

**FINAL REPORT - 2018-11-28****IMAGING OF PENETRATING TRAUMA**

(STAB INJURIES, GUNSHOT WOUNDS, IMPALEMENT INJURIES)

- REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

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## SUMMARY OF RECOMMENDATIONS

- an evidence-based consensus by International and Nordic clinical and radiological experts

### ISOLATED PENETRATING HEAD INJURY

- ALL PATIENTS
  - non-contrast head CT (use scout to localize foreign objects)
- SALVAGEABLE PATIENTS
  - non-contrast head CT (use scout to localize foreign objects)
  - CTA from vertex to aortic arch (neck CTA) to detect vascular injuries
    - Facial vascular injuries are included
  - CTV in selected cases if sinus rupture is suspected (such as in penetrating posterior fossa injuries)
- In case of GSW, consider additional
  - DSA if metal artifacts and CTA is inconclusive

Wound marks are not required

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### ISOLATED PENETRATING NECK INJURY

#### WHICH PATIENT SHOULD GO TO RADIOLOGY

- Hemodynamically stable patients with suspected platysma injury, without “hard signs”\*
  - \*(active hemorrhage, expanding or pulsatile hematoma, bruit or thrill in the area of injury, shock unresponsive to initial fluid resuscitation, massive hemoptysis or hematemesis, and air bubbling through the injury site)
- Wound marks are recommended

#### WHAT RADIOLOGY EXAMS SHOULD BE PERFORMED

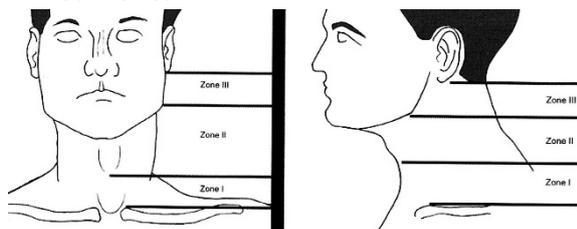
- CR (if CT is not available)
  - Localize foreign objects (bullets)
- CTA head+neck (from vertex to at least aortic arch)
  - CT scout to identify foreign objects
  - *Note:* CTA will reveal AV-fistulas as well
- CTA head+neck+thorax if “Zone I and II\*\*” injuries, as 15-20% have chest injuries

If CT is inconclusive with regard to airway injury, consider laryngoscopy and/or bronchoscopy

In case of suspected cervical esophageal injury, endoscopy preferred to esophagography

In case of high suspicion and inconclusive endoscopy, consider esophagography (swallow study)

#### \*\*Neck zones



## REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

### PENETRATING TORSO (TRUNK) INJURY

**EMERGENT SURGERY** when needed – i.e. at the discretion of the surgeon in charge.

#### **IMAGING IN ER/OR**

Pre-CT imaging is not encouraged in stable patients

- Unstable patients
  - e-FAST and chest X-ray (+ pelvic X-ray in GSW)
    - Cave: Large hemothorax may conceal hemopericardium
- Wound marking recommended (Arrow, paperclip, Vitamin E capsule...)

#### **WHICH RADIOLOGICAL EXAMS SHOULD BE PERFORMED IN STABLE PATIENTS (to help to decide to operate or not, and to guide the surgeon and/or interventionist)**

1. CT scouts: localize foreign bodies in GSW to define the optimal scan length
2. CT chest-abdomen with i.v. contrast, especially if the entry wound is below intermammary line in stab wounds and almost always with GSW.
  - a. Consider triple contrast CT. (Level II Evidence, see Appendix for details).
  - b. Late arterial (to visualize arterial injuries) to lesser trochanters + venous phase abdomen.
  - c. Add late phase (5-10 min delay) if kidney and ureter are in injury trajectory.  
Radiologist's supervision required
3. CT cystogram should be performed in urinary bladder injuries
4. Wound marking strongly recommended (Arrow, paperclip, Vitamin capsule...)

*CO<sub>2</sub>-DSA can be used in unequivocal cases with suspected vascular injuries*

*Peroperative angiogram is not discussed here*

*Angioembolization is part of management and not discussed here*

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### PENETRATING EXTREMITY INJURY

- Exsanguinating or acutely ischemic and site of injury is known -> no vascular imaging
- CTA is the diagnostic study of choice when vascular imaging is required (Level 1 evidence)
- This applies, however, imaging outside OR. In OR, imaging is conventional angiography
- Wound marking is recommended.

# MASS CASUALTIES – major incidents (MI)

## PREPARATION

DISASTER PLAN SHOULD BE IN PLACE AND COORDINATED

- Radiology is an integral part of the response to major incidents
- Develop strategies to maintain effective communication (vertically and horizontally)
- Maintain CT capability and capacity during the reception phase of a MI
- Traumatic brain injury management is especially dependent on CT

PATIENT FLOW PLANNING

- Identification of patients
- Routine for identifying unknown patients
- Identify and eliminate bottlenecks
- Removal of patients from radiology department after scans

## IMAGING

ROLE OF FAST/E-FAST

- Triage for CT in the initial phase

WHAT CT PROTOCOLS TO USE

- Whole body trauma protocol (WBCTT) available on all scanners, techs should be trained
- Ideally one standardized protocol for all hospitals for maximum efficiency
- Consider WBCT in ALL patients requiring CT in mass casualty events (especially blast events), to avoid rescans

IMAGE, READING AND REPORTING FLOW

- Basic imaging data to PACS
- Reading directly at CT or workstation
- Quick, concise documentation, standardized reporting\*
- Consider backup paper-based system
- Life-threatening findings must be reported immediately

RADIOLOGY PLAYS A SIGNIFICANT PART IN MULTIDISCIPLINARY ASSESSMENT;  
WHICH SHOULD BE PLANNED FOR IN TERMS OF LOAD MANAGEMENT

\* **Standardized report example:** <http://www.nordictraumarad.com/Homepage/Download-File/f/287341/h/7ef5cf88d5ac5b8adb4a5ba2ea9ddbc8/Poster>

**End of consensus recommendation summary**

## REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

### Background/Presentation

Nordic forum for trauma and emergency radiology (NORDTER) staged this meeting as its third consensus conference. We held this multidisciplinary consensus meeting to review the literature and to scrutinize surgical and radiological routines. We invited international and Nordic expertise for guidance through the evidence in the literature; and summoned Nordic representatives for surgery, vascular surgery and trauma & interventional radiology to create evidence-based recommendations for the Nordic trauma scene.

As in our earlier consensus conferences; expert speakers presented the evidence/literature status for radiology/intervention and surgery/vascular surgery; followed by a consensus discussion. The group discussions followed an informal format with the chairperson directing discussion and delegating tasks. Although our group was encouraged to attempt to reach consensus, members were also encouraged to include alternative views.

The references after each topic were provided by the speakers. The number of references were kept to minimum, and only the most pertinent were included.

For those who would like to be more familiar with consensus decision making, please refer to Murphy MK, Black NA, Lamping DL, McKee CM, Sanderson CFB, Askham J, *et al.* Consensus development methods, and their use in clinical guideline development. *Health Technol Assessment* 1998; 2(3).

### Expert speakers

#### **Kathirkamanathan Shanmuganathan, M.D.**

Professor of Radiology, Department of Diagnostic Radiology & Nuclear Medicine, University of Maryland School of Medicine, Baltimore, USA

#### **Deborah M. Stein, M.D., MPH, FACS, FCCM**

R Adams Cowley Professor in Shock and Trauma, University of Maryland School of Medicine, Baltimore, USA; Chief of Trauma and Medical Director, Neurotrauma Critical Care, R Adams Cowley Shock Trauma Center, University of Maryland Medical Center, Baltimore, USA

#### **Karim Brohi, Professor, FRCS FRCA**

Director, Centre for Trauma Sciences, Queen Mary University of London; Consultant Trauma & Vascular Surgeon, Barts Health NHS Trust; Director, London Major Trauma System, Great Britain

#### **Ajay Singh, M.D.,**

Associate Director, Division of Emergency Radiology, Department of Radiology, Massachusetts General Hospital, Boston, USA

#### **Carl Montán, MD, PhD,**

(surgeon, vascular surgeon; Director Disaster Medicine courses); Senior consultant, Dept. of Vascular Surgery, Karolinska University Hospital, Stockholm, Sweden

**REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017****Consensus group**

## NORDIC TRAUMA SURGEONS/CLINICIANS

**Eva-Corina Caragounis**, Surgeon, head of trauma team, Sahlgrenska University Hospital, Gothenburg

**Lennart Adamsson**, Orthopedic surgeon, head of the Trauma Unit, Karolinska University Hospital, Stockholm

**Fredrik Linder**, Surgeon, Head of trauma team. Akademiska Sjukhuset, Uppsala University Hospital

**Martin Weckman**, Surgeon, Helsinki University Hospital, Finland.

## VASCULAR SURGEON

**Carl Montán**, Senior consultant, Dept. of Vascular Surgery, Karolinska University Hospital, Stockholm

## NORDIC RADIOLOGISTS

**Maria Lindblom**, Linköping University hospital

**Birthe Höjlund**, Rigshospitalet, Copenhagen

**Ilja Laesser**, Sahlgrenska University Hospital, Gothenburg

**Frank Bensch**, Helsingfors Central University hospital, Helsinki

**Mari Nummela**, Helsingfors Central University hospital, Helsinki

**Johann Baptist Dormagen**, University Hospital, Oslo

## NORDTER ORGANIZING GROUP/ RADIOLOGISTS

**Hampus Eklöf**, Head of Radiology, Unilabs, Sweden

**Seppo Koskinen**, Professor of radiology, Karolinska Institutet, Karolinska University Hospital, Stockholm

**Bertil Leidner**, freelance radiologist, formerly Karolinska University Hospital, Huddinge, Stockholm

**Mats Beckman**, Head of trauma unit/radiology, Karolinska University Hospital, Solna, Stockholm

## INTERVENTIONAL RADIOLOGIST

**Wojciech Cwikiel**, interventional radiologist, Skane University Hospital, Lund

## TRAUMA RADIOGRAPHERS

**Helen Milde**, radiographer, Sahlgrenska University Hospital, Gothenburg

**Seyma Cankaya**, radiographer, Trauma Unit, Karolinska University hospital, Solna, Stockholm

## REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

### The report and recommendations structure

- a. Isolated penetrating head injury
- b. Isolated penetrating neck injury
- c. Penetrating torso (trunk) injury
- d. Penetrating extremity injury
- e. Mass casualties

Each part follows the same structure

- I Consensus summary
- II Action cards
- III Reference documents

The second part “Action Cards” (- structured information flow cards) presents the most important information in a structure geared to be used in the critical situation, possible to print and have at hand. The action cards answer the following questions: Who needs the information? What questions needs to be answered?

Surgeon –when & what radiological exam to order; Radiographer – what exam? what to prepare?

Radiologist – what exam? what diagnostic focus?

## ISOLATED PENETRATING HEAD INJURY

### ISOLATED PENETRATING HEAD INJURY

#### CONSENSUS SUMMARY:

- ALL PATIENTS
  - non-contrast head CT (use scout to localize foreign objects)
- SALVAGEABLE PATIENTS
  - non-contrast head CT (use scout to localize foreign objects)
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    - Facial vascular injuries are included
  - CTV in selected cases if sinus rupture is suspected (such as in penetrating posterior fossa injuries)
- In case of GSW, consider additional
  - DSA if metal artifacts and CTA is inconclusive

Wound marks are not required.

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- ACTION CARD:
  - Who needs the information? What question(s) to be answered?***
  - Surgeon – what radiological exam to order***
  - All patients - Non-contrast head CT –
  - Salvageable patients – non-contrast head CT (use scout to localize foreign objects) – CTA vertex to aortic arch; – CTV if sinus injury is suspected

## REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

### ***Radiographer -What exam? What to prepare?***

- Non-contrast CT of the Head; include whole face
- CTA – head & neck to aortic arch  
(– CTV if sinus injury is suspected)
- ***prepare*** contrast for all patients

### ***Radiologist – What exam?***

- ***ALL***: Non-contrast CT of the Head; include whole face  
FOR SALVAGABLE PATIENTS
- non-contrast head CT (use scout to localize foreign objects)
- CTA – head & neck to aortic arch -  
– CTV if sinus injury is suspected
- (GSW - DSA if metal artifacts/inconclusive CTA)

### ***Diagnostic focus?***

- (use scout to localize foreign objects)
- Brain injury,
- vascular injuries head & neck;
- facial injuries incl vascular

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## REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

### ISOLATED PENETRATING NECK INJURY

#### WHICH PATIENT SHOULD GO TO RADIOLOGY

- Hemodynamically stable patients with suspected platysma injury, without “hard signs” \*
  - \*(active hemorrhage, expanding or pulsatile hematoma, bruit or thrill in the area of injury, shock unresponsive to initial fluid resuscitation, massive hemoptysis or hematemesis, and air bubbling through the injury site)
- Wound marks are recommended

#### WHAT RADIOLOGY EXAMS SHOULD BE PERFORMED

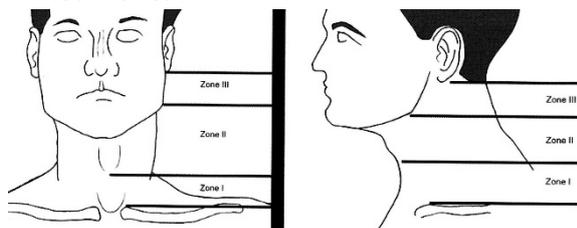
- CR (if CT is not available)
  - Localize foreign objects (bullets)
- CTA head+neck (from vertex to at least aortic arch)
  - CT scout to identify foreign objects
  - *Note:* CTA will reveal AV-fistulas as well
- CTA head+neck+thorax if “Zone I and II\*\*” injuries, as 15-20% have chest injuries

If CT is inconclusive with regard to airway injury, consider laryngoscopy and/or bronchoscopy

In case of suspected cervical esophageal injury, endoscopy preferred to esophagography

In case of high suspicion and inconclusive endoscopy, consider esophagography (swallow study)

#### \*\*Neck zones



#### ACTION CARD:

#### **Who needs the information? What question(s) to be answered?**

##### **Surgeon – Which patient to image?**

- Hemodynamically stable patients with suspected or obvious platysma violation without “hard signs” – see below\*

##### **What radiological exam to order?**

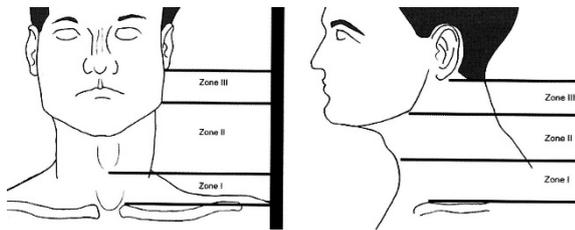
- CTA – head & neck → aortic arch & **possibly thorax** (Zone I + II) \*  
 --[If CT is not possible – consider radiographs to localize foreign object (bullets)]  
 - Wound marks are recommended (vitamin E capsules)

##### **If inconclusive CT**

- in regard to airway injury, consider laryngoscopy and/or bronchoscopy  
 - if suspected cervical esophageal injury, endoscopy preferred to esophagography  
 - In case of high suspicion & inconclusive endoscopy, consider esophagography (swallow study)

## REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

\* **Hard signs:** active hemorrhage, expanding or pulsatile hematoma, bruit or thrill in the area of injury, shock unresponsive to initial fluid resuscitation, massive hemoptysis or hematemesis, and air bubbling through the injury site



### **Radiographer - what to prepare?**

- CTA – head & neck → aortic arch & add thorax on request
- *prepare contrast* for all patients
- ask for wound marks

### **Radiologist - what exam?**

- CTA head & neck to aortic arch – consider including whole thorax (zone I+II injuries)

### **What diagnostic focus?**

- look for wound marks
- vascular injuries – ongoing bleeds, AV- fistulas
- lung/mediastinal injuries
- airway injury?
- esophageal injury?
- look for foreign bodies (scout view!)

## REFERENCES

de Vries CS, Africa M, Gebremariam FA, van Rensburg JJ, Otto SF, Potgieter HF. The imaging of stab injuries. *Acta Radiol.* 2010 Feb;51(1):92-106. doi: 10.3109/02841850903225198. Review. PubMed PMID: 20088643.

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## PENETRATING TORSO (TRUNK) INJURY

### PENETRATING TORSO (TRUNK) INJURY

**EMERGENT SURGERY** when needed – i.e. at the discretion of the surgeon in charge.

#### IMAGING IN ER/OR

Pre-CT imaging is not encouraged in stable patients

- Unstable patients
  - e-FAST and chest X-ray (+ pelvic X-ray in GSW)
    - Cave: Large hemothorax may conceal hemopericardium
- Wound marking recommended (Arrow, paperclip, Vitamin E capsule)

#### **WHICH RADIOLOGICAL EXAMS SHOULD BE PERFORMED IN STABLE PATIENTS**

**(to help to decide to operate or not, and to guide the surgeon and/or interventionist)**

1. CT scouts: localize foreign bodies in GSW to define the optimal scan length
2. CT chest-abdomen with i.v. contrast, especially if the entry wound is below intermammary line in stab wounds and almost always with GSW.
  - a. Consider triple contrast CT. (Level II Evidence, see Appendix for details).
  - b. Late arterial (to visualize arterial injuries) to lesser trochanters + venous phase abdomen.
  - c. Add late phase (5-10 min delay) if kidney and ureter are in injury trajectory.  
Radiologist's supervision required
3. CT cystogram should be performed in urinary bladder injuries
4. Wound marking strongly recommended (Arrow, paperclip, Vitamin capsule...)

*CO<sub>2</sub>-DSA can be used in unequivocal cases with suspected vascular injuries*

*Peroperative angiogram is not discussed here*

*Angioembolization is part of management and not discussed here*

ACTION CARD:

### **IMAGING IN ER/UNSTABLE PATIENT**

***Who needs the information? What question(s) to be answered?***

***Surgeon –when & what radiological exam to order***

- Emergency surgery if needed
- Unstable patients – e-FAST & chest X-ray & pelvic X-ray in GSW
- Stable patients – Pre-CT imaging is NOT encouraged

***Radiographer – what exam? what to prepare?***

- ER – chest/pelvic X-ray- (portable) x-ray machine
- wound markings – paper clip/E-vitamin capsule
- (e-FAST – bring ultrasound machine)

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### ***Radiologist – what exam? What diagnostic focus?***

- (e-FAST)
  - chest X-ray; foreign bodies/wound markings
  - beware – box of death – large hemothorax may conceal hemopericardium
- 

## IMAGING IN THE STABLE PATIENT

(to help to decide to operate or not, and to guide the surgeon and/or interventionist)

### ***Who needs the information? What question(s) to be answered?***

#### ***Surgeon - Contraindications to CT (see also full text document)***

##### **Absolute:**

Hemodynamic instability - Emergent laparotomy or thoracotomy is needed

##### **Relative:**

Pneumoperitoneum on radiograph

Peritonitis

Hematuria: However, many renal injuries that can be managed nonoperatively may still present with hematuria. CT is often used for grading penetrating renal injuries

Hematochezia: Usually indicative of hollow visceral injury requiring laparotomy

Hematemesis

#### ***Surgeon –when CT:***

- ***request CT thorax & abdomen - dual phase***

***(- if agreed on locally, use triple contrast CT in dual phase)***

- Wound marking strongly recommended, paper clip/E-vitamin capsule\*

#### ***Radiographer – what exam? what to prepare?***

- Use CT scouts to localize foreign bodies in GSW to define the optimal scan field
- CT chest-abdomen - late arterial (to visualize arterial injuries) to lesser trochanters+ venous phase abdomen.
- Consider triple contrast – i.e. addition of oral + rectal contrast

#### ***- Contrast recommendations from Karolinska University Hospital, Stockholm:***

--- Oral: 50 ml Iohexol (Omnipaque) 140 mg I / ml in 450 ml water;

--- Rectal: 150 ml Iohexol (Omnipaque) 140 mg I / ml in 1350 ml water

- late phase? – if urological injuries!

- if CT cystography: 25 ml Omnipaque 240 mg I / ml in 225 ml NaCl 9 mg/ml

#### ***Radiologist – what exam?***

- CT chest-abdomen - late arterial (to visualize arterial injuries) to lesser trochanters+ venous phase upper/whole abdomen.
- Consider triple contrast CT. (Level II Evidence). (if agreed on locally)
- Add late phase (5-10 min delay) if kidney and ureter are in injury trajectory.
- CT cystogram should be performed in urinary bladder injuries

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- check Wound marking strongly recommended, paper clip/E-vitamin capsule etc.\*
- (- Use CT scouts to localize foreign bodies in GSW)

### ***What diagnostic focus?***

Tangential or superficial wounds: Exclusion of peritoneal or pleural penetration

Thoracoabdominal wounds/anterior abdominal wounds: For gastric, small bowel, or colonic injury, high-grade solid organ injury, pancreaticobiliary injury, major vascular injury, and diaphragmatic injury

Transpelvic gunshot wounds: For rectal or bladder injury, and intra- vs. extraperitoneal involvement; evaluate for major vascular injury;

Back and flank wounds: For retroperitoneal injury potentially involving colon, kidneys, ureters or major vessels

Precordial, parasternal, periclavicular and transmediastinal wounds: For cardiac injuries, closed aortic or great vessel injuries, and aerodigestive tract injuries

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## REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

### PENETRATING EXTREMITY INJURY

- Exsanguinating or acutely ischemic and site of injury is known -> no vascular imaging
- CTA is the diagnostic study of choice when vascular imaging is required (Level 1 evidence)
- This applies, however, imaging outside OR. In OR, imaging is conventional angiography
- Wound marking is recommended.

#### ACTION CARD:

#### ***Who needs the information? What question(s) to be answered?***

##### ***Surgeon –when & what radiological exam to order***

NO IMAGING needed when exsanguinating or acutely ischemic and site of injury is known.

CTA of the injured extremity – method of choice - Wound marking is recommended  
In OR – conventional angiography

##### ***Radiographer – what exam? what to prepare?***

CTA – prepare adding venous series over same field of examination

##### ***Radiologist – what exam?***

CTA – consider adding venous series

##### ***What diagnostic focus?***

Bleeding

Pseudoaneurysm

AV-fistula

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# MASS CASUALTIES – major incidents (MI)

## PREPARATION

DISASTER PLAN SHOULD BE IN PLACE AND COORDINATED

- Radiology is an integral part of the response to major incidents
- Develop strategies to maintain effective communication (vertically and horizontally)
- Maintain CT capability and capacity during the reception phase of a MI
- Traumatic brain injury management is especially dependent on CT

PATIENT FLOW PLANNING

- Identification of patients
- Routine for identifying unknown patients
- Identify and eliminate bottlenecks
- Removal of patients from radiology department after scans

## IMAGING

ROLE OF FAST/e-FAST

- Triage for CT in the initial phase

WHAT CT PROTOCOLS TO USE

- Whole body trauma protocol (WBCT) available on all scanners, techs should be trained
- Ideally one standardized protocol for all hospitals for maximum efficiency
- Consider WBCT in ALL patients requiring CT in mass casualty events (especially blast events), to avoid rescans

IMAGE, READING AND REPORTING FLOW

- Basic imaging data to PACS
- Reading directly at CT or workstation
- Quick, concise documentation, standardized reporting\*
- Consider backup paper-based system
- Life-threatening findings must be reported immediately

RADIOLOGY PLAYS A SIGNIFICANT PART IN MULTIDISCIPLINARY ASSESSMENT;  
WHICH SHOULD BE PLANNED FOR IN TERMS OF LOAD MANAGEMENT

\* **Standardized report example:** <http://www.nordictraumarad.com/Homepage/Download-File/f/287341/h/7ef5cf88d5ac5b8adb4a5ba2ea9ddbc8/Poster>

## REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

### ACTION CARD:

#### SURGEON

*–when & what radiological exam to order*

e-FAST – consider using e-FAST to triage for CT in the initial phase

Trauma-CT – consider including whole body scan for every patient to avoid rescanning  
- (retransporting the patient to the CT suite during a major incident causes confusion)

#### RADIOGRAPHER

*what exam? what to prepare?*

Ideally one standardized CT-protocol for all for maximum efficiency

Consider WBCT in all patients requiring CT in mass casualty events  
(especially blast events) to *avoid rescans*

#### RADIOLOGIST

*what exam? What diagnostic focus?*

e-FAST – consider using to triage for CT in the initial phase

Trauma-protocol available on all scanners.

Ideally **one standardized protocol** for all for maximum efficiency

Consider **WBCT in all** patients requiring CT in mass casualty events  
(especially blast events) to avoid rescans

Basic imaging data to PACS, **reading directly from modality console/workstation**

Quick, concise documentation, **standardized reporting** - based on local practice  
(consider backup paper-based system)

Life-threatening findings must be reported immediately

### REFERENCES

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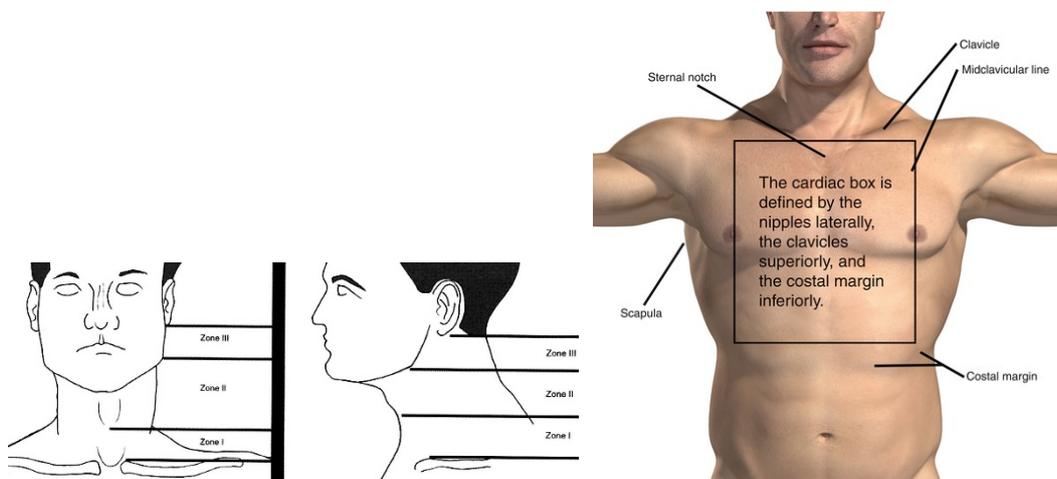
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## ADDENDUM

### - abbreviations

- BCVI – blunt cerebrovascular injuries
- CTA – CT angiogram
- CTV – CT venogram
- DSA – digital subtraction angiography
- ER – emergency room
- OR – operating room
- e-FAST – Extended FAST (incl. exam for pneumothorax)
- FAST – focused assessment with sonography for trauma
- GSW – gunshot wound
- Triple contrast CT – with oral, rectal and intravenous contrast media
- WBCT – whole body CT
- MI major incident–

### - images – body areas



## REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

**Triple contrast CT** with the use of oral, rectal and intravenous contrast is recommended by US centers in order to optimize diagnosis of hollow viscous injuries. In blunt trauma free extraluminal air indicates visceral injury. In penetrating injury free air only indicates peritoneal violation. Thus, the use of oral/rectal contrast is more indicated in penetrating trauma, compared to blunt trauma CT. There is a fair amount of support in the literature for the use of triple contrast but no decisive evidence.

If triple contrast is to be used in the Scandinavian trauma scene, it is necessary to have a consensus agreement in the local hospital and to train the procedure, in order not to lose time in critical cases.

**Wound markings** are recommended with paper clips or Vitamin E capsules. Paper clips do not give significant artifacts in new CT scanners. Vitamin E capsules contain fat and give no artifacts at all.

**Contrast recommendations** from *Karolinska University Hospital, Stockholm*:

Oral: 50 ml Iohexol (Omnipaque) 140 mg I / ml in 450 ml water;

Rectal: 150 ml Iohexol (Omnipaque) 140 mg I / ml in 1350 ml water

In urinary bladder – CT cystography: 25 ml Omnipaque 240 mg I / ml in 225 ml NaCl 9 mg/ml.

### Reference for Triple contrast CT

#### TRIPLE-CONTRAST MULTIDETECTOR CT FOR PENETRATING TORSO TRAUMA INDICATIONS AND

CONTRAINDICATIONS: Multidetector CT for Penetrating Torso Trauma: State of the Art1. David Dreizin, MD Felipe Munera, MD. Radiology.rsna.org Radiology: Volume 277: Number 2—November 2015

#### INDICATIONS (from this reference article)

1. Tangential or superficial wounds: Exclusion of peritoneal or pleural penetration.
2. Thoracoabdominal wounds/ anterior abdominal wounds: For gastric-, small bowel, or colonic injury., high-grade solid organ injury, pancreaticobiliary injury, major vascular injury, and diaphragmatic injury
3. Transpelvic gunshot wounds: For rectal or bladder injury, and intra- versus extraperitoneal involvement; evaluate for major vascular injury; performed for surgical planning or to evaluate potential candidates for nonoperative management
4. Back and flank wounds: For retroperitoneal injury potentially involving colon, kidneys, ureters or major vessels
5. Precordial, parasternal, periclavicular and transmediastinal wounds: For cardiac injuries, closed aortic or great vessel injuries, and aerodigestive tract injuries
6. Other:
  - a. For wounds not amenable to local wound exploration (ie, gunshot wounds, obese or muscular patients, back and flank injuries, wounds above costal margin, long obliquely oriented wounds)
  - b. For severe distracting pain, neurologic injury, or intoxication, which may confound physical examination;
  - c. For patients with neurologic or extremity injuries which require surgical intervention and cannot be closely monitored

**REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017****CONTRAINDICATIONS (from this reference article)****Absolute:**

- Hemodynamic instability not responsive or transiently responsive to fluid resuscitation (sometimes defined as systolic blood pressure <90 mmHg after 2 liters of intravenous fluid).
  - CT would delay life-saving care like emergent laparotomy or thoracotomy

**Relative:**

1. Pneumoperitoneum on radiograph: Air may result from perforated hollow viscera but can also be introduced into the abdominal cavity through wound track or from pneumothorax migrating through a diaphragmatic defect
2. Peritonitis: Subjective sign. May be masked or mimicked by severe pain. Classically from hollow visceral perforation but can sometimes result from solid organ injuries
3. Hematuria: May indicate surgical renal injury or ureteral injury. However, many renal injuries that can be managed nonoperatively may still present with hematuria. CT is often used for grading penetrating renal injuries
4. Hematochezia: Usually indicative of hollow visceral injury requiring laparotomy; however, hematochezia may result from extraperitoneal rectal injury, which can be treated laparoscopically in select cases. Preoperative CT can often be used to distinguish between extra- and intraperitoneal rectal injury
5. Hematemesis: If the patient is hemodynamically stable, CT may occasionally be used to determine injuries before surgical intervention

REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

**ACTION CARD – SURGEON**

**MASS CASUALTIES – major incidents (MI)**

***When & what radiological exam to order***

E-FAST – consider using e-FAST to triage for CT in the initial phase

Trauma-CT – consider including whole body scan for every patient to avoid rescanning  
- (retransporting the patient to the CT suite during a major incident causes confusion)

**ISOLATED PENETRATING HEAD INJURY**

***What radiological exam to order***

- All patients - Non-contrast head CT –

- Salvageable patients – Non-contrast head CT and CTA vertex to aortic arch– CTV if sinus injury is suspected

**ISOLATED PENETRATING NECK INJURY**

***Which patient to image?***

- Hemodynamically stable patients with suspected or obvious platysma violation without “hard signs” – see below\*

***What radiological exam to order?***

- CTA – head & neck → aortic arch & **possibly thorax** (Zone I + II) \*

--[If CT is not possible – consider radiographs to localize foreign object (bullets)]

- Wound marks are recommended (vitamin E capsules)

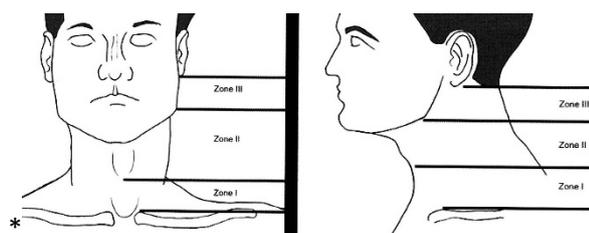
***If inconclusive CT***

- in regard to airway injury, consider laryngoscopy and/or bronchoscopy

- if suspected cervical esophageal injury, endoscopy preferred to esophagography

- In case of high suspicion & inconclusive endoscopy, consider esophagography (swallow study)

\* **Hard signs:** active hemorrhage, expanding or pulsatile hematoma, bruit or thrill in the area of injury, shock unresponsive to initial fluid resuscitation, massive hemoptysis or hematemesis, and air bubbling through the injury site



## REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

### PENETRATING TORSO (TRUNK) INJURY

#### IMAGING IN ER/UNSTABLE PATIENT

##### *When & what radiological exam to order*

Emergency surgery if needed

- Unstable patients – e-FAST & chest X-ray & pelvic X-ray in GSW
- Stable patients – Pre-CT imaging is NOT encouraged

#### IMAGING IN THE STABLE PATIENT

(to help to decide to operate or not, and to guide the surgeon and/or interventionist)

- **Contraindications to CT** (see also full text document)

##### Absolute:

Hemodynamic instability - Emergent laparotomy or thoracotomy is needed

##### Relative:

Pneumoperitoneum on radiograph

Peritonitis

Hematuria: However, many renal injuries that can be managed nonoperatively may still present with hematuria. CT is often used for grading penetrating renal injuries

Hematochezia: Usually indicative of hollow visceral injury requiring laparotomy

Hematemesis

##### **When CT:**

- *request CT thorax & abdomen - dual phase*

*(- if agreed on locally, use triple contrast CT in dual phase)*

- Wound marking strongly recommended, paper clip/E-vitamin capsule\*
- 

### PENETRATING EXTREMITY INJURY

#### *Who needs the information? What question(s) to be answered?*

##### *Surgeon –when & what radiological exam to order*

NO IMAGING needed when exsanguinating or acutely ischemic and site of injury is known.

CTA of the injured extremity – method of choice - Wound marking is recommended

In OR – conventional angiography

**ACTION CARD RADIOGRAPHER****ISOLATED PENETRATING HEAD INJURY*****Radiographer -What exam? What to prepare?***

- Non-contrast CT of the Head; include whole face
- CTA – head & neck to aortic arch
- (– CTV if sinus injury is suspected)
- **prepare** contrast for all patients

**ISOLATED PENETRATING NECK INJURY*****Radiographer - what to prepare?***

- CTA – head & neck → aortic arch & add thorax on request
- **prepare contrast** for all patients
- ask for wound marks

**PENETRATING TORSO (TRUNK) INJURY****IMAGING IN ER/UNSTABLE PATIENT*****Radiographer – what exam? what to prepare?***

- ER – chest/pelvic X-ray- (portable) x-ray machine
- wound markings – paper clip
- (e-FAST – bring ultrasound machine)

**IMAGING IN THE STABLE PATIENT*****Radiographer – what exam? what to prepare?***

- Use CT scouts to localize foreign bodies in GSW to define the optimal scan field
- CT chest-abdomen - late arterial (to visualize arterial injuries) to lesser trochanters+ venous phase abdomen.
- Consider triple contrast – ie addition of oral + rectal contrast
- **Contrast recommendations from Karolinska University Hospital, Stockholm:**
  - Oral: 50 ml Iohexol (Omnipaque) 140 mg I / ml in 450 ml water;
  - Rectal: 150 ml Iohexol (Omnipaque) 140 mg I / ml in 1350 ml water
- late phase? – if urological injuries!
- if CT cystography: 25 ml Omnipaque 240 mg I / ml in 225 ml NaCl 9 mg/ml

**PENETRATING EXTREMITY INJURY*****Radiographer – what exam? what to prepare?***

- CTA – prepare adding venous series over same field of examination

**REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017****MASS CASUALTIES – major incidents (MI)*****Radiographer – what exam? what to prepare?***

Ideally one standardized CT-protocol for all for maximum efficiency

Consider WBCT in all patients requiring CT in mass casualty events  
(especially blast events) to *avoid rescans*

REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

**ACTION CARD – RADIOLOGIST**

**ISOLATED PENETRATING HEAD INJURY**

***Radiologist – What exam?***

- ALL: Non-contrast CT of the Head; include whole face
- FOR SALVAGABLE PATIENTS
- Non-contrast head CT
- CTA – head & neck to aortic arch -
- CTV if sinus injury is suspected
- (GSW - DSA if metal artifacts/inconclusive CTA)

***Diagnostic focus?***

- (use scout to localize foreign objects)
- Brain injury,
- vascular injuries head & neck;
- facial injuries incl vascular

**ISOLATED PENETRATING NECK INJURY**

***Radiologist - what exam?***

- CTA head & neck to aortic arch – consider including whole thorax (zone I+II injuries)

***What diagnostic focus?***

- look for wound marks
- vascular injuries – ongoing bleeds, AV- fistulas
- lung/mediastinal injuries
- airway injury?
- esophageal injury?
- look for foreign bodies (scout view!)

**PENETRATING TORSO (TRUNK) INJURY**

**IMAGING IN ER/UNSTABLE PATIENT**

***Radiologist – what exam? What diagnostic focus?***

- (e-FAST)
- chest X-ray; foreign bodies/wound markings
- beware – box of death – large hemothorax may conceal hemopericardium

**IMAGING IN THE STABLE PATIENT**

***Radiologist – what exam?***

- CT chest-abdomen - late arterial (to visualize arterial injuries) to lesser trochanters+ venous phase upper/whole abdomen.
- Consider triple contrast CT. (Level II Evidence). (if agreed on locally)
- Add late phase (5-10 min delay) if kidney and ureter are in injury trajectory.
- CT cystogram should be performed in urinary bladder injuries
- check Wound marking strongly recommended, paper clip/E-vitamin capsule etc.\*

## REPORT FROM NORDTER CONSENSUS MEETING, SIGTUNA OCT 18-19, 2017

(- Use CT scouts to localize foreign bodies in GSW)

### ***What diagnostic focus?***

Tangential or superficial wounds: Exclusion of peritoneal or pleural penetration

Thoracoabdominal wounds/ anterior abdominal wounds: For gastric, small bowel, or colonic injury, high-grade solid organ injury, pancreaticobiliary injury, major vascular injury, and diaphragmatic injury

Transpelvic gunshot wounds: For rectal or bladder injury, and intra- versus extraperitoneal involvement; evaluate for major vascular injury;

Back and flank wounds: For retroperitoneal injury potentially involving colon, kidneys, ureters or major vessels

Precordial, parasternal, periclavicular and transmediastinal wounds: For cardiac injuries, closed aortic or great vessel injuries, and aerodigestive tract injuries

## PENETRATING EXTREMITY INJURY

### ***Radiologist – what exam?***

CTA – consider adding venous series

### ***What diagnostic focus?***

Bleeding

Pseudoaneurysm

AV-fistula

## MASS CASUALTIES – major incidents (MI)

### RADIOLOGIST

*what exam? What diagnostic focus?*

e-FAST – consider using to triage for CT in the initial phase

Trauma-protocol available on all scanners.

Ideally **one standardized protocol** for all for maximum efficiency

Consider **WBCT in all** patients requiring CT in mass casualty events (especially blast events) to avoid rescans

Basic imaging data to PACS, **reading directly from modality console/workstation**

Quick, concise documentation, **standardized reporting** - based on local practice (consider backup paper-based system)

Life-threatening findings must be reported immediately

**End of document**