

Joint Theater Trauma System Clinical Practice Guideline

Radiology: Imaging Trauma Patients in a Deployed Setting

Original Release/Approval	24 Nov 2014	Note: This CPG requires an annual review.	
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Supersedes:	This is a new CPG and must be reviewed in its entirety.		
<input type="checkbox"/> Minor Changes (<i>or</i>)	<input type="checkbox"/> Changes are substantial and require a thorough reading of this CPG (or)		
<input type="checkbox"/> Significant Changes			

1. **Goal.** To provide general guidelines for the Radiologist for the performance of imaging in trauma patients in a deployed setting.
2. **Background.** Given the catastrophic injuries sustained by high-energy mechanisms, including high velocity ballistic trauma and blast injuries often seen during the current conflict, rapid diagnosis and treatment is required to optimally treat these critically injured patients. Due to advances in aggressive resuscitation techniques and the speed of the latest generation CT scanners (16/64-slice and beyond), rapid trauma scans utilizing CT and US imaging can usually be performed prior to taking the patient to the operating room potentially providing the trauma team with lifesaving information.
3. **Imaging Evaluation.**
 - a. **Radiographs.** The initial radiographic evaluation of a trauma patient begins with supine AP chest and pelvis radiographs taken in the trauma bay usually with a portable x-ray machine. The initial focus being major cardiopulmonary injury and fracture dislocations of the pelvis, the latter can be an indicator of life-threatening internal hemorrhage and/or need for pelvic stabilization.
 - **Fragments.** Radiographs can easily demonstrate metallic fragments common in military specific trauma that can be helpful in determining potential sites of injury and injury tracts.
 - **Cervical spine.** Cervical spine radiographic evaluation has been largely replaced by Computed Tomography (CT) and should only be performed when a CT is unavailable (see Cervical Spine Evaluation CPG).
 - **Extremity injuries.** If extremity injury is suspected, radiographs can be obtained; however, these can be time-consuming and should not delay more diagnostic imaging with CT if it is available. Additionally with CT, extremity osseous and soft tissue injuries can be easily identified with the added benefit of a lower extremity angiogram as well (see Trauma CT “Panscan” below).
 - **Retrograde Urethrogram.** When there is a clinical suspicion of possible urethral injury, which can occur with significant pelvic fractures or penetrating perineal injury, a retrograde urethrogram may be helpful to further characterize the injury. One field expedient method uses the portable x-ray machine with a single oblique AP scout image of the pelvis. 10cc of contrast is injected into the tip of the urethra through a Foley catheter. While injecting additional contrast through the catheter an image of the pelvis/urethra is obtained in the same slight AP oblique position. This

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- image is typically obtained at the end of an injection of 17-20 cc of IV contrast but prior to the completion of the injection to insure full luminal distention with contrast.
- **Equipment.** A variety of portable x-ray units are utilized in theater at role 2 and role 3 facilities. Many of the portable units, especially at the role 2 level, have limited ability to penetrate (limited range of kVp and mAs) soft tissues. Obtaining lateral views generally requires penetrating a greater thickness of soft tissue, particularly in large patients, and often produces very limited quality images. AP projection images should be adequate on most portable units, but will rely upon the radiographer to optimize technique to maximize image quality.
 - **Radiation Safety.** Members of the trauma team should have lead aprons and thyroid shields available near the trauma bay. In ideal situations, trauma team members will don the lead shielding beneath other personal protective equipment prior to patient arrival. Distance is also protective from radiation exposure. If feasible based on the patient's condition, any personnel without lead shielding should move a short distance (recommended minimal distance 6 feet) away from the x-ray unit. Cross table lateral images produce a much higher level of radiation exposure to personnel in the trauma bay and nearby areas and should only be obtained when absolutely necessary.
- b. FAST Examination.** The FAST scan has been validated only in hemodynamically unstable blunt trauma patients, although it has come into widespread use for penetrating trauma in the deployed setting. If positive, these scans provide quick information that can aid trauma surgeons in triaging patients. FAST in combat trauma has a high false negative rate, therefore negative FAST scans cannot rule out injury.¹
- 1) **Diagnostic Peritoneal Lavage.** In the absence of a CT scanner, diagnostic peritoneal lavage (DPL) should be considered in determining need for laparotomy in unstable patients with negative FAST scans.
 - 2) **Radiologist Role.** At role 3s, the Radiologist can perform FAST scans in the Emergency Department on a hand held portable ultrasound device thus freeing up the ER providers and surgeons to either perform other assessments or interventions, or care for additional patients in the trauma bays. This also allows the radiologist to provide preliminary interpretations of the portable chest x-ray/pelvis exams on the digital portable machines while in the trauma bay. ER physicians and surgeons can also perform FAST scans and interpret plain radiographs which can be a valuable adjunct allowing the radiologist to begin interpreting the CT scans once they begin to be obtained.
 - 3) **Equipment.** The examination is performed with a standard 3-7 MHz curved array US probe with a portable machine. Real-time imaging is performed without saving static images.
 - 4) **Standard Examination.** The standard FAST examination is focused on evaluating for the presence of free intraperitoneal fluid in the bilateral upper quadrants and midline pelvis at the bladder. An evaluation for cardiac activity and hemopericardium/tamponade is also performed.

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- 5) **Additional Examination.** The cardiac portion of the exam can also rapidly identify an empty heart from exsanguination requiring massive transfusion. In the case of massive exsanguination, the examination should be rechecked for free fluid after blood given. Clot identified within a ventricle indicates prolonged asystole and may aid in the decision to terminate efforts. Pneumothorax or hemothorax may also be identified.
- c. **Trauma CT “Panscan”.** If at all possible given the patient’s clinical stability, a trauma CT can be performed before going to Operating Room (OR). Often indications for surgical intervention are already present; however the CT scan can provide additional information to the surgeon, identifying unsuspected and potentially clinically significant injuries. Given the relatively small footprint of most role 3 facilities the patient can be taken to the OR immediately following the acquisition of the CT scan, with the radiologist providing the pertinent findings to surgeons while in the OR. For clinically unstable patients, this trauma CT can be obtained after continued resuscitation and surgical intervention in the OR.
- **CT Protocol (Adult).** See [APPENDIX A](#). Initial acquisition includes noncontrast CT through head and face (to include the entire mandible), at 1 mm axial slices which allows isotropic sagittal and coronal reformatted images. This scan is followed by a contrast enhanced CT from the level of the Circle of Willis through the pelvis. Alternatively in the setting of significant lower extremity trauma such as dismounted blast injury, the scan can be performed through the lower extremities (default through the feet) allowing evaluation of skeletal and vascular injury of the lower extremities. A discussion with the trauma team should be performed prior to the scan to establish the inferior extent of the scan coverage. Of course additional information including long bone fractures and metallic fragments can be seen on the scout image, which may alter the scan coverage to include those areas. Some difficulties may arise if the patient is taller than 6ft, however this can be ameliorated by scanning from the head to as low as possible, then physically sliding the patient up on the gantry and scanning through the remainder of the legs.
 - **CT Review.** 3D workstations are a required resource in any civilian trauma center and are a required resource for any Role 3 where major casualties are expected. They allow the radiologist a rapid overview of injuries and ability to zoom in to abnormalities. Additionally these powerful workstations allow for rapid creation of detailed 3D shaded surface and multiplanar reconstructions that allow for a broad overview of numerous soft tissue and osseous injuries at different locations and accentuate the location of fragments. Utilizing these shaded bone or skin surface and MPR images can be very helpful for injury tract analysis. The workstation also allows for focus arterial vascular analysis, thus supporting early identification of more subtle vascular injuries that can have a significant clinical impact on patient morbidity and mortality.
 - **IV Access.** 18g antecubital IV is typically desired – if placed on MEDEVAC platform prior to arrival, the cannula must be thoroughly rechecked/flushed to ensure function and avoid contrast extravasation. More distal upper extremity IVs should

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typically not be used due to the risk of extravasation and compartment syndrome. A central line can be used for contrast power injection although one must read the manufacturer's guidelines. A large lumen resuscitation catheter such as those utilized for the Belmont rapid infusion (normally rated up to 9cc/sec) can most often handle the contrast injection. Ensure that the correct size catheter lumen is utilized for the power injection as the catheter will often have various sized lumens. The largest lumen of the catheter would be the best to handle the power injection. Of course **should the Belmont be used at the same time it should be turned off during the injection** to avoid dilution of the contrast with the instillate from the Belmont.

Current intraosseous needles should NOT be used for contrast administration.

- **CT Contrast Injection.** The goal of the injection is to provide concurrent solid organ enhancement, arterial enhancement, and pulmonary arterial. Typical doses are approximately 150 cc of Iovue 300 or 340 contrast utilizing a dual phase injection – 80cc at 1.4 cc/sec, followed immediately by 70cc at 3.5 cc/sec for the pan scan. The scan is started 2-3 sec before the completion of the contrast injection to maximize pulmonary arterial filling. For **pediatric injection volume and rates by weight**, see [APPENDIX B](#).
- **Rectal Contrast.** This can be helpful when evaluating penetrating flank injuries or possible rectal involvement below the peritoneal reflection from pelvic injuries. One may utilize 1L of saline/water with the addition of 1 bottle (50ml) of IV contrast. A Foley catheter is used to cannulate the rectum and the balloon is instilled with saline. In the setting of significant rectal or perineal trauma the Surgeon may need to place the Foley catheter in the rectum.
- **Delayed Images.** Routinely performed for further evaluation of identified solid organ injury to identify active extravasation or pseudoaneurysm formation, which can aid the surgeons in grading the solid organ injury. Additionally, contrast excretion within the ureters and subsequently into the bladder can also aid in diagnosis of injuries to these structures.
- **CT Cystogram.** At least 500 cc of saline plus IV contrast is infused through the indwelling urinary catheter. The catheter is then clamped for the CT examination. This type of exam is performed following the routine trauma CT with 1mm thick images acquired through the pelvis with the bladder filled. If necessary additional axial imaging of the bladder can be performed following the drainage of the contrast to detect more subtle extraperitoneal bladder injuries which may be obscured by the distended bladder.
- **Radiation.** Radiation certainly remains a concern during the performance of all imaging particularly with Computed Tomography. The radiologist should pay particular attention to mAs and kVp settings.
- **CT Language Settings.** Become familiar with the languages available/preloaded on the scanner for breathing instructions, which often include: English, French, Spanish, Japanese, and Chinese. Using interpreters available in your facility, record the same instructions in commonly encountered languages of coalition partners and host nation

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patients: Arabic, Pashtun, Dari, Farsi, Georgian, Italian, Danish, Estonian, etc). Ensure to select the correct language at the time of scan setup for each patient. Using these instructions will improve image quality for awake patients.

- d. **Military Working Dogs (MWD).** Refer to MWD CPG. Given the nature of military operations in the current conflict MWD have sustained similar injuries to dismounted soldiers and will need CT trauma pan scans as well. These examinations will typically be performed in consultation with Veterinarians who will sedate the dog as necessary for the scan. Utilize a scanning protocol based on the pediatric settings to include the doses of and rates of contrast administration. See [APPENDIX B](#).
- e. **Image Transfer.** In the CENTCOM theater of operations MEDWEB remains the vehicle to transfer images between medical facilities in theater and back to CONUS through LRMC. All patients evacuated through US CASEVAC should have images sent ahead of time as well as have a CD created to send with the patient as a backup. Although at times trauma patients' true name may not be known during the initial evaluation, it should be stressed that usually it becomes known sometime soon thereafter. Ensuring the patient's information is updated with the real name rather than a local hospital's trauma name will ensure those studies are available for review through the health care evacuation system.

4. Performance Improvement (PI) Monitoring.

- a. Intent (Expected Outcomes).
 - 1) All trauma patients arriving at a role 3 hospital receive proper and expeditious radiologic screening of injuries.
- b. Performance/Adherence Measures.
 - 1) Identification of missed injuries that would have been identified with appropriate radiographic imaging and/or reading.
- c. Data Source.
 - 1) Patient Record
 - 2) Department of Defense Trauma Registry (DoDTR)
 - 3) Theater Image Repository
- d. System Reporting & Frequency.

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Theater Trauma System (JTTS) Director, JTTS Program Manager, and the Joint Trauma System (JTS) Performance Improvement Branch.

5. **Responsibilities.** It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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6. References.

1. Stockinger, ZT. FAST ultrasound is not useful in the evaluation of most combat trauma. 24th Annual Scientific Meeting of the Eastern Association for the Surgery of Trauma; Naples, FL; 25-29 January, 2011.
2. Nguyen D, Platon A, Shanmuganathan K, et al. Evaluation of a Single-Pass Continuous Whole-Body 16-MDCT Protocol for Patients with Polytrauma. *AJR* 2009; 192:3-10.
3. Graham R. Battlefield Radiology. *British Journal of Radiology* 2012 (85); 1556-1565.
4. Scalea T, Rodriguez A, Chiu W, et al. Focused Assessment with Sonography for Trauma (FAST): Results of an International Consensus Conference. *J Trauma* 1999; 46:466-472.
5. Gibb I, Denton E. Guidelines for imaging the injured blast/ballistic patient in a Mass Casualty Scenario.
6. The Royal College of Radiologists. Standards of practice and guidance for trauma radiology in severely injured patients. London: *The Royal College of Radiologists* 2011.
7. Shanmuganathan K, Mirvis S, Chiu W et al. Penetrating Torso Trauma: Triple-Contrast Helical CT in Peritoneal Violation and Organ Injury-A Prospective Study in 200 Patients. *Radiology* 2004; 231:775-784.
8. Morgan D, Nallamala L, Kenney et al. CT Cystography: Radiographic and Clinical
9. Predictors of Bladder Rupture. *AJR*: 174, January 2000.

Approved by CENTCOM JTTS Director,
JTS Director and CENTCOM SG

Opinions, interpretations, conclusions, and recommendations are those of the authors
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APPENDIX A TRAUMA CT PROTOCOL

1. Unenhanced spiral brain 1.25mm (bone and soft tissue algorithm); 5mm reconstructions immediately available for review.
2. Circle of Willis to symphysis (bone and soft tissue algorithms).
 - a. 150ml biphasic contrast injection – initial 65ml at 2ml/sec then 85 ml at 3.5ml/sec
 - b. Scan starts at 60 sec

This gives both portal venous enhancement with good arterial contrast at the same time and the scan can be carried on down to the legs/feet is necessary. The cervical contrast has been very useful both for penetrating injury and for spinal injury/vertebral artery injury.

3. The use of delayed scans limited to specific cases at the request of the radiologist.

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APPENDIX B PEDIATRIC (MWD) INJECTION PROTOCOLS

Child Weight (kg)	Venous Phase Rate/Volume	Arterial Phase Rate/Volume	Total Contrast Delivered
5	0.2sec/7mls	0.4sec/3mls	10
10	0.3sec/14mls	0.6sec/6mls	20
15	0.4sec/20mls	0.8sec/10mls	30
20	0.5sec/26mls	1.0sec/14mls	40
25	0.6sec/33mls	1.3sec/17mls	50
30	0.7sec/40mls	1.6sec/20mls	60
35	0.8sec/47mls	1.8sec/23mls	70
40	0.9sec/53mls	2.1sec/26mls	80
45	1.0sec/60mls	2.2/30mls	90
50	1.2sec/66mls	2.4sec/34mls	100
55	1.3sec/73mls	2.6sec/37mls	110
60	1.4sec/80mls	2.8sec/40mls	120
70	1.6sec/94mls	3.3/46mls	140
GE Color Coded Pediatric Settings (mA/kV)			
Pink	6.0-7.5 kg	59.5-66.5 cm	
Red	7.5-9.5kg	66.5-74 cm	
Purple	9.5-11.5kg	74-84 cm	
Yellow	11.5-14.5kg	84.5-97.5 cm	
White	14.5-18.5kg	97.5-110cm	
Blue	18.5-22.5kg	110-122cm	
Orange	22.5-31.5kg	122-137cm	
Green	31.5-40.5kg	137-150cm	
Black	40.5-55 kg		

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APPENDIX C

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGs

1. **Purpose.** The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of “off-label” uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.
2. **Background.** Unapproved (i.e., “off-label”) uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing “investigational new drugs.” These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.
3. **Additional Information Regarding Off-Label Uses in CPGs.** The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the “standard of care.” Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.
4. **Additional Procedures.**
 - a. **Balanced Discussion.** Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.
 - b. **Quality Assurance Monitoring.** With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.
 - c. **Information to Patients.** Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.