trauma. It is not routinely performed because of the time required in the emergent setting. The use of MRI is mainly reserved for problem-solving of findings identified on initial imaging studies.

Variant 7: Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.
I. Radiography trauma series

In the initial workup of a stable patient, trauma series radiographs include portable AP radiographs of the chest and pelvis. A portable AP chest radiograph helps screen for immediately life-threatening findings, such as tension pneumothorax, hemothorax, and significant mediastinal injury, as well as confirms line placement. However, radiographs have a low sensitivity for injuries such as pneumothorax (39.1%) compared with CT [13]. A portable radiograph of the pelvis can evaluate for unstable pelvic injuries and hip dislocation [14].

Variant 7: Adult. Major blunt trauma. Hemodynamically stable. Suspected chest trauma. Initial imaging.
J. US chest

There is no relevant literature to support the use of non-FAST US of the chest in patients who are hemodynamically stable with suspected chest trauma. Although it can be useful for detecting pleural fluid and pneumothorax, it lacks sensitivity for pulmonary, aortic, cardiac, and musculoskeletal injury [5,6]. This examination should not be confused with bedside FAST or E-FAST.

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging.

In the case of suspected major blunt trauma to a pregnant patient, the information provided by imaging will allow for the effective detection of traumatic injuries while taking into consideration the safest and most efficient modalities for both the patient and fetus. This will serve to reduce the delay in appropriate interventions and treatment plans.

FAST is often used as a triage tool in the trauma bay or prehospital setting. Although it can be useful for early detection of free fluid in the abdomen, pneumothorax, hemothorax, and pericardial effusion, its low sensitivity makes it an inadequate imaging modality to exclude significant injury to the chest or abdomen [5,6].

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging.
A. CT abdomen and pelvis with IV contrast

For blunt trauma in a pregnant patient, CT of the abdomen and pelvis with IV contrast may still be recommended when there is a life-threatening concern for the mother or fetus. The study is typically performed in the portal venous phase 70 seconds after contrast administration, for ideal characterization of solid organ injury. This may be obtained in conjunction with CTA if there is a concern for renal infarction or arterial injury, as well as delayed imaging of the abdomen and pelvis if perinephric fluid suggests renal pelvis or ureteral trauma [24,25]. The administration of oral contrast material has not been found to alter the sensitivity or specificity for blunt abdominal injuries and is not recommended because it can delay definitive diagnosis of other injuries [31].

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging. B. CT abdomen and pelvis without and with IV contrast

There is no relevant literature to support the use of CT of the abdomen and pelvis without and with IV contrast as initial imaging in patients who are hemodynamically stable and pregnant in the setting of major blunt trauma.

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging. C. CT abdomen and pelvis without IV contrast

CT of the abdomen and pelvis without IV contrast has a low sensitivity for detecting visceral organ injury compared with CT of the abdomen and pelvis with IV contrast [9].

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging. D. CT whole body with IV contrast

Risks and benefits must be specifically weighed regarding WBCT imaging of the pregnant patient. There remains no practice consensus or validated decision rules for deciding which patients should receive WBCT versus selective CT imaging for blunt trauma. Some studies have found no survival benefit [17]. Meta-analyses have yielded conflicting results concerning improvements in mortality [17-20]. Therefore, clinical judgement remains vital for determining which patients should obtain WBCT versus selective CT.

Indications that may warrant WBCT imaging, as defined above, include high-velocity (>35 mph) MVC, MVC resulting in rollover or passenger ejection, motorcycle trauma, bicycle injury, MVC-pedestrian collision, and a fall from a height of >15 feet. Additional considerations include patient age and functional status, hemodynamic stability, neurological status, and results of initial imaging from portable radiographs of the chest and pelvis and/or FAST. CT of the chest, abdomen, and pelvis with IV contrast has a greater sensitivity for detecting visceral organ and vascular injury compared with noncontrast CT, and contrast-enhanced CT of these areas should be primarily considered unless absolutely contraindicated [9]. Patients who have an abnormal chest radiograph in the setting of trauma have clinically significant rates of major injury on the CT chest [20].

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging. E. CT whole body without IV contrast

WBCT has a low sensitivity for detecting visceral organ injury compared with CT of the abdomen and pelvis with IV contrast [9,24].

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging. F. CTA abdomen and pelvis with IV contrast

CTA may be carried through the abdomen and pelvis to assess for active arterial bleeding to abdominopelvic viscera and soft tissues. CTA of the abdomen has been shown to detect more splenic vascular injuries than CT of the abdomen in the portal venous phase alone [24].

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging. G. CTA chest with IV contrast

CTA of the chest in the arterial phase is used in the case of blunt trauma primarily to assess for aortic or other major vessel injury, in addition to other injuries within the chest [9]. Noncontrast CT of the chest has a lower sensitivity for detecting vascular injuries [9].

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging.

H. MRI abdomen and pelvis without and with IV contrast

There is no relevant literature to support the use of MRI abdomen and pelvis without and with IV contrast as initial imaging in patients who are hemodynamically stable and pregnant in the setting of major blunt trauma.

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging.
I. MRI abdomen and pelvis without IV contrast

There is no relevant literature to support the use of MRI abdomen and pelvis without IV contrast as initial imaging in patients who are hemodynamically stable and pregnant in the setting of major blunt trauma.

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging.
J. Radiography trauma series

In the initial workup of a stable patient, trauma series radiographs include portable AP radiographs of the chest and pelvis. A portable AP chest radiograph helps screen for immediately life-threatening findings, such as tension pneumothorax, hemothorax, and significant mediastinal injury, as well as confirms line placement. However, radiographs have a low sensitivity for injuries such as pneumothorax (39.1%) compared with CT [13]. A portable radiograph of the pelvis can evaluate for unstable pelvic injuries and hip dislocation [14].

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging.
K. US abdomen and pelvis

In pregnant patients with blunt abdominal trauma, the health and wellbeing of both the mother and fetus are a concern. Although pelvic US is useful to assess for fetal wellbeing, US of the abdomen and pelvis has been found to have a sensitivity of only 11% for significant abdominal and pelvic trauma, significantly lower than CT [28]. Depending on the clinical scenario, panel members recommend US pregnant uterus examination with or without CT imaging.

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging.
L. US pelvis

In pregnant patients with blunt abdominal trauma, the health of both the mother and fetus are of concern. The pelvic US that is typical performed to evaluate the nongravid uterus, ovaries, and urinary bladder is supported in the literature. A focused US examination of the pregnant uterus can assess the uterus and evaluate the amniotic fluid level and measure the biophysical profile, as well as assess the extent of fetal injury and demise. Additionally, other studies have found that US has an 11% sensitivity for significant abdominal and pelvic trauma [28].

Variant 8: Major blunt trauma. Hemodynamically stable. Pregnant patient. Initial imaging.
M. US pregnant uterus

In pregnant patients with blunt abdominal trauma, the health of both the mother and fetus are of concern. US of the pregnant uterus can assess the uterus, evaluate the amniotic fluid level, and measure the biophysical profile, as well as assess the extent of fetal injury and demise. US can also assess for the presence of free fluid and retroplacental hemorrhage, although the sensitivity for detecting abruption may not exceed 40% to 50%. Additionally, studies have found that US has an 11% sensitivity for significant abdominal and pelvic trauma [28]. The gravid uterus is at increased risk of rupture from blunt trauma and uterine rupture is a life-threatening emergency.

Summary of Highlights

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- **Variant 1**: Even in hemodynamically unstable patients, radiographic examination is performed simultaneously with the initial resuscitation and primary clinical survey. Traditionally, and in most practices, patients with polytrauma demonstrating signs of hemodynamic instability would be operatively managed without CT whole body with IV contrast imaging. However, the panel agrees that the decision to perform CT imaging in this scenario is highly dependent on the provider's practice environment. WBCT with IV contrast while continuing resuscitation has been reported to help determine the optimal surgical approach and prevent delay of definitive management, and may be appropriate.
- **Variant 2**: In hemodynamically stable polytrauma patients, WBCT with IV contrast plays a vital role in management, in addition to traditional radiographic evaluation.
- **Variant 3**: In the setting of hemodynamically stable polytrauma and suspected facial injury, CT head without IV contrast, CT maxillofacial without IV contrast, CTA head and neck with IV contrast, and CT whole body with IV contrast are usually appropriate. Polytrauma patients with facial injuries are at increased risk for cerebral vascular injuries. Imaging protocols may vary between institutions.
- **Variant 4**: In polytrauma patients with suspected extremity injuries, it is usually appropriate to undergo a routine trauma radiographic series, radiography extremity in the area of interest, and CT whole body with IV contrast. Temporal imaging order may vary; however, each of these examinations are considered as part of the initial imaging evaluation of the patient. In some cases in which there is clinical suspicion for vascular injury to the extremity, CTA extremity of the area of interest with IV contrast may be appropriate.
- **Variant 5**: In polytrauma patients with suspected bowel or mesenteric injury, it is usually appropriate to undergo routine trauma radiographic series, either selective CT or CTA of the abdomen and pelvis with IV contrast or as part of a CT whole body with IV contrast.
- **Variant 6**: In polytrauma patients with suspected urinary system injury, it is usually appropriate to undergo routine trauma radiographic series, either selective CT of the abdomen and pelvis with IV contrast or as part of a CT whole body with IV contrast. CTA of the abdomen and pelvis and CT cystography maybe appropriate in certain clinical presentations. Delayed excretory phase imaging should be accompany the CT of the abdomen and pelvis.
- **Variant 7**: In polytrauma patients with suspected chest trauma, it is usually appropriate to undergo routine trauma radiographic series, either selective CT or CTA of the chest with IV contrast or as part of a CT whole body with IV contrast.
- **Variant 8**: In hemodynamically stable, pregnant, polytrauma patients, imaging plays a vital role in management of both the pregnant patient and unborn embryo or fetus. Radiography trauma series, US pregnant uterus, or CT abdomen and pelvis are usually appropriate. In addition to traditional radiographic evaluation, WBCT with IV contrast and CTA imaging may be appropriate; however, there should be efforts to limit the number of CT image phases in this clinical scenario.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Safety Considerations in Pregnant Patients

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- ACR–SPR Practice Parameter for the Safe and Optimal Performance of Fetal Magnetic Resonance Imaging (MRI)
- ACR-SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Patients with Ionizing Radiation
- ACR-ACOG-AIUM-SMFM-SRU Practice Parameter for the Performance of Standard Diagnostic Obstetrical Ultrasound
- ACR Manual on Contrast Media
- ACR Manual on MR Safety

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

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. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). 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*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”

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