Trauma Practice Management Guideline

WMCHealth

2024 Edition

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TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 1

INITIAL ASSESSMENT AND RESUSCITATION

Trauma Team Assignment

1. **Trauma Team Leader (TTL):** Surgical resident (PGY 4 or 5), fellow: directs the overall resuscitation and performs or assists lifesaving procedures.
2. **Trauma Attending (TA):** Supervises all aspects of the resuscitation and is the designated trauma triage officer directing flow of patients to the OR, CT, and ICU.
3. **Primary MD (PMD):** Surgical resident (PGY 1-3), fellow or APP: performs primary survey and secondary survey, may perform/ assist with invasive procedures (central venous access, chest tube insertion, wound explorations, etc.)
4. **Primary Airway MD (PAMD):** ED Attending, Anesthesia resident with Anesthesia Attending Supervision: assesses patient's airway and maintains C-spine stabilization, performs head examination (pupillary and verbal response, control of bleeding from scalp lacerations)
5. **ED Attending (EDA):** Function as/ or supervising/ assisting the PAMD. In the absence of the TA, responsible for the resuscitation and supervising the TTL, until arrival of the Trauma Attending. The EDA may also assume the role of TTL during resuscitation of multiple patients.
6. **Scribe Nurse (Scribe):** Primarily responsible for documentation of the resuscitation/ flow sheet and assuring tests and labs as ordered are completed.
7. **Primary Nurse (PN):** Direct patient care during all aspects of the trauma resuscitation, including administering any medications for rapid sequence intubation, antibiotics, or medications for pain or sedation.
8. **Secondary Nurse (SN):** Level I Activations Only: Direct patient care during all aspects of the trauma resuscitation, including obtaining blood for lab work, medication administration, and operating the Rapid Transfuser / Belmont.
9. **Patient Care Technician (PCT):** Assisting with direct patient care during all aspects of the trauma resuscitation, including placing monitoring, removing clothing/ exposure, securing patient valuables, and placing ID band on patient.
10. **Respiratory Therapist (RRT):** Assisting airway management, obtaining the initial blood gas specimen, and maintaining the mechanical ventilator.
11. **Radiology Technician (XRT):** Present at all trauma resuscitations and prepared to perform the standard X-rays as directed by the Trauma Team Leader.
12. **Medical Student (MS):** Tasks commensurate with abilities as assigned by either the Trauma Team Leader or Primary MD.
13. **WMC Security:** In the event of violent crime, security officers will be available for safety issues and crowd control.

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ADULT TRAUMA ACTIVATION CRITERIA (GEQ 15 YEARS OLD)

ADULT **LEVEL I RESPONSE** (FROM THE TIME ACTIVATION IS INITIATED):

Trauma Attending	**IMMEDIATELY** (within 15 mins)
Trauma Surgical Resident (PGY IV or V)	Immediately
Emergency Medicine Attending	Immediately
Emergency Medicine Resident (PGY II or III)	Immediately
Anesthesia Attending	Immediately
Anesthesia Resident (PGY III)	Immediately
Trauma Nurses (Primary, Secondary & Scribe)	Immediately
Orthopedic Resident	Immediately Available by Phone
Neurosurgery Resident	Immediately Available by Phone
X-Ray Technician	Immediately
Blood Bank	Immediately Available by Phone
Blood Product Courier	Immediately
STAT Lab	Immediately Notified
Radiology Resident	Immediately Available by Phone

ADULT LEVEL 1 TRAUMA ACTIVATION CRITERIA

Physiologic Criteria:

- Traumatic Cardiopulmonary arrest
- GCS < 12 **OR** GCS < *14 currently taking anticoagulants (ASA and Plavix included)*
- *Any confirmed SBP <100 from scene to WMC arrival*
- *Any patient with a HR > than SBP*
- Respiratory distress (rate < 10 or> 29) **AND/OR** airway compromise
- Any ongoing blood or blood products transfusing for hemodynamic maintenance
- ANY and **ALL** intubated patients- OR-patients in need of emergent airway

Anatomic Criteria:

- Penetrating injury to the head, torso, neck, or groin area proximal to the elbow/knee
- Uncontrolled external bleeding
- Clinically **unstable** pelvic fractures: Diastasis symphysis pubis GEQ 5cm; SI joint widening; Butterfly fragment fracture (all 4 pubic rami fractured), base deficit GEQ -I 0
- **Two or more** long bone fractures
- Amputations of any extremity (excluding digits)
- Poly-Trauma **(2 or more** involved systems)
- **ALL PREGNANT PATIENTS 28 weeks** gestation after major trauma
- Significant Burns GEQ 15% TBSA associated with traumatic injury (including inhalation injury)
- Spinal Cord injury / paralysis

Mechanism of Injury:

- Vehicular Ejection OR prolonged extrication (> 20 min)
- High Speed Collision (> 30 MPH) with gross injury AND age ≥ 65 year of age
- Death of another occupant in the same vehicle
- Motorcycle or bicycle impacted at ≥ 20 MPH
- Falls > 20 feet
- Pedestrian Struck > 20 mph with gross injury

Physician Discretion:

- The Emergency Department or Trauma Attending initiates a Level 1 Activation

ADULT **LEVEL II RESPONSE** FROM THE TIME ACTIVATION IS INITIATED):

*ALL inter-facility transfers (ED to ED) will be activated as Level 2, unless any report identifies criteria to upgrade to Level 1

* Trauma Attending to see all Level 2 activations within 4 hours of arrival

Senior Trauma Surgical Resident (PGY IV or V)	Immediately
Emergency Medicine Attending	Immediately
Emergency Medicine Resident (PGY II or III)	Immediately
Respiratory Therapist	Immediately
Orthopedic Resident	Immediately Available by Phone
Neurosurgery Resident	Immediately Available by Phone
X-ray Technician	Immediately
Blood Bank	Immediately Available by Phone
STAT Lab	Notified
Radiology Resident	Immediately Available by Phone

ADULT LEVEL II TRAUMA ACTIVATION CRITERIA

Physiologic Criteria:
- GCS 13-15

Anatomic Criteria:
- Clinically stable pelvic fracture
- One long bone fracture

Mechanism of Injury:
- High Speed Collision (>30 MPH) **without** gross injury **AND** age ≥ 65 years
- Unrestrained Passenger involved in a rollover
- Prolonged Extrication (> 20 min) **without** gross injury
- Pedestrian impacted at GEQ 20 MPH
- Falls ≥ 10 feet-**OR -** *any fall with a (+) LOC ≥ 65 years of age*
- Motorist/Cyclist/Rider separated from object (motorcycle/bicycle/ATV/horse/snowmobile/dirt bike)
- Patient suspected of hanging

Physician Discretion:
- The Emergency Department or Trauma Attending initiates a Level II Activation
- The Emergency Department or Trauma Attending will notify Neurosurgery Resident to respond immediately for closed/open head injuries

Adult Consult Response (from time consultation is placed):

Surgical Resident for ED (PGY II-III)	Call-back w/in 15min of consult
Senior Trauma Resident (PGY IV-V)	Notified by ED surgical resident by phone w/in 30min to evaluate, examine, & communicate recommendations w/in 45min
Trauma Attending	By phone after vital diagnostic imaging

ADULT TRAUMA CONSULT POLICY

All patients arriving through the Emergency Department with trauma mechanisms not meeting Trauma Level I or II activation can generate a trauma consultation based on the discretion of the Emergency Medicine department. All such patients with traumatic brain injury or poly-systems trauma must generate a trauma consultation.
Trauma consultations must be seen by PGY-2 or higher level resident within 60 minutes of request, and immediately staffed with the on-call Trauma Surgery Attending.

ADULT LEVEL III RESPONSE (EMERGENCY DEPARTMENT ONLY):

Emergency Attending	Immediately
Emergency RN	Immediately

ADULT LEVEL III TRAUMA ACTIVATION CRITERIA

- Any EMS call involving a traumatic mechanism that may result in injury but does not meet Level 1 or 2 criteria, with a low threshold to call a Level 3 if the patient is ≥ 65 years old AND/OR is taking anticoagulation (including ASA and Plavix)
- Fall from a height that does not meet Level 1 or 2 criteria, particularly patients ≥ 65 years old
- MVC which does not meet Level 1 or 2 criteria, particularly patients ≥ 65 years old
- Pedestrian Stuck at low speed particularly patients ≥ 65 years old
- Physician or Nurse discretion.

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Standard Trauma Resuscitation

Resource Management – Identification
Trauma resuscitation team members should identify themselves by name and roles prior to the arrival of the patient with the use of the stickers provided outside of every trauma bay.

Prehospital personnel bring the patient into the Trauma Resuscitation room and assist in moving the patient to the resuscitation bed. A brief report following the MIST format including mechanism of injury, vital signs, GCS, treatments and responses, and any pertinent past medical history is provided and should not exceed 60 seconds in length. Other conversation during the report should be kept to a minimum. The Scribe nurse should record all information as reported to the trauma team.

Primary Survey: ATLS Principles- ABCDE: any life-threatening conditions discovered should be immediately treated.

Airway/ C- spine: Assessment of the airway is performed by the PAMD and EDA positioned at the head of the bed in collaboration with the TTL regarding definitive airway management. If intubation is NOT necessary, the RRT should place O2 by high-flow mask on all patients. During intubation, cervical spine precautions should be maintained.

Breathing: The PAMD and PMD should assess breathing. PCT places the pulse oximeter on the patient, and RRT obtains blood gas.

Circulation: The PCT places ECG leads and auto blood pressure cuff while PN obtains an initial manual blood pressure. Two large bore IV's are placed and PMD assesses pelvis stability, central, then peripheral pulses, skin color, and mental status. All sites of external hemorrhage are controlled. Blood for laboratory evaluation should be obtained during line placement or by the PN.

Disability: Disability is assessed by noting GCS, pupil examination, and ability to move all 4 extremities.

Exposure and Environment: the patient is undressed for complete examination and subsequently covered with warm blankets. Warm IV fluids should be given via fluid warmer in all multi-trauma patients.

Secondary Survey: Complete head-to-toe exam.

PMD continues with the secondary survey once the primary survey is complete and the patient demonstrates the appropriate physiologic response to resuscitation. This should include a rapid examination of the patient's entire anterior and posterior surfaces, including the flanks, and a rectal exam. The entire spinal column from occiput to sacrum is inspected and palpated for deformity, step-off, and pain and the patient is rolled to adequately examine both flanks and axilla. All findings are verbalized to the entire team.

The TTL determines the need and exact sequence of placement of additional IV's, the timing of laboratory assessment, and radiologic assessment required. Trauma X-rays should be obtained immediately following examination of the back. These typically include chest X-ray for blunt trauma and appropriate AP and cross-table lateral films for penetrating trauma.

The PMD should perform a detailed head-to-toe examination while X-rays and other procedures are being performed and findings communicated. A FAST (Focused Assessment with Sonography for Trauma) should be performed on all patients with hypotension and/or suspected abdominal injury and uploaded into the ultrasound machine software.

Consultants should be notified early upon recognition of injuries that need their evaluation. Fractures should be splinted and wounds dressed appropriately.

The TTL will then determine where and when the patient should be moved from the resuscitation room to complete the work-up. It may be determined that an unstable patient requires transport out of the resuscitation room prior to completing the full work-up for operative intervention or to continue the resuscitation in the Operating Room or TICU (Trauma Intensive Care Unit).

ADDITIONAL IMPORTANT POINTS

- EVERY PERSON TAKES RESPONSIBILITY FOR THEIR OWN SHARPS
  Disposal of sharps is the responsibility of the person using the sharp instrument. A large sharps box is readily accessible in each trauma room.

- No X-rays are obtained during insertion of any IV's, especially central line insertion.

- If the patient's initial BP is within normal limits, repeat BP will be obtained every 5 minutes until specified by the TTL. If the patient is hypotensive, then obtain every 1 minute until specified by the TTL.

- Personal Protective Equipment (PPE) should be worn by ALL individuals participating in the trauma resuscitation during ALL trauma activations.

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IN THE EMERGENCY DEPARTMENT:

Given the appropriate history, mechanism of injury, and physical examination the following guidelines are followed:

A. Primary Survey X-Rays
   1. CXR film should be obtained for all trauma activations

   2. AP Pelvis for:
      a. pelvic tenderness
      b. physical findings of fracture or dislocation
      c. hemodynamic instability
      d. GSW to pelvic area

B. Secondary Survey Imaging Studies
   1. CT TRAUMAGRAM (head, occiput to T1, chest including aortic arch, abdomen, and pelvis) should be obtained for hemodynamically stable blunt trauma patients with:
      a. an abnormal neurologic exam, history of LOC, or post-traumatic amnesia
      b. unreliable or abnormal abdominal exam
      c. question of aortic arch injury on CXR
      d. mechanism of injury or physical exam deemed by clinical judgment to support the test

   2. EXTREMITY X-rays with multiple views should be obtained for:
      a. pain/deformity/crepitus
      b. abnormalities in the neurovascular exam

   3. CYSTOGRAPHY: Hematuria associated with pelvic fractures is best evaluated with a CT cystogram, although an X-ray cystogram may be performed with 300 cc of contrast (full and post-void). Abdomino-pelvic CT scan is the method of choice for evaluating blunt renal injury. Patients with high suspicion of renal injury should undergo a CT Urogram to evaluate for collecting system injury - most of this can be addressed in other sections.

   4. OUTSIDE CT/ TRANSFERRED PATIENTS: Repeat imaging will be at the discretion of the attending trauma surgeon (TA).

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1. INITIAL ASSESSMENT AND RESUSCITATION
E. Operating Room Notification

OBJECTIVE: To define the mechanism of notification to the operating room that a patient requires an immediate surgical procedure.

Guidelines:

1. Upon decision by the Trauma Team Leader (TTL) that a patient requires an immediate surgical procedure, the OR charge nurse will be called.

2. The anesthesiologist present in the Trauma Bay will contact the anesthesia team to prepare the OR.

3. The following information will be conveyed:

   a. Patient name, age, Medical Record Number
   b. Attending surgeon
   c. Type of procedure to be performed (e.g., laparotomy, thoracotomy, neck exploration, etc.).
   d. The approximate time that the procedure should be performed (now, 5 minutes, 15 minutes, etc.).
   e. Blood products needed
   f. Hemodynamic status of patient

4. For emergency surgery, the OR will be readied for all trauma patients within 15 minutes :

   a. Specific Trauma Cart based on planned procedure
   b. Rapid Infuser on Ready status
   c. Courier in OR if MTP activated

5. Once the decision for emergent operation has been made, proceed as soon as possible to the operating room.

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TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 2

CLINICAL MANAGEMENT GUIDELINE

OBJECTIVE: To define the delineation of responsibility for airway management in the Trauma Resuscitation Bay.

GUIDELINE: The Trauma Attending (TA) is responsible for determining the necessity of obtaining a definitive airway. The EM physician (EDA) or the anesthesiologist may intubate the patient depending on the assessment of airway difficulty. All patients whose airway could not be secured in the field will be intubated by the anesthesiology attending.

SCOPE: This guideline includes all physicians, allied health providers, and nurses who practice in the Trauma Resuscitation Bay.

PROCEDURE:

1. The Trauma Attending is in charge of the patient's airway, including decisions for intubation and adjunctive management. Should the patient require intubation, either the EM attending or the Anesthesia Attending will proceed based on the perceived airway difficulty.

2. EM Physicians will perform intubations only when there is agreement between the Anesthesiology and Trauma Attending. The Trauma Attending will be at the bedside supervising patient management and decision making.

<u>Intubation Indications</u>:

1. Airway obstruction
2. Hypoventilation
3. Persistent hypoxemia (SaO_2 <90%) despite supplemental oxygen
4. Severe cognitive impairment (Glasgow Coma Scale score ≤ 8)
5. Severe hemorrhagic shock
6. Cardiac arrest
7. Facial or neck injury with the potential for airway obstruction
8. Cervical spinal cord injury with any evidence of respiratory insufficiency
9. Major cutaneous burn (≥ 40% total body surface area)
10. Smoke inhalation injury with potential for impending airway obstruction
11. Persistent combativeness refractory to pharmacologic agents

<u>Procedural Options:</u>

1. Orotracheal intubation guided by video laryngoscopy (VL) is the initial procedure of choice for trauma patients

2. When tracheal intubation cannot be achieved rapidly with VL, additional measures to secure the patient's airway may be used, including:
    a. Direct laryngoscopy
    b. Blind-insertion supraglottic devices (LMA, Cobitube, King Airway)
    c. Bougie assisted intubation
    d. Fiberoptic guided intubation
    e. Surgical cricothyroidotomy

3. Rapid Sequence intubation (RSI) is the preferred method of airway management
4. All patients are to maintain cervical spine immobilization and precautions at all times
5. All patients are considered to have a full stomach
6. The choice of pharmacologic agents used in RSI needs to take into account patient factors, including hemodynamic instability, presence of traumatic brain injury, or comorbid conditions. In order to standardize the stocked medications, the following medications will be available for intubation in the Trauma Resuscitation Bay:
    a. Succinylcholine
    b. Rocuronium
    c. Etomidate
    d. Midazolam
    e. Propofol
    f. Ketamine
7. RSI drug regimen should be given to achieve the following clinical objectives:
    a. Adequate sedation and neuromuscular blockade
    b. Maintenance of hemodynamic stability and CNS perfusion
    c. Maintenance of adequate oxygenation
    d. Prevention of increased intracranial hypertension
    e. Prevention of vomiting and aspiration

Agent	***Dose***	***Onset***	***Duration***
Premedication			
Fentanyl	1-5 mcg/kg	30-45 s	0.5-1 h
Midazolam	0.1-0.3 mg/kg	2-3 min	2-3 h
Lidocaine	1-1.5 mg/kg	30-90 s	10-20 min
Induction			
Etomidate	0.3 mg/kg	10-60 s	4-10 min
Propofol	1-2 mg/kg	10-50 s	5-10 min
Ketamine (IV)	1-2 mg/kg	30-60 s	5-15 min
Neuromuscular blockade			
Rocuronium	0.6 to 1.2 mg/kg	1-2 min	40-60 min
Succinylcholine	1-1.5 mg/kg	30-60 s	5-15 min

8. Oral intubation attempts should be limited to three before performing a surgical airway.
9. In patients with complex maxillofacial trauma, a surgical airway may be the first/best choice

Trauma Airway Management

Airway Assessment

- All trauma airways are potentially high-risk. Anticipate a difficult airway.
- Identify critical team members and verbalize role assignments.
- Initiate pre-oxygenation (1,2).
- Consider Ketamine (0.5-1.0 mg/kg IV/IO) for delayed sequence intubation if combative or otherwise uncooperative patient (3,4,5).
- Recall that the neutral position ("C-spine stabilization") degrades the laryngoscopic view.

Rapid Sequence Induction (RSI) and Intubation Pathway

1. **Confirm equipment availability and function.**
   IV/IO, suction, self-inflating bag and mask, oxygen source, laryngoscope- video (preferred) or direct (if video not available) (5, 20), ETT with stylet and/or gum elastic bougie, oral & nasal airways, surgical airway kit, drugs, C02 detector, monitors, other rescue equipment
2. **Pre-Oxygenate (Denitrogenate) the lungs (1,2,6)**
   - Prolongs tolerance of apneic period
   - Goal is ≈ 3 minutes of tidal volume breathing at 90% FiO2.
   - With standard reservoir facemask set flow rate of oxygen as high as possible
   - Recommend augmenting with nasal cannula at 15L/min oxygen in preparation for apneic oxygenation, leave in situ throughout procedure (2,8)
   - Elevate head of bed if not contraindicated.
3. **Maintain cervical spine stabilization.**
4. **Remove front of cervical collar**
5. **Consider cricoid pressure simultaneous w/ medication administration (9,10)**
6. **Administer medications :** Initiate RSI

Sedative/hypnotic
- Ketamine (1st Line): 2 mg/kg IV/IO
- Etomidate (2nd Line): 0.3 mg/kg IV/IO

Unstable patients require reduced dosage of induction agent.

Neuromuscular Blockade
- Rocuronium: 1.2 mg/kg IV/IO or
- Vecuronium: 0.1 mg/kg IV/IO or
- Succinylcholine: 1.5 mg/kg IV/IO

7. **Perform laryngoscopic tracheal intubation.**
   - Following onset of neuromuscular blockade
   - Recommend gum elastic bougie as primary ETT stylet.
8. **If laryngoscopic view is poor:**
   - Apply external laryngeal manipulation technique(s)
   - Consider alternative visualization method or Supraglottic airway device.
9. **Confirm tracheal intubation.**
   - Visualize tube passing between the vocal cords (First Line)
   - Wave form or digital capnography when available (Second Line)
   - Easy chest rise, equal axillary breath sounds/absence of gastric insufflation, CO2 Calorimeter, and "fog" in ETT
   - Esophageal detector bulb or fiber optic confirmation during cardiac arrest
10. **Provide continuing care IAW Anesthesia CPG**

Recommendations for Pediatric Patients

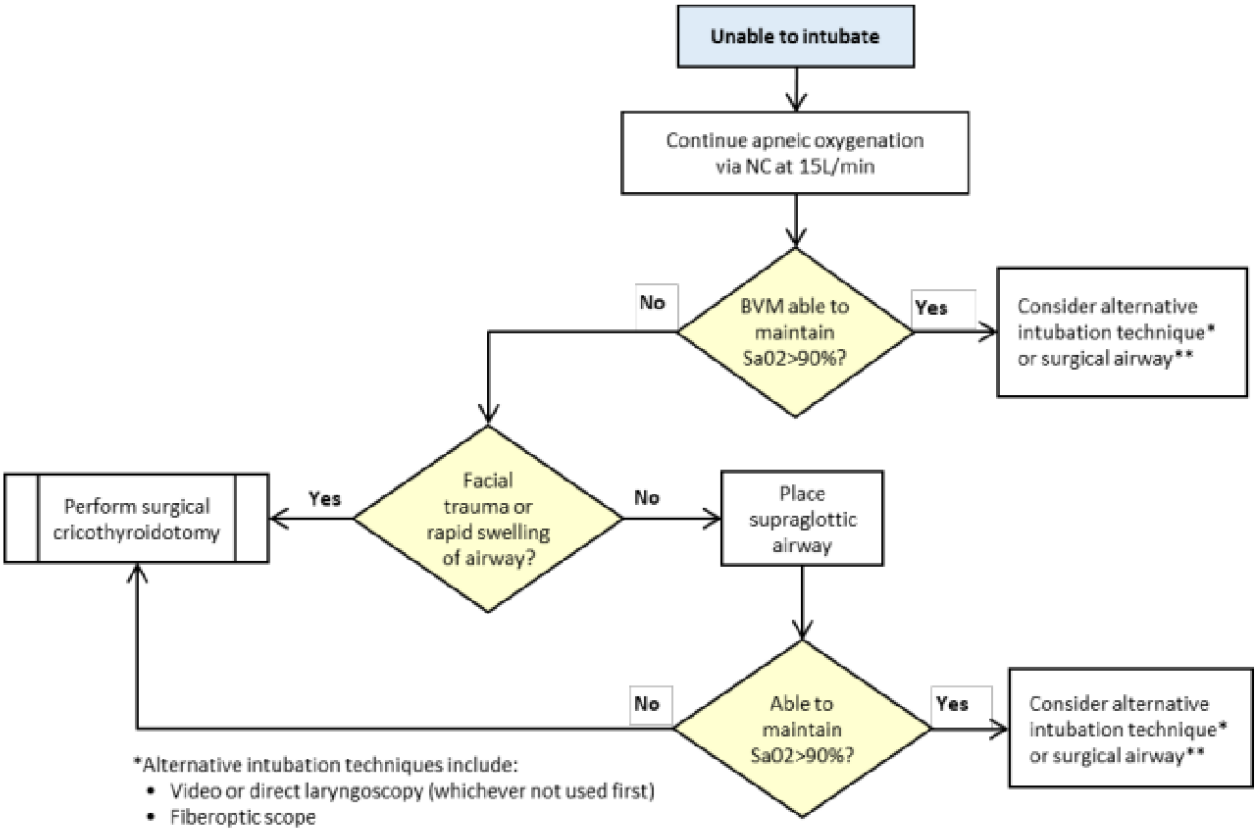
1. Train to expect pediatric patients. Have a dedicated pediatric airway cart, including Broselow tape or equivalent.
2. Pre-dose with atropine IV/IO (0.02mg/kg, minimum dose 0.1mg, maximum dose 0.5mg) in all <1 years old, those <5 who are receiving succinylcholine, and in all who receive a 2nd dose of succinylcholine.
3. Induction -
   - Ketamine (first line) 2mg/kg IV/IO
   - Etomidate (second line) 0.3mg/kg IV/IO
4. Neuromuscular blockade -
   - Succinylcholine 1.5mg/kg IV/IO (2mg/kg <5 years old) or
   - Rocuronium 1mg/kg IV/IO
5. Avoid surgical airway in <12 years old - use needle cricothyroidotomy (12-14 gauge), tracheostomy preferred over surgical cricothyroidotomy

Unable to Intubate: Can You Mask Ventilate?

Mask Ventilation Pearls
- Skilled operator
- Good seal
- Jaw thrust
- Oral airway
- Nasal airway(s)
- Two operator mask ventilation

YES	• Improve position, change blade/operator, laryngeal manipulation technique, gum elastic bougie. • Attempt alternate technique: Fiber optic, video laryngoscope, tracheal trans illumination device. • More than ≈ 3 attempts at intubation may abolish your ability to mask ventilate due to edema caused by laryngoscopy. • Surgical airway (Cricothyroidotomy or tracheostomy)
NO	• Emergency pathway...seconds matter. • Supraglottic airway or • Surgical cricothyroidotomy

Difficult Airway Management



*Alternative intubation techniques include:

- Video or direct laryngoscopy (whichever not used first)
- Fiberoptic scope
- Transtracheal illumination device
- Retrograde wire with Magill forceps
- Changing providers

**Surgical airway includes both tracheostomy and surgical cricothyroidotomy will be performed.

Confirmation of Successful Tracheal Intubation

While direct visualization of the endotracheal tube passing through the vocal cords is evidence of proper endotracheal tube placement, additional confirmatory objective studies should be employed:

a. Auscultation of bilateral breath sounds
b. End-tidal carbon dioxide detector/Continuous waveform capnography
c. Chest radiograph
d. Ultrasound (Reserved for experienced technicians)

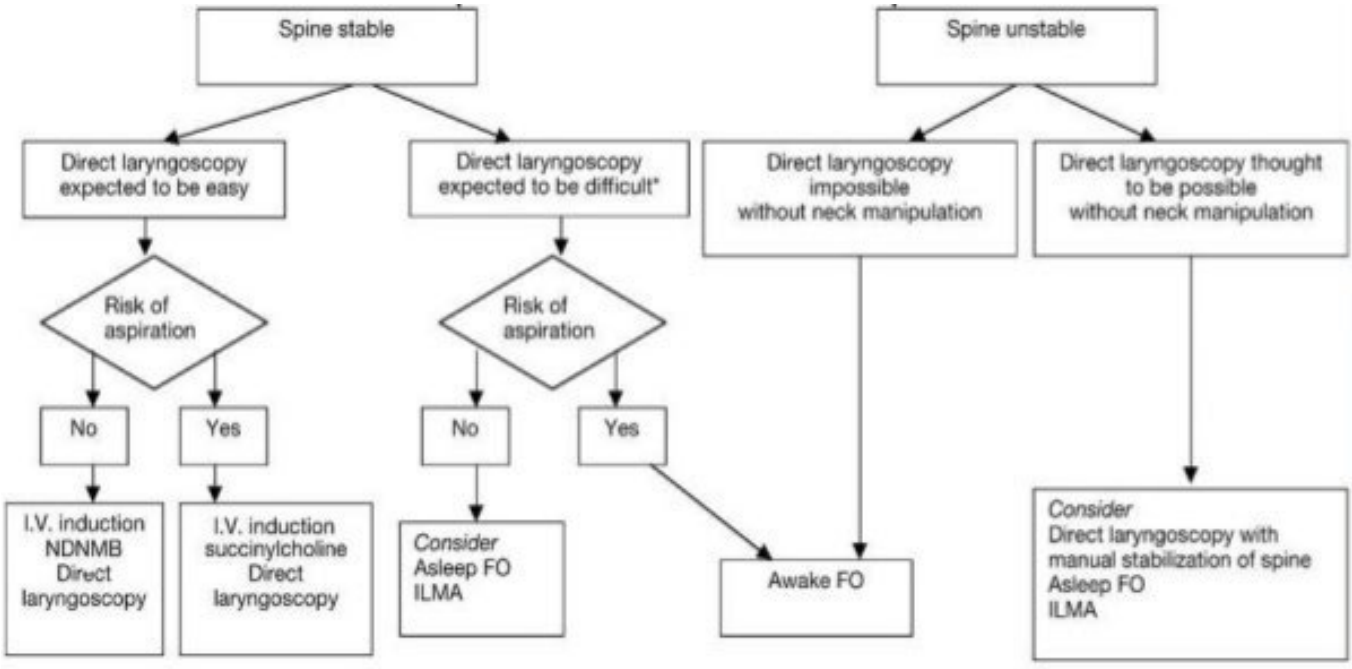
In patients who are intubated and require exchange of the endotracheal tube, management should incorporate an airway exchange catheter and/or fiberoptic bronchoscopy

Presence of a laryngeotracheal airway or esophageal obturator airway may indicate a potentially difficult airway and a high risk of aspiration. These are non-definitive airways. These airways should be removed only with an anesthesiologist present as well as the presence of a surgeon capable of a surgical airway.

Repositioning of the endotracheal tube mandates confirmation of position radiographically prior to transporting patient.

Intubation in patients with Cervical Spine injury

All blunt trauma patients requiring intubation in the trauma bay should be considered to require cervical spine precautions. Patients who are transferred from other hospitals should be considered to require cervical spine precautions unless imaging and work-up from outside hospital has clinically cleared the cervical spine.



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TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 3

HEAD AND NECK GUIDELINES

OBJECTIVE

Care of the trauma patient mandates evaluation for potential injury of the cervical spine. Specific issues addressed include the population requiring cervical spine imaging, which, if any additional diagnostic imaging is required, and application of these considerations to the comatose patient.

GUIDELINE

In conjunction with Radiology, Orthopedic Surgery, and Neurosurgery, the division of Trauma has developed the following recommendations, which represent the institutional adaptation of practice guidelines previously developed by the Eastern Association for the Surgery of Trauma and the New York State In-Hospital Cervical Spine Clearance Guidelines in Blunt Trauma with modifications based on established collective practice patterns and review of currently available literature. These guidelines are intended to assist in the evaluation of the trauma patient with suspected cervical spine injury.

A. IDENTIFICATION OF PATIENTS AT RISK FOR CERVICAL SPINE INJURY
   1. All blunt trauma patients should be suspected of having sustained cervical spine injury until proven otherwise. Patients who arrive with adequate cervical spine immobilization in place should remain immobilized until evaluated by the treating physician. Patients who arrive without cervical spine immobilization should be immobilized at the discretion of the treating physician based on mechanism of injury and clinical suspicion of C-spine injury.
   2. All life-threatening hemodynamic and pulmonary problems should be addressed before a prolonged cervical spine evaluation is undertaken.

B. NEED FOR RADIOGRAPHIC EVALUATION OF THE CERVICAL SPINE
   1. Trauma patients may be considered to have a stable cervical spine and require no radiographic studies if they satisfy all of the following criteria:
      a. normal level of alertness
      b. no evidence of intoxication
      c. no painful distracting injury
      d. no focal neurologic deficit / paresthesias
      e. no midline cervical spine tenderness
      f. no pain on confrontational exam, in the absence of distracting injuries
      g. no history of Ankylosing Spondylitis or cervical spine anomalies
   2. All other trauma patients should undergo radiographic evaluation:
      a. A high-quality axial CT scans with reconstruction should be the primary method of radiographic clearance for bony injury.
         1. MRI may also be used to evaluate for ligamentous injury.
      b. Patients with focal neurologic deficits may require emergent or urgent MRI evaluation of the spinal cord in addition to CT evaluation of the axial bony spine. This test should be ordered in consultation with a spine service (orthopedic surgery or neurosurgery).
   3. If radiographic examination fails to reveal injury and patient has no neurologic deficits, an attempt to clear the c-spine clinically may be undertaken.
      a. If patient has no pain to palpation or passive movement (confrontational exam), immobilization (collar) may be removed.
      b. If patient is found to have neck pain to palpation or movement, flexion/extension radiographs of the cervical spine / MRI should be performed (see above).
      c. If no injury is identified during these studies, symptomatic treatment of neck pain is provided with a soft collar.

d. If cervical instability is identified, patient should remain immobilized and spine service consult should be obtained.

C. NEED FOR SPINE SERVICE CONSULTATION:

1. If radiographic abnormality is identified, cervical spine immobilization should be continued, and spine service consultation should be obtained.
2. Any patient found to display evidence of neurologic deficit must remain immobilized, *despite radiographic findings* until evaluated by spine service.

D. COMATOSE PATIENTS

Patients who present with altered level of consciousness, not expected to improve within 24 - 48 hours, should undergo the following studies:

1. Axial CT scan of cervical spine (see B.2.a. above).
2. If injuries are identified using the high-quality Axial CT scan, immobilization should be maintained, and spine service should be consulted.
3. If no injury is identified by CT, the cervical spine should be considered to be stable and immobilization (cervical collar) may be discontinued.

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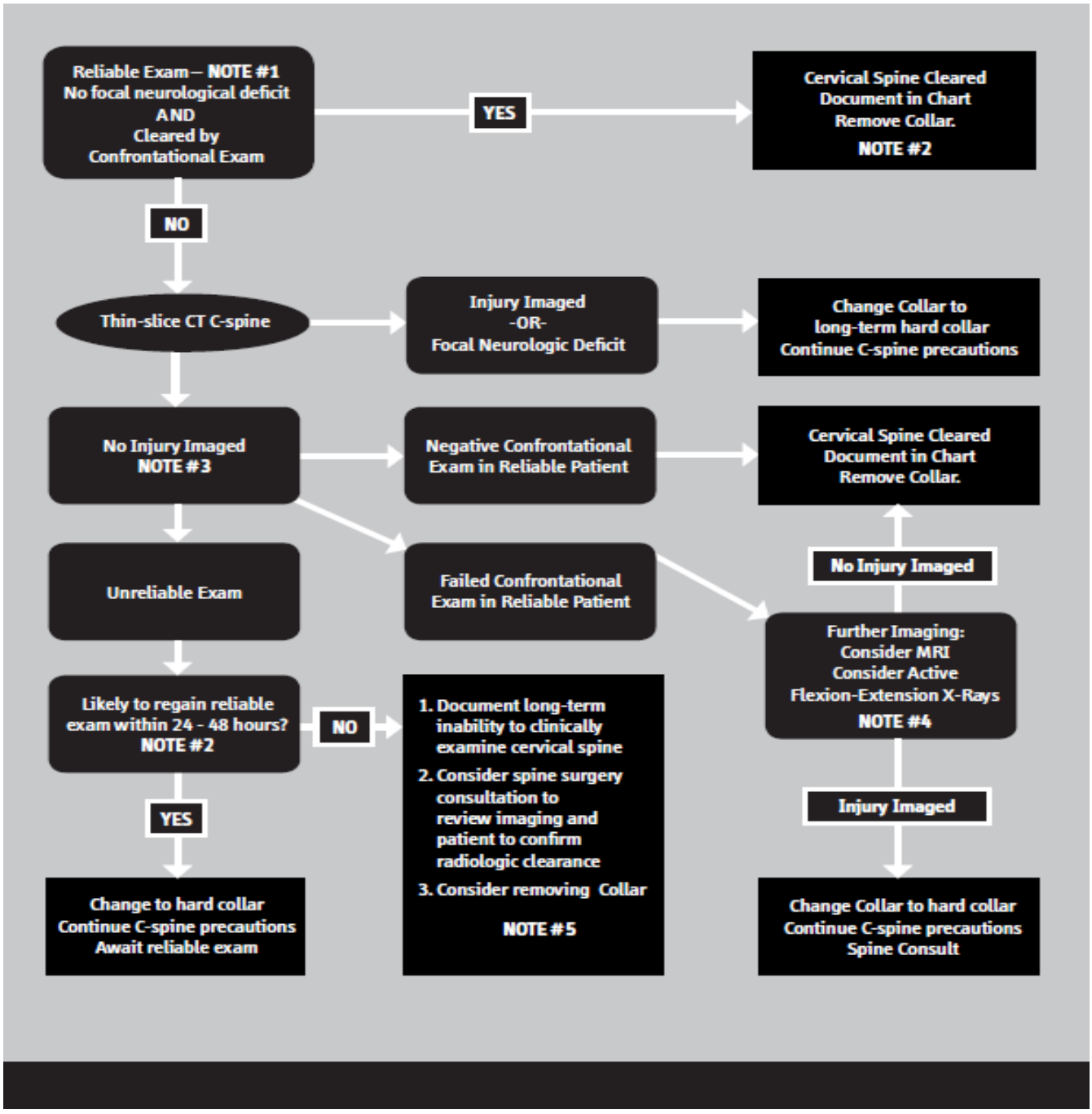
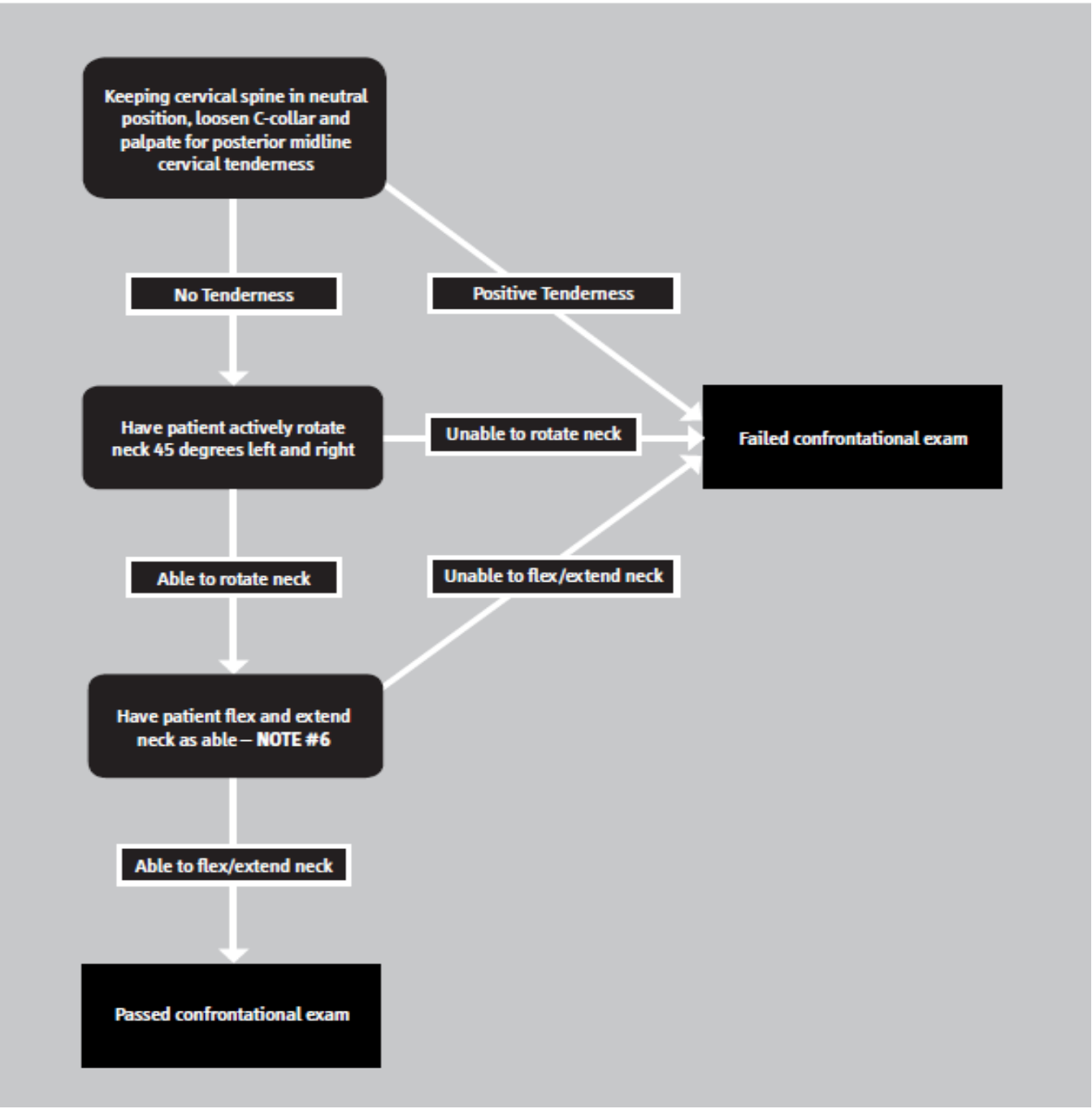
APPENDIX: New York State Inpatient Cervical Spine Clearance Guidelines



New York State Inpatient Cervical Spine Confrontational Exam Protocol



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OBJECTIVE: Define priorities in the management of facial trauma.

GUIDELINES: The management of maxillofacial injuries involve the application standard resuscitation priorities as delineated in Chapter 1 with particular emphasis placed the airway and controlling the severe bleeding that can be associated with maxillofacial trauma. Of note, severe maxillofacial injuries can be frequently associated with traumatic brain injury and cervical spine fractures.

The following management principles apply to patients with severe maxillofacial injuries:

1. Airway: Avoid naso-tracheal intubation; orotracheal intubation with in-line stabilization is the accepted modality to secure the airway. Severe maxillofacial trauma involving the mouth and the mandible may necessitate a cricothyroidotomy.
2. Bleeding: Patients with severe maxillofacial trauma are at risk of having obstruction of the airway from aspiration of blood and/or loose teeth. Any suggestion of aspiration must be accompanied by a prompt evaluation of a secure airway followed by intervention as necessary.
3. Circulation: Severe bleeding can occur from lacerations associated with maxillofacial fractures. Scalp bleeding should be promptly controlled with an interlocking suture. Anterior nasal bleeding should be controlled with anterior packing. Posteriorly nasal bleeding should be controlled with a Foley catheter and anterior packing. Control facial bleeding with interlocking 3-0 Prolene.
4. Disability: Perform a complete neurological examination in the conscious patient. If there is anisocoria, consider the possibility of oculomotor nerve injury or eye globe injury. Always assess ocular movements to check for entrapment.
5. Expose: Include evaluation of the external ear canals for hemotympanum and assess the oral cavity for missing teeth.

Imaging includes CT of the head and of the maxillofacial structures with thin cuts. All patients with severe maxillofacial trauma (Le Fort II and III) should be subjected to a CTA of the head and neck to exclude blunt cerebrovascular injuries.

For open facial fractures involving extra-oral or mucosal surfaces (tooth-bearing areas), there is no strong evidence available at this time to recommend for or against antibiotics administration. In cases where lacerations or open facial fractures result in the consultation of facial trauma services, recommendations for antimicrobial therapy will be followed in a collaborative fashion. Therefore, if the patient has open facial fractures, give 1 g of cefazolin IV. Laceration without gross contamination or signs of infection does not warrant antibiotic therapy. If the lacerations are associated with fractures involving the sinuses, you can either add clindamycin 600 mg IV every 8 hours or, conversely, give 3 g IV amoxicillin clavulanate[1] (Level 3). Basilar skull fractures with or without CSF leak do not require antibiotic prophylaxis[2,3] (Level 1).

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OBJECTIVE: To define the diagnosis and the management of blunt cerebrovascular injuries.

GUIDELINE: Blunt injuries to the carotid and vertebral vessels (BCVI) are diagnosed in approximately one of 1000 (0.1%) patients hospitalized for trauma. The majority of these injuries are diagnosed after the development of symptoms secondary to central nervous system ischemia resulting in a neurologic morbidity of 80% and an associated mortality of 40%. If appropriate screening for BCVI is done, then the incidence rises to approximately 1% of all blunt trauma patients and up to 2.7% in patients with an ISS ≥ 16.

Patients with one or more the following criteria should undergo evaluation for BCVI via Neck CTA:

1. Neurologic abnormality that is not explained by the diagnosed injury
2. Epistaxis from a suspected arterial source after maxillofacial trauma
3. Expanding cervical hematoma
4. Stroke on CT scan
5. Near hanging with anoxia
6. Asymptomatic patients with significant blunt head trauma defined by:
   - GCS ≤ 8
   - Closed head injury with diffuse axonal injury
   - Fracture of the petrous bone
   - Basilar skull fracture extending into carotid foramen, occipital condyle fractures
   - Cervical spine fracture, subluxation, or ligamentous injury at any level with/ without fracture extending to the foramen transversarium
   - Severe Facial Trauma, including Le Fort II and III facial fractures
   - Near hanging with concern for hypoxic-ischemic brain injury
   - Neck soft tissue injury (seatbelt sign, hanging, or hematoma)

The following grading system should be used (Denver Grading System[4]):

Grade I: Intimal irregularity or dissection or intramural hematoma < 25% narrowing
Grade II: Dissection or intramural thrombus, hematoma with ≥ 25% narrowing
Grade III: Pseudoaneurysm
Grade IV: Occlusion
Grade V: Transection with extravasation

Management of BCVI:

All patients with BCVI need a neurosurgery consult

Unless there are specific contraindications, treatment of any grade BCVI will be Aspirin 81- 325 mg daily as early as safely possible, after injury identification, to be initiated by trauma team.

CTA is repeated in one week to assess the evolution of the injury and subsequently as an outpatient as directed by Neurosurgical recommendation. Grade 3 and above injuries may require intervention via formal angiogram/ endovascular technique with interventional neurosurgery.

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OBJECTIVE: Traumatic Brain Injury (TBI) - The Brain Trauma Foundation, Neurocritical Care Society, and the American College of Surgeons provide Guidelines or Consensus Statements informing best care for patients with TBI. However, care should be individualized as Guidelines do not reflect best care for every patient.

GUIDELINE: TBI is defined as a patient sustaining an alteration in brain function or other evidence of brain pathology caused by an external force and severe TBI is determined when the post-resuscitation Glasgow Coma Score is less than 9.

Management and Neurosurgery consultation of the patient with TBI is based on Brain Injury Guideline (BIG) Criteria (see Table 1).

Table 1 – BIG Criteria

BRAIN INJURY GUIDELINE			
Variables	**BIG 1**	**BIG 2**	**BIG 3**
Abnormal Neurologic exam *	No	No	Yes
Intoxication	No	No/Yes	No/Yes
CAP/DOAC	No	No	Yes
Skull Fracture	No	Non-displaced	Displaced
SDH	≤ 4 mm	5 - 7 mm	≥ 8 mm
EDH	≤ 4 mm	5 - 7 mm	≥ 8 mm
IPH	≤ 4 mm, 1 location	5 - 7 mm, 2 locations	≥ 8 mm, multiple locations
SAH	Trace	Localized	Scattered
IVH	No	No	Yes
Midline Shift	None or < 2 mm	None or < 2 mm	≥ 2 mm
Coagulopathy present	No	No	Yes
THERAPEUTIC PLAN			
Hospitalization	No Observation (6 hrs)	Yes	Yes
Repeat Head CT	No	No	Yes
Neurosurgery Consult	No	No	Yes
Admit to ICU	No	No	Yes

BIG: brain injury guidelines; CAP: Coumadin, Aspirin, Plavix; DOAC: Direct Oral Anticoagulants, Eliquis, Pradaxa, Xarelto; EDH: epidural hemorrhage; IVH: intra-ventricular hemorrhage; IPH: intra- parenchymal hemorrhage; LOC: loss of consciousness; NSC: neurosurgical consultation; RHCT: repeat head computed tomography; SAH: subarachnoid hemorrhage; SDH: subdural hemorrhage.
* GCS ≤ 13 is considered abnormal

A. Criteria for Neurosurgical Response <30 minutes:
- Penetrating intracranial injury with GCS greater than 5 and less than 13
- Acute Subdural Hematoma greater than 10 mm, midline shift > 5 mm, and GCS < 9
- Acute Epidural Hematoma greater than 18 mm, midline shift > 4 mm (lesions > 30 cm^3), and GCS < 9
- Posterior Fossa (cerebellar) ICH with hydrocephalus and GCS < 9

B. INTRA CRANIAL Pressure (ICP) Monitoring;
- Patients with GCS ≤ 8 and abnormal CT scan.
- Routine sampling of CSF is not supported due to the increased risk of infection (Neurocritical Care Society EVD Consensus Statement). CSF should only be sampled when meningitis/ventriculitis is suspected - fever alone is not reason to open a CSF line.
- All ICP monitors should be checked for function by verifying the presence of a waveform once per shift so long as ICP is not elevated and it is otherwise safe to do so. (abnormal response may consider displacement of the monitor)
- All patients requiring ICP monitoring require placement of an arterial line and central venous access. Central Line placement in the jugular veins should be avoided.

C. Anti-Epileptic Treatment

Should be administered to all patients with TBI for no longer than 7 days. A longer course may be considered for patients exhibiting seizure activity, penetrating brain trauma, or other high-risk findings.

High-risk criteria for development of post traumatic seizures:
1. acute subdural, epidural, or intracerebral hematoma (SDH, EDH, or ICH)
2. open-depressed skull fracture with parenchymal injury
3. seizure within the first 24 hours after injury
4. GCS < 10
5. Penetrating Brain Injury
6. History of significant alcohol use
7. Cortical (hemorrhagic) Contusion on CT

Keppra 1000 mg load followed by 500 mg IV/PO BID
- In select cases, Fosphenytoin may be used as an alternative (requires level check; levels in the high therapeutic range (15-20) are most beneficial).

D. Anesthetics, Analgesics, Sedation:
- Every effort should be made to preserve the clinical exam.
- Fentanyl and Propofol are the first line choices for analgesia and sedation as they are titratable and have short half-lives allowing for serial neurological examinations.
- Every patient should have a morning sedation holiday with documented neurologic exam off sedation at least every 24 hours with q1h RASS & pupillary exams.
- Benzodiazepines, such as midazolam or lorazepam, are Tier 3 use for refractory ICPs
- Barbiturate prophylactic use should be avoided.

- May be used only to manage refractory ICP (only after consultation with neurosurgery regarding initiating use in lieu of decompressive craniotomy or subsequent to decompressive craniectomy)
- The discontinuation of barbiturates should be considered if ineffective at controlling ICP after 24 hours.

E. Deep Venous Thrombosis (DVT) Prophylaxis:
- Mechanical prophylaxis should be employed early after admission.

F. Chemical VTE prophylaxis will be initiated per the chemical VTE prophylaxis guidelines

Nutrition:
- Tube feedings initiated within 24 hours unless contraindicated.
- If the patient is intubated and has GCS < 9, then feedings should be started as soon as logistically feasible.
- 140% of patient's metabolic needs should be replaced if they are not paralyzed and 100% if they are paralyzed.
- 15% of calories replaced should be provided as protein.

G. Blood pressure/ Cerebral Perfusion Pressure (CPP):
- If ICP is being monitored, target pressures for vasoactive medications should be based on CPP. In severe TBI, the standard starting CPP target range is 60-70 mmHg.
- As a general rule, systolic blood pressure less than 200 mmHg should not be iatrogenically reduced after TBI because this increased risk of cerebral ischemia.
- CPP target goals will be based on patient's auto regulatory status. Autoregulating patients usually require higher CPP and may benefit from CPP greater than 70 mmHg, those not auto regulating usually benefit from lower CPP.
  - Autoregulation may be best identified with Pressure Reactivity Index (PRx)
  - CPP direct therapy is associated with a reduction in 2-week mortality (4th Ed BTF Guidelines).

H. Hyperosmolar Therapy/ Hypertonic Saline Administration:
- Every patient receiving hypertonic/hyperosmolar therapy needs serum sodium and osmolality order q6h.
- In the absence of ICP elevation, normal serum sodium (135-145 mEq/mL) should be maintained.
- Continuous infusion of 3% HTS is the preferred approach to correct hyponatremia in hypovolemic or euvolemic patients.
- Bolus of 23.4% saline must be administered via central line. Continuous cardiac monitoring must be in place during the infusion, and care providers must watch closely for physiologic changes that might prompt a cessation or slowing of the infusion.
- 3% saline infusions that exceed a rate of 50 mL/hr must be administered via a central line. Bolus dosing of 3% hypertonic saline can be performed concurrent with a continuous infusion and must be administered via central line.
- Hyperosmolar therapy should not be administered prophylactically (in the absence

of intracranial pressure elevation or neurological decline).

- Hypotonic IV fluids along with D5 containing fluids are absolutely contraindicated except in rare instances.
- Mannitol, cutoff for administration is Na > 155 mEq/mL and serum osmoles > 320 Osm/kg
- Hypertonic Saline, cutoff for administration is Na > 160 and serum osmoles > 360 Osm/kg
- Mannitol (0.25 - 1 g/kg) may be considered for use in patients without ICP monitoring who exhibit clinical decline but requires Attending approval.
- If mannitol is used, hypovolemia must be avoided, and if it occurs, use of mannitol should be avoided. Therefore, Hypertonic Saline remains the first line of treatment.

I. Glucose:

- Hyperglycemia is associated with exacerbation of hypoxic ischemic brain injury and may lead to worse overall outcome
- Goal serum glucose 100-180 mg/dl
  - Initiate insulin drip if two serum glucose measurements > 250 mg/dl or a single measurement > 300 mg/dl; aim to keep glucose < 180 mg/dl
  - Priority in glycemic management is avoiding hypoglycemia (serum glucose < 100 mg/dl)

J. Temperature:

- Goal temperature < 38.0 ℃
- Tylenol for T > 38.3 ℃, Cultures for T > 38.5 ℃
  - consider Arctic Sun for sustained temperature > 38.5 ℃ not relieved with Tylenol and less invasive cooling measures.
- Warming Blanket for Temperature < 35.5 ℃
- Prophylactic hypothermia not recommended

K. Infection Prophylaxis:

- There is no evidence to recommend routine antibiotic prophylaxis for intracranial monitors, and routine exchange of ventricular catheters is not recommended.
- Level II recommendations are to pursue early tracheostomy (< 7 days) to reduce days of mechanical ventilation, but this does not affect mortality or risk of pneumonia.

L. Hematocrit/Hemoglobin:

- Although blood transfusion should be avoided in general, it is recognized that increasing hemoglobin levels is the most efficient means for increasing oxygen delivery if that is a target or goal. CPP control is a means for ensuring oxygen delivery.
- Every attempt should be made to achieve a platelet count > 100,000 prior to neurosurgical procedure. INR should generally be kept < 1.5

M. Mechanical Ventilation:

- All patients should have continuous $ETCO_2$ monitoring. The goal in Severe TBI with elevated ICP is $ETCO_2$ 30-35 and 35-45 if no signs of elevated ICP.

- $PaCO_2$ goal of 35-40 mmHg unless otherwise instructed. In patients requiring ICP monitoring consider an end-tidal CO_2 monitor. PaO_2 goal of > 70 to 90 mmHg (hyperoxia PaO_2 > 100 can be detrimental and should be avoided).
- Do not hyperventilate patient without signs of herniation.
- Low $PaCO_2$ values are harmful especially in the first 24 hours of injury and when sustained. Initial target should be pCO_2 35-40.
- Lower levels of PCO_2 can be effective in lowering the ICP but should only be targeted if there is concurrent $PbtO_2$ or JVO_2 sat monitoring. It is also known that hyperventilation effects are only temporary and should only be used if patient is to undergo emergent decompressive craniectomy and there is threat of impending herniation.
- ABG results outside of target range must have corrective action within an hour of an abnormal result evidenced by ventilator changes and new ABG order.

N. Intracranial Pressure:

1. Patients should not be treated with therapies to lower ICP prophylactically (e.g., cooling, sedation, paralysis, or hyperosmolar therapy)
2. ICP treatment threshold is 22 mmHg (4th Ed BTF Guidelines)
3. Sustained ICP elevation > 22 mmHg requires evaluation and intervention:
    1. Patient positioning
        a. Head of bed > 30°
        b. C-Collar adjustment/ loosen
    2. Evaluate sedation and analgesia (see Anesthetics, Analgesics, Sedation above)
    3. $PaCO_2$/ $EtCO_2$ evaluation (goal 35- 40)
    4. Osmotic therapy (see Serum Electrolytes/osmolarity above)
    5. If above medical management fails to lower ICP- STAT Neurosurgery notification
4. If ICP cannot be controlled, every effort should be made to maintain an acceptable CPP
5. Auto regulatory principles can be exploited as an adjunctive approach to normalize ICP

O. Early Tracheostomy and Percutaneous Endoscopic Gastrostomy:

- Should be considered in patients with GCS ≤ 8 (sustained for greater than 24 hours) with CT scan demonstrating TBI.
- < 7 days after ICU admission.

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OBJECTIVE: This guideline applies to patients with life-threatening hemorrhage, only. Reversal of anticoagulants and antiplatelet agents is a risk versus benefit decision including, but not limited to:

1. Severity of hemorrhage
2. Stability already demonstrated on serial imaging
3. Type and dose of anticoagulant
4. Indication for anticoagulation and risk of subsequent thromboembolic event

Final decision for anticoagulation reversal is at the discretion of the trauma surgeon, except in cases of isolated hip fractures which the decision of reversal will be at the discretion of the orthopedic surgery attending.
Patients who have taken their most recent oral factor Xa or oral direct thrombin inhibitor dose ≥ 18 hours ago should receive reversal at the discretion of the trauma attending and neurosurgery service. Adjunctive tests, including conventional coagulation assays, anti-factor Xa levels, and ROTEM may help elucidate the presence of ongoing anticoagulant effect.

Anticoagulant	Reversal Agent	Redose Considerations
Unfractionated Heparin	If < 3 hrs from last dose: Protamine 1 mg/100 units of heparin administered (max 50 mg)	May consider for ongoing bleeding and post-treatment aPTT > 30 with Protamine 0.5 mg/100 u of heparin given in the last 3 hours.
Enoxaparin (Lovenox) Dalteparin (Fragmin)	If < 8 hrs from last dose: Protamine 1 mg per 1 mg enoxaparin (max 50 mg) If 8-12 hrs from last dose: Protamine 0.5 mg per 1 mg enoxaparin (max 50 mg)	May consider for ongoing bleeding and elevated post-treatment anti-factor Xa with Protamine 0.5 mg/1 mg of enoxaparin.
Dabigatran (Pradaxa)	< 2 hrs since ingestion: consider activated charcoal Idarucizumab 2.5 mg IV push x2 q15 min (5 mg total dose)	May consider for ongoing bleeding and post-treatment aPTT > 30.
Argatroban Bivalirudin	None	

Abixaban (Eliquis) Rivaroxaban (Xarelto)	< 2 hrs since ingestion: consider activated charcoal < 18 hrs since last dose: Follow Andexanet Alfa screening form in Cerner to order piggyback and infusion. DO NOT ADMINISTER Andexanet Alfa to patients that have already received PCC. If patient does not meet WMC screening criteria for Andexanet Alfa, may consider PCC 50 units/kg (max 5,000 units)	The role of additional doses is unclear in this population. May consider PCC 25 units/kg (max 2,500 units) for ongoing bleeding and post-treatment unfractionated heparin anti-factor Xa level > 0.5. Repeat dosing of Andexanet Alfa has not been studied.
Edoxaban Betrixaban	< 2 hrs since ingestion-consider activated charcoal PCC 50 units/kg (max 5,000 units)	
Warfarin (Coumadin)	< 2 hrs since ingestion: consider activated charcoal Vitamin K 10 mg IV IF INR HAS NOT RESULTED, DO NOT WAIT FOR INR; administer 25 units/kg Kcentra and recheck INR. INR 2 - < 4: 25 units/kg (max 2,500 units) INR 4 – 6: 35 units/kg (max 3,500 units) INR > 6: 50 units/kg (max 5,000 units)	If ongoing bleeding and repeat INR > 1.5, may administer additional PCC dosed by INR.

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TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 4

THORACIC INJURY

4. THORACIC INJURY
A. Rib Fractures

OBJECTIVE: To define the management of patients with multiple rib fractures.

GUIDELINE: The following guidelines include our own experience with patients with multiple rib fractures, as well as the published guidelines by the Eastern Association for the Surgery of Trauma[1, 2].

The decision about the disposition and the management of patients with rib fracture(s) should be based on the following factors:

1. The age of the patient, including the presence of co-morbid conditions such as diabetes and cardiac/pulmonary co-morbidity
2. The measured vital capacity at the time of the initial evaluation.
3. The number of rib fractures.
4. The presence or absence of pulmonary contusion.
5. The presence or absence of pneumo/hemothorax and/or flail chest.

<u>Disposition and Management</u>

1. Patients younger than 65 years of age with 1-3 rib fractures and a vital capacity (VC) assessed by incentive spirometry ≥ 15 mL/kg may be discharged home from the emergency department.
2. Patients younger than 65 years of age with ≥ 4 rib fractures and a VC ≥ 15 mL/kg will be admitted to the floor with measurements of their VC. If the VC remains ≥ 15 mL/kg, they will be monitored for 24 hours, at which time they will be evaluated for possible discharge home. If their VC decreases below 15 mL/kg, they will be transitioned to a combination of IV narcotics and multimodal analgesia (Level 2). For worsening VC, consider upgrade to step-down unit or ICU as clinically appropriate. They will undergo further measurements of their VC to assess whether they've reached the threshold value of 15 mL/kg. Patients with VC less than 15 mL/kg will be admitted to the ICU for management with IV narcotics and lidocaine patch. They will undergo serial measurement of their VC, and if the VC does not reach the threshold value of 15 mL/kg, they will be referred for placement of epidural analgesia.
3. Patients older than 65 with ≥ 4 rib fractures will be stratified according to the presence or absence of pulmonary contusion (PC) and/or flail chest (FC). These patients will be preferentially admitted to the intensive care unit. Patients will be treated with multimodal analgesia using a combination of multimodal analgesia, including narcotics, independent of their VC. These patients will be evaluated by the regional anesthesia team for neuraxial block (paravertebral, erector-spinae, or epidural analgesia). Incentive spirometry will be used routinely.
4. All patients with multiple rib fractures showing signs of respiratory failure will be treated with supplemental nasal cannula, high flow nasal cannula, CPAP/BiPAP as needed with progression to endotracheal intubation and support with mechanical ventilation as needed.
6. Patients with multiple rib fractures, severely displaced rib fractures, flail chest, and/or

severe pain including those requiring mechanical ventilation will be considered on an individual basis for rib plating (Level 3).

7. Patients with survivable injuries who have severe respiratory failure will be evaluated for extracorporeal membrane oxygenation (ECMO).

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OBJECTIVE: To define the treatment of occult pneumothorax (OPTX)

GUIDELINES:

OPTX is defined as a PTX not identified on plain CXR but only on CT scan imaging. The incidence ranges from 2% to 10%, with some authors suggesting up to 20%. There are no specific predictive models that can discriminate which patients will require tube thoracostomy in the form of either a chest tube (CT) or a pigtail catheter. Historically, the implementation of positive pressure ventilation (PPV) in a patient with OPTX was deemed to predispose the patient to a higher risk of tension PTX; therefore, placement of CT was deemed necessary. It is now clear that the application of PPV does not necessarily convert an OPTX in a radiological detectable or tension PTX [1] (Level 3). The most reliable predictor of tube thoracostomy is progression of the OPTX to a radiologically detectable PTX on CXR and the occurrence of respiratory distress with a > 90% and > 80% need for CT with the progression of OPTX and respiratory distress, respectively[2].

Based on the available evidence, OPTX should be observed even when PPV is required. A repeat chest X-ray should be obtained in 4 hours. The overall failure of observation is < 10% without increased morbidity and mortality. Progression of the OPTX to a radiologically detectable PTX on repeat plain CXR and/or the occurrence of respiratory distress requires placement of either a pigtail catheter or a small size chest tube[2,3].

Disposition and Management

1. Patients should be admitted to the floor, step down, or ICU, based on criteria in Chapter 4 A. Telemetry with continuous pulse oximetry monitoring should be used.

2. A repeat Chest X-ray should be performed 4 hours after the previous one.

3. Tube thoracostomy should be performed based on the patient's clinical status and conversion to pneumothorax visible on Chest X-ray.

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OBJECTIVE: To define a standardized modality for the treatment of blunt traumatic hemothorax (HTX) and pneumothorax (PTX).

GUIDELINE:

1. If HTX is present on CXR in the trauma bay, insert a chest tube. In the absence of hemodynamic instability, a 14F pigtail catheter should be placed in the mid-axillary line in the 5th intercostal space[6].
2. Hemodynamically unstable patients with HTX should have a chest tube placed in the mid-axillary line in the 5th intercostal space.
3. Before insertion, antibiotics should be considered: one gram of cefazolin IV, or 600 mg of clindamycin IV2 if the patient is penicillin-allergic.
4. Post-procedure CXR to assess completeness of evacuation of HTX. If there is radiographic evidence of residual HTX and the CT position is adequate, consider inserting a second CT.
5. If the HTX is present on day 3 on the CXR, obtain a CT scan of the chest for volumetric assessment; if the volume is ≥ 300 mL (volume = d2 x L), schedule VATS procedure as soon as possible.
6. If the patient has contraindication to the performance of VATS, give intrapleural TPA using the following method:
   a. Use 50 mg of TPA in 100 mL of NS (0.5 mg/mL); inject in CT using sterile technique, clamp CT for one hour, and roll the patient, if possible, to distribute the solution.
   b. Unclamp the CT and allow drainage
   c. Repeat the process daily for 3 days
   d. If HTX < 300 mL on repeat CT scan, no additional intervention is required.
   e. Remove the CT when drainage is < 200 mL/24 hrs[4].
7. For PTX, consider placement of pigtail thoracostomy if larger than 35 mm, or chest tube if hemodynamic unstable.
8. Hemodynamically stable patients with pneumothorax should be considered for 14F pigtail thoracostomy.
9. For left-sided hemothorax requiring pigtail thoracostomy, use ultrasound guidance and consider open tube thoracostomy. For left-sided pneumothorax, consider open thoracostomy.

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To be Reviewed:

4. THORACIC INJURY
D. Widened Mediastinum / Thoracic Aortic Injury

OBJECTIVES:

1. Define the indications for pursuing further work up of the widened mediastinum following blunt injury.
2. Identify signs of possible thoracic aortic injury.

DEFINITION:

The mediastinum is defined as "widened" if it measures ≥ 8 cm at the level of the second ICS on an AP CXR taken at 100 cm from the chest or if the mediastinum/chest ratio is > 0.38.
Traumatic aortic injury (TAI) involves a disruption of the thoracic aorta from blunt horizontal deceleration at the level of the ligamentum arteriosum, which is just distal to the origin of the left subclavian artery.

GUIDELINE:

Any patient who has a widened mediastinum or any of the following radiological findings on the CXR following a deceleration MOI (mechanism of injury) should be considered to have a TAI until proven otherwise:

a. Apical cap.
b. Depressed left mainstem bronchus.
c. Trachea or esophagus deviated to the right.
d. Obliterated aorto-pulmonary window.

1. Evaluate and treat the ABCs, as described in Chapter 1.
2. Assess for symptomatic upper extremity BP differences (> 10 mmHg), pseudocoarctation syndrome, or infrascapular murmur. These are also suggestive of aortic injury.
3. If the possibility of TAI is considered at any point in the resuscitation, avoid hypertension. Tachycardia and Hypertension should be treated with impulse control with short-acting medications (e.g., esmolol, Cleviprex).
4. Obtain a CTA of the chest since as it is very sensitive and specific for the diagnosis of TAI (95-100% sensitivity, NPV 99-100%)[1]. If the CTA of the chest shows mediastinal blood or aortic disruption, immediately contact the vascular/cardiothoracic service to determine whether there is a BAI (blunt aortic injury) or if there is a need for an angiogram.
5. Injury classification:
   - Grade 1: Intimal tear (IT) - Injuries confined to intima
   - Grade 2: Intramural hematoma/large intimal flap
   - Grade 3: Pseudoaneurysm - the presence of aortic external contour abnormality and contained rupture (Incidence 71% with 76% survival).
   - Grade 4: Rupture with the presence of aortic external contour abnormality and free contrast extravasation or hemothorax at thoracotomy (Incidence 6.4% with 11% survival).
6. The following are recommended clinical treatment guidelines for the management of BAI based on UW (University of Washington) experience[2]:
   A. All patients with radiographic evidence of BAI should undergo anti-impulse therapy with ß-blockade, if tolerated, coupled with antiplatelet therapy (81 mg aspirin) for low grade injuries, as appropriate.

B. Observation alone with interval follow-up CTA within 30 days is appropriate for all intimal tears less than 10 mm.
C. Management of intimal tears less than 10 mm is appropriate with repeat imaging within 7 days to assess for progression. Evidence of progression should be managed, when possible, with endovascular repair.
D. Grade 3 injuries should undergo urgent repair (< 24h after admission)
E. Grade 4 injuries should undergo emergency repair
F. TEVAR should be performed as opposed to open repair when possible from hemodynamic and technical standpoints to minimize morbidity (including stroke, paraplegia, and renal failure) and mortality[3].
G. All patients with an aortic external contour abnormality should be considered for semi-elective (1 week or less) EVAR if there is a high likelihood of survival from other associated injuries. These patients should be monitored with CT imaging at: 1 month, 6 months, 1 year, and every other year thereafter. Patients with hypotension on presentation and aortic arch hematoma of more than 15 mm should be repaired with EVAR methods on a more urgent basis.
H. Intentional left subclavian artery coverage without revascularization is well tolerated in a majority of patients with BAI. Consider Carotid subclavian bypass if necessary.
I. Patients with severe TBI and an aortic external contour abnormality should be considered for earlier repair.

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OBJECTIVE: To define the diagnosis and management of blunt cardiac injury.

Definition:
Blunt cardiac injury (BCI) includes a spectrum of injuries, including asymptomatic myocardial muscle contusion, significant arrhythmia, acute heart failure, valvular injury, or cardiac rupture.

AAST Injury Scale (limited to blunt cardiac injury)

Grade I
Blunt cardiac injury with minor EKG abnormality; no specific ST wave changes, PACs, PVCs, or persistent sinus tachycardia.

Grade II
Heart block or ischemic changes without cardiac failure.

Grade III
1. Sustained or multifocal PVCs
2. Septal rupture, pulmonary or tricuspid valve incompetence, papillary muscle dysfunction, or distal coronary artery occlusion without cardiac failure
3. Blunt pericardial laceration with cardiac herniation
4. Cardiac failure

Grade IV
1. Septal fracture, pulmonary or tricuspid valve incompetence, papillary muscle dysfunction, or distal coronary artery occlusion causing cardiac failure
2. Aortic or mitral incompetence
3. Injury to the right ventricle, right or left atrium

Grade V
1. Proximal coronary artery occlusion
2. Left ventricular perforation
3. Stellate injuries, less than 50% loss of the right ventricle, right atrium or left atrium

Grade VI
1. Avulsion of the heart

Guidelines:
The most common complication of blunt injury to the myocardium is the presence of arrhythmia in the form of sinus tachycardia, premature atrial contractions, atrial fibrillation, and premature ventricular contractions. Rarely, a right bundle branch block or ST elevation and T-wave flattening can be seen.

Diagnosis:
Risk factors for possible BCI include chest impact at a speed greater than 15 mph, marked precordial tenderness with ecchymosis or contusion, the presence of sternal fractures, the presence of multiple anterior rib fractures, presence of seatbelt contusion across the anterior chest wall, and the presence of severe bilateral pulmonary contusions.

1. **Sinus tachycardia** is the most common rate abnormality seen with the BCI. In patients with a normal EKG and normal troponin I level, BCI is ruled out (Level 2). Furthermore, the presence of a sternal fracture is not correlated with the presence of BCI (Level 2)

2. An admission **12-lead EKG with troponin I** level is the most sensitive screening test for the diagnosis of BCI; it should be obtained in all patients where there is a suspicion of BCI (Level 1).
   The addition of troponin I to the EKG increases the negative predictive value from 95% to 100%. In view of the very low cost of adding troponin levels to the EKG, it is appropriate for us to use troponin I in addition to a 12-lead EKG in patients with suspected BCI. CPK with isoenzymes analysis is not useful in predicting which patients have or will have complications related to BCI, therefore, it should not be obtained (Level 2).

Treatment:

1. All patients with suspected diagnosis of BCI should be admitted for observation on telemetry for a period of 24 hours (Level 2).
2. Patients with normal EKG and abnormal Troponin should be admitted for telemetry.
3. Patients with ST or T wave abnormalities, new arrhythmia, and hemodynamic instability should be evaluated with a transthoracic or transesophageal echo.
4. Patients with ischemic changes on the EKG and elevated cardiac enzymes are treated similarly to patients with acute MI.
5. Cardiology should be consulted at the discretion of the attending trauma surgeon.

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OBJECTIVE:

To develop a guideline to assess thoracic and lumbar spine injury in order to standardize the approach to this clinical problem. In conjunction with Radiology, Orthopedic Surgery, and Neurosurgery, the division of Trauma Surgery has developed the following recommendations based on established collective practice patterns and review of current available literature. These guidelines are intended to assist in the evaluation of the trauma patient with suspected thoracic and/or lumbar spine injury.

GUIDELINE:

A. IDENTIFICATION OF PATIENTS AT RISK FOR THORACIC AND LUMBAR SPINE INJURY
   1. All trauma patients should be suspected of having sustained thoracic and lumbar spine injury until proven otherwise. Patients who arrive with adequate spine immobilization in place should remain immobilized until evaluated by the treating physician. Patients who arrive without spine immobilization should be immobilized at the discretion of the treating physician based on mechanism of injury and clinical suspicion of injury.
   2. All life-threatening hemodynamic problems should be addressed before a prolonged thoracic and lumbar spine evaluation is undertaken.

B. INDICATIONS FOR RADIOGRAPHIC EVALUATION OF THE THORACIC AND/OR LUMBAR SPINE

   Trauma patients should undergo thoracic and/or lumbar imaging if they meet one or more of the following criteria:
      a. Presence of midline spine tenderness
      b. Presence of focal neurologic deficit and/or paresthesia
      c. Predisposing mechanism of injury:
         - Fall $\geq$ 10 feet
         - Ejection from motor vehicle in crash $\geq$ 50 mph
         - GCS $\leq$ 8

   Patients without predisposing MOI and a low GCS may not require immediate evaluation of the thoracic and lumbar spine.

C. RADIOGRAPHIC EVALUATION OF THORACIC AND LUMBAR SPINE
   1. Thoracic and lumbar spine images can be reformatted from torso CT images obtained for the diagnosis of injuries after trauma.
      a. These reformatted images need to be separately ordered and reports will be dictated separately.
   2. If Chest and/or Abdominal CT imaging is unnecessary, dedicated thoracic or lumbar CT imaging can be ordered.
   3. Patients with focal neurologic deficits may require emergent or urgent MRI evaluation of the spinal cord, in addition to CT evaluation of the axial bony spine. MRI should be ordered in consultation with the Spine Service (orthopedic surgery or neurosurgery).

D. NEED FOR SPINE SERVICE CONSULTATION
1. If a radiographic abnormality is identified, spine immobilization should be maintained and the Spine Service consultation should be obtained.
   a. Less than four isolated transverse process fractures may not require Spine Service consultation.
2. Any patient with neurologic deficit must remain immobilized independent of radiographic findings until evaluated by the Spine Service.

E. COMATOSE PATIENTS
Patients with altered level of consciousness who do not improve within 24 hours should undergo the following studies:
1. Reformatting of torso CT imaging to screen the thoracic and lumbar spine for injury within 24 hours of initial CT imaging.
2. Dedicated thoracic or lumbar CT imaging if reformatted images are not available.
3. If patient condition permits, the thoracic and lumbar spines should be cleared within 24 hours of admission.
4. Patients with minor mechanisms of injury may not require imaging of the thoracic and lumbar spine at the discretion of the trauma attending.

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OBJECTIVE:
To provide a guideline for the diagnosis and management of patients with traumatic non-penetrating spinal cord injury (SCI).

Definitions:
Spinal shock: spinal cord dysfunction based on physiologic rather than structural disruption. Resolution typically occurs within 24 hours of injury. Resolution is diagnosed when the reflex arcs distal to the level of injury have returned.

Neurogenic shock: refers to flaccid paralysis, areflexia, and loss of sensation with hypotension associated loss of peripheral vascular resistance in spinal cord injury (T1-L2 sympathetic outflow disruption). It almost always resolves within 24-48 hours of injury.

The bulbo-cavernous reflex: refers to the contraction of the anal sphincter in response to squeezing of the glans of the penis in men, the clitoris in women, or tugging of the urethral catheter in both. The absence of this reflex indicates the presence of spinal shock. The return of this reflex is indicative of the end of spinal shock. If the reflex is present at the time of the injury (absence of spinal shock), then the patient has a complete SCI, and the deficit will not improve.

Complete spinal cord injury: no sensation or voluntary movement caudal to the level of injury in the presence of an intact bulbo-cavernous reflex. The level of injury is named by the last spinal level of partial neurologic function. One can expect up to one or two levels of root recovery, although the prognosis for recovery is extremely poor.

Incomplete spinal cord injury: some neurologic function persists caudal to the level of injury after the return of the bulbo-cavernous reflex (as a general rule, the greater the function and the faster the recovery, the better the prognosis).

Sacral sparing: represented by the presence of perianal sensation, voluntary rectal contraction, and great toe flexor activity. It indicates partial continuity of the white matter tracts, namely, corticospinal and spinothalamic, with implied continuity between the cerebral cortex and the lower sacral motor neurons.

Brown-Sequard syndrome: a hemicord injury with ipsilateral motor paralysis, loss of proprioception and light touch sensation, and contralateral hypesthesia to pain and temperature. The prognosis is good, with 90% of patients regaining bladder function and ambulation.

Central cord syndrome: it is typically an extension injury in middle-aged person with osteoarthritic spine. It presents with upper extremity flaccid paralysis (more involved) and spastic paralysis lower extremities (less involved) in the presence of sacral sparing. The prognosis is fair, with 50% to 60% of patients regaining sensory and motor function of the LEs.

Tetraplegia: Complete SCI associated with a spinal cord or nerve root deficit not involving the cranial nerves above and including C8, T1 roots.

Paraplegia: Complete SCI associated with a spinal cord or nerve root deficit below and including T2.

SCI involves a primary mechanical injury by way of compression, penetration, laceration, shear, and/or distraction followed by a host of secondary injury mechanisms, including (1) vascular compromise leading to reduced blood flow, loss of autoregulation, loss of microcirculation, vasospasm, thrombosis, and hemorrhage, (2) electrolyte shifts, permeability changes, loss of cellular membrane integrity, edema, and loss of energy metabolism, and (3) biochemical changes including neurotransmitter accumulation, arachidonic acid release, free radical and prostaglandin production, and lipid peroxidation. Systemic hypotension in the setting of acute spinal cord injury, with coincident loss of spinal cord autoregulatory function, compounds local spinal cord ischemia by further reducing spinal cord blood flow and perfusion[1,2].

Guidelines:

1. Follow the ABCs.
2. Perform a complete neurologic exam looking for neurologic deficit and the level of the deficit.
3. Maintain spine precautions.
4. If tetraplegia or paraplegia is present, document the presence or absence of the bulbo-cavernous reflex.
5. Rule out hemorrhagic shock and treat the hypotension (SBP < 90 mmHg or MBP < 65 mmHg), if present, first with volume resuscitation and blood products as needed and subsequently, if needed, with norepinephrine titrated to maintain an MBP at 80-90 mmHg[3,4].
6. Obtain CT scan of the C and TLS spine.
7. Consult the Spine Service
8. Admit to ICU
9. Be aware of pulmonary dysfunction in quadriplegics[5] (lesion ≤ C5), which may require intubation and mechanical ventilation.
10. If in doubt, intubate and provide ventilator support for the following patients:
    - Patients with VC < 10 mL/kg
    - Patients unable to clear secretion and/or able to cough effectively
    - Patients who develop hypercapnia on high-flow O_2
11. Consider early tracheostomy ≤ 7 days[6].
12. Obtain PM&R consult early for referral to SCI Rehabilitation Centers

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To be Reviewed:

OBJECTIVE:

To provide guidelines for the diagnosis and management of patients with penetrating thoracic injuries.

GUIDELINES:

1. Any penetrating injury to the chest must be assumed to have caused internal organ damage, which may involve the:
   a) Lungs and/or tracheobronchial tree (65% - 90%)
   b) Esophagus (rare)
   c) Great vessels (4%)
   d) Cardiac (50%)
   e) Diaphragm (30%)

2. In all unstable patients, assess the ABCs and secure the airway as quickly as possible, if necessary, while you obtain vascular access above and below the diaphragm.

3. If the patient has sustained cardiac arrest and has had signs of life (e.g., pulse, EKG activity, cardiac activity on the FAST) at any time (< 15 minutes before arrival) or is *in extremis* with low blood pressure, proceed directly to a left antero-lateral resuscitative thoracotomy in the 5th ICS, just below the nipple in the male or below the mammary fold in women.

4. If hemodynamically unstable or in respiratory distress, insert a large bore chest tube on the side where breath sounds are absent. If there is no improvement, consider placing another chest tube on the opposite side. Hemodynamic instability can be due to massive HTX. Signs of tension PTX/HTX include:
   a) Absent breath sounds
   b) Distended neck veins.
   c) Shift of the trachea.
   d) Dullness to percussion on the affected side

5. Pericardial FAST exam and obtaining CXR should be the first studies of choice.

6. Indications for prompt transfer of the patient with HTX to the OR for thoracotomy include:
   a) Initial drainage of ≥ 1,500 mL of blood
   b) Drainage ≥ 2-300 mL/hr for ≥ 3 hours.
   c) Massive air leak causing loss of ≥ 40% of TV.

7. If the injury is in the "**cardiac box**," between nipples, xiphoid, and sternal notch, you must rule out a cardiac injury. Look for signs of tamponade, namely, hypotension, distended neck veins, distant heart sounds, and pulsus paradoxus.
   a) Unstable patient: OR for left anterolateral thoracotomy (preferred) or median sternotomy as dictated by suspected injury.

b) Stable patient: perform the subxiphoid portion of the FAST/ Ultrasound for the presence or absence of cardiac effusion, *remember, FAST cannot rule out cardiac injury when there is a hemothorax on CXR.*
c) If positive pericardial FAST: take the patient to the OR for a subxiphoid pericardial window and/or median sternotomy.
d) FAST negative for effusion with negative CXR (no hemothorax): admit for observation
e) FAST negative and CXR with hemothorax: consider subxiphoid window.

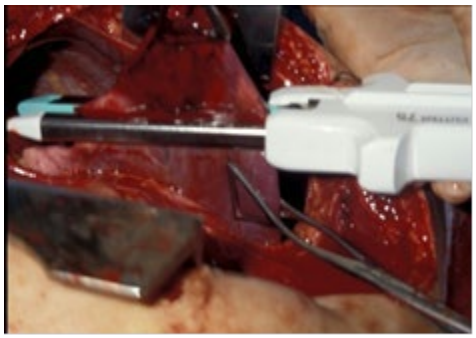
Approach to specific injuries

Tracheo-bronchial tree: regardless of the MOI (blunt or penetrating), the majority of injuries are within 2.5 cm of the carina with the following distribution: main stem 86%, distal bronchial 9.3%, and complex injuries 8%. Associated intrathoracic and mediastinal injuries are the rule. Cervical injuries may present with stridor, hemoptysis, cervical subcutaneous emphysema, hoarseness, or respiratory distress secondary to an obstructed airway. Thoracic injuries generally present with pneumothorax (PTX) and/or hemothorax (HTX). A PTX that persists after chest tube placement or has a continuous air leak indicates possible tracheobronchial damage. The ''fallen lung sign'' is a radiographic feature that is highly specific for tracheobronchial injury. On the CXR, the lung is falling away from rather than toward the hilum.

1. The diagnosis of tracheobronchial injury is made based on clinical and radiological findings and it is confirmed by bronchoscopy.
2. Most injuries should be approached through a right thoracotomy over the 5th rib since the majority of injuries are within 2.5 cm of the carina.
3. Left main stem bronchial injuries > 3 cm distal to the carina are best approached through a left posterolateral thoracotomy.
4. A dual-lumen endotracheal tube (Carlen or Robert Shaw) should be used for intubation.
5. The injury should be repaired with interrupted monofilament suture with extraluminal knots protected by buttressing with a muscle flap. Up to 2 cm of trachea can be resected with primary reconstruction.
6. The approach to the unstable patient with a massive air leak compromising oxygenation and ventilation, who cannot be brought to the OR because of hemodynamic instability, includes single lung ventilation. If necessary, extracorporeal veno-venous membrane oxygenation can be done.

Lung parenchyma[6]*:*

1. Superficial bleeding can be controlled with suture ligation with sutures.
2. Deep bleeding from penetrating injuries should be controlled with GIA stapler tractotomy to expose the bleeding vessels and subsequent suture ligature of the bleeding vessels with absorbable sutures.
3. Most lung injuries that require thoracotomy can be treated with tractotomy and non-anatomic lung resection. Shown below is a GSW to the lung treated with a GIA resection.



4. Try to avoid clamping the hilum since the right ventricle cannot tolerate the increased afterload. If the bleeding cannot be controlled and you must clamp the pulmonary hilum and you do not have adequate exposure, you can control the bleeding by twisting the lung 180 degrees after taking down the inferior pulmonary ligament. Always attempt to control the bleeding first with pressure, including bimanual pressure, if necessary.
5. Trauma pneumonectomy has a very high mortality and should be avoided. If the patient is unstable at the end of your control of the bleeding, do not hesitate to complete your operation with the damage control approach to the chest. If performing trauma pneumonectomy, consider VV ECMO to offload the right heart.

Esophagus[7]:

Esophageal injuries are rare. They are usually caused by penetrating injuries. The cervical esophagus is the first 15cm from the incisors and is approximately 6cm long. The thoracic esophagus is the next 15cm (23cm from incisors). The intra-abdominal esophagus is 2-3cm long (38cm from incisors). The approach to the upper and middle thoracic esophagus is via a right postero-lateral thoracotomy in the 5th or 6th ICS. In contrast, the approach to the lower third is via a left postero-lateral thoracotomy in the 7th or 8th ICS. Caution to avoid injury to the Azygos vein on the right side (can be divided if necessary) or thoracic duct on the left side. Primary repair in two layers, with absorbable sutures for the mucosa and non-absorbable for the muscle layer. Buttress with pleural/pericardial flap or intercostal muscle flap should be done in all injuries < 24 hours. If necessary, you can use a diaphragmatic flap. Routine wide drainage should be performed.

Great vessels[8]:

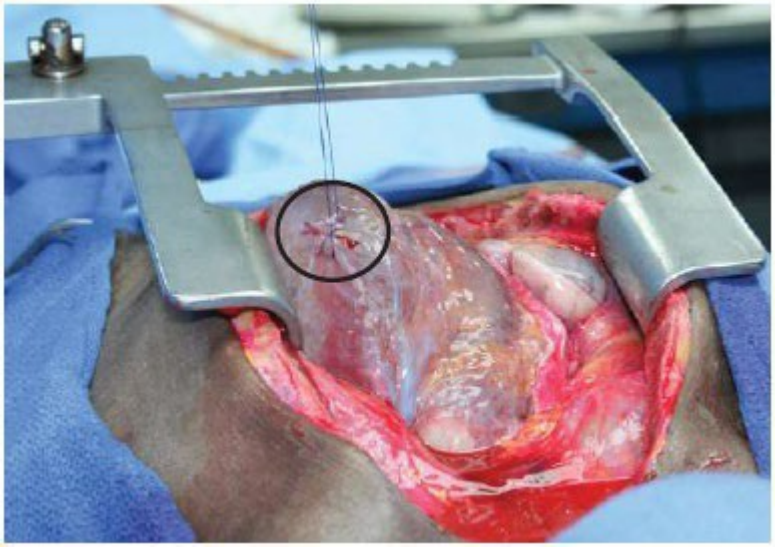
1. The great vessels of the aorta include the left subclavian, the left common carotid, and the innominate arteries. Great vessel injuries are rarely encountered after penetrating chest trauma (4%) because victims typically exsanguinate into the chest or externally before arrival to the hospital. The presence of a wound at the base of the neck or a transmediastinal gunshot should alert you to the possibility of great vessel injury. The patient may be pulseless or moribund at presentation, and diagnosis is confirmed at the time of resuscitative thoracotomy.
2. In the stable patient or in the patient who is stable after resuscitation, the diagnosis can be confirmed with CTA. The incision of choice is a median sternotomy with a supraclavicular extension if necessary.

In the case of isolated injury to the left subclavian (partial transection), temporary control can be achieved with a trans-brachial retrograde balloon approach and definitive control can be achieved with the deployment of a covered stent. Proximal control can also be obtained through a median sternotomy at the origin of the vessel.

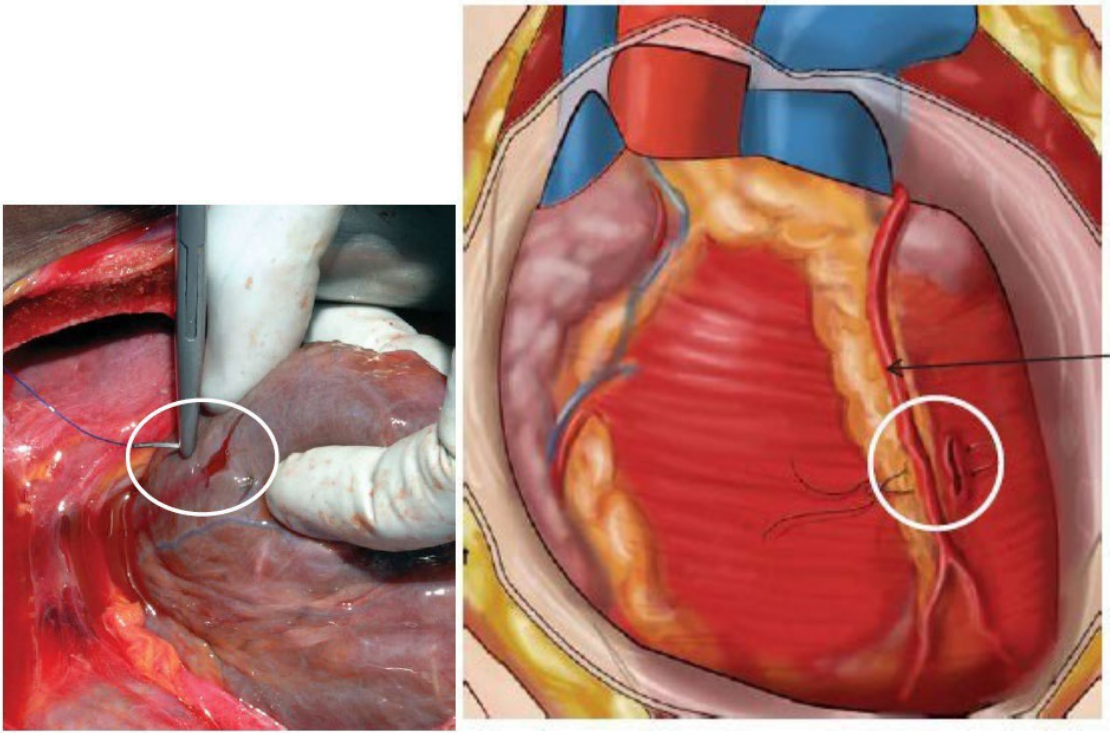
Cardiac[9]:

Distribution of injuries include the right ventricle 40%, left ventricle 40%, right atrium 24%, left atrium 3%, and coronary arteries 5%.

Atrial wounds can be controlled rapidly with a Satinsky clamp and then oversewn with a running 3-0 Prolene suture, as shown below.



Injuries to the free wall of the right and left ventricle that are remote from the coronary arteries are controlled with digital pressure and then repaired using horizontal mattress polypropylene sutures (3-0 or 4-0) with large needles and pledgets, if necessary. Injuries near the coronary arteries must be closed without encompassing the coronary artery. Horizontal mattress sutures are placed deep and lateral to the coronary artery across the injury and out the opposite side, as shown on the next page.



An alternate temporary way to control bleeding involves placement of a Foley catheter in the injury site; while the method is described as simple, it is **not recommended** for ventricular injuries because it is associated with complications.

Once you have repaired the cardiac injury, you must exclude a coexistent intra-cardiac injury. If the patient is stable, consider an intra-operative TEE; otherwise delay the TEE to a later time since the intra-cardiac injury may be delayed.

Diaphragm:
The incidence of injuries is 1% in patients with blunt trauma and 8% in patients undergoing laparotomy for thoraco-abdominal trauma.
Penetrating injuries to the lower chest have a high incidence of diaphragmatic injuries: 32% with SWs and 59% with GSWs.
Patients with left lower chest injuries from SWs without evidence of peritonitis should undergo diagnostic laparoscopy during their hospitalization. Diaphragmatic injuries may be repaired laparoscopically or open. Those with peritonitis should undergo conventional laparotomy.

All patients with penetrating thoracoabdominal trauma should be considered for laparotomy or laparoscopy to rule out associated abdominal injuries, depending on the patient's hemodynamics and preoperative workup.

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4. THORACIC INJURY
I. Air Travel after Traumatic Pneumothorax

OBJECTIVE: To define a standardized approach for permission to fly in patients with traumatic pneumothorax (PTX).

GUIDELINE:
The issues regarding air travel after traumatic PTX include the effect of changes in the barometric pressure associated with commercial flights traveling at altitudes ranging from 32,000 to 45,000 ft. on the expansion of even a very minimal residual PTX and on the occurrence of recurrent PTX from reopening of sealed lung leaks. Boyle's law states that the volume of a gas is inversely proportional to the pressure to which it is exposed. Thus, as barometric pressure falls in the aircraft cabin during the ascent, trapped air in any non-communicating body cavity (e.g., non-communicating PTX, lung bleb, lung bulla, and lung cyst) will expand. It is estimated that the volume of air in a non-communicating body cavity, such as a PTX, will increase by approximately 38 percent upon ascent from sea level to the maximum "cabin altitude" of 8,000 feet (2438 mt). Furthermore, should a PTX recur in flight, in the absence of trained personnel, and with the typical arterial oxygen saturation of the cabin pressurized typically at 8,000 ft. of 55 to 68 mmHg, the patient would be at risk of death unless the aircraft descended immediately to an altitude < 12,500 ft. For this reason, patients with traumatic PTX scheduled to fly must be instructed on the most recently accepted guidelines: Air Transport Committee Guidelines[1] and Level II evidence by Cheatham and Safcsak[2].

A patient is deemed safe for air travel 2 weeks after resolution of the PTX with confirmation of the resolution by a CXR immediately before air travel. One must individualize this guideline to individual patients taking into consideration the age of the patient, pre-existing pulmonary conditions, as well as cardiac co-morbidities.

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TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 5

SOLID ORGAN INJURY

5. SOLID ORGAN INJURY

OBJECTIVE: Define therapeutic guidelines for the non-operative management of solid organ injuries (SOI)

This guideline does not take into account concomitant injuries.

Patients with ongoing hemodynamic instability despite resuscitation and concern for hemorrhage for solid organ or intraabdominal injury as the source of that instability, i.e., free fluid on FAST, SOI, or hemoperitoneum on CT should be rapidly triaged to the operating room for laparotomy.

All patients with peritonitis on physical exam should receive prompt surgical exploration (laparotomy or laparoscopy) regardless of hemodynamic status or injury grade.

Therapeutic Anticoagulation and Antiplatelet Agents:
For SOI patients taking pre-injury therapeutic anticoagulation,
Grade 1 and 2 SOI – consider reversal of anticoagulation
Grade 3-5 SOI – recommend reversal of therapeutic anticoagulation.
Routine administration of platelets or DDAVP for patients on antiplatelet agents is not recommended; however, it may be considered in patients requiring blood transfusion.

VTE Prophylaxis:
See SOI section of VTE prophylaxis guideline.

Repeat Imaging for Delayed Vascular Malformation, Age ≥ 18:
Patients treated with angioembolization or with grade 1 or 2 injuries do not require routine further imaging.
Grade 3 SOI - repeat imaging at the discretion of the Attending Trauma Surgeon.
Grade 4 and 5 - routine repeat imaging on hospital day 4 is recommended.
Recommend CTA with arterial and delayed venous phase as the imaging modality of choice.

Activity Restriction:
Patients should refrain from strenuous physical activity, physical education class, and contact sports for the AAST Grade of the Injury + 2 weeks. For example, a patient with a grade 2 liver injury should be restricted for 4 weeks (2+2).

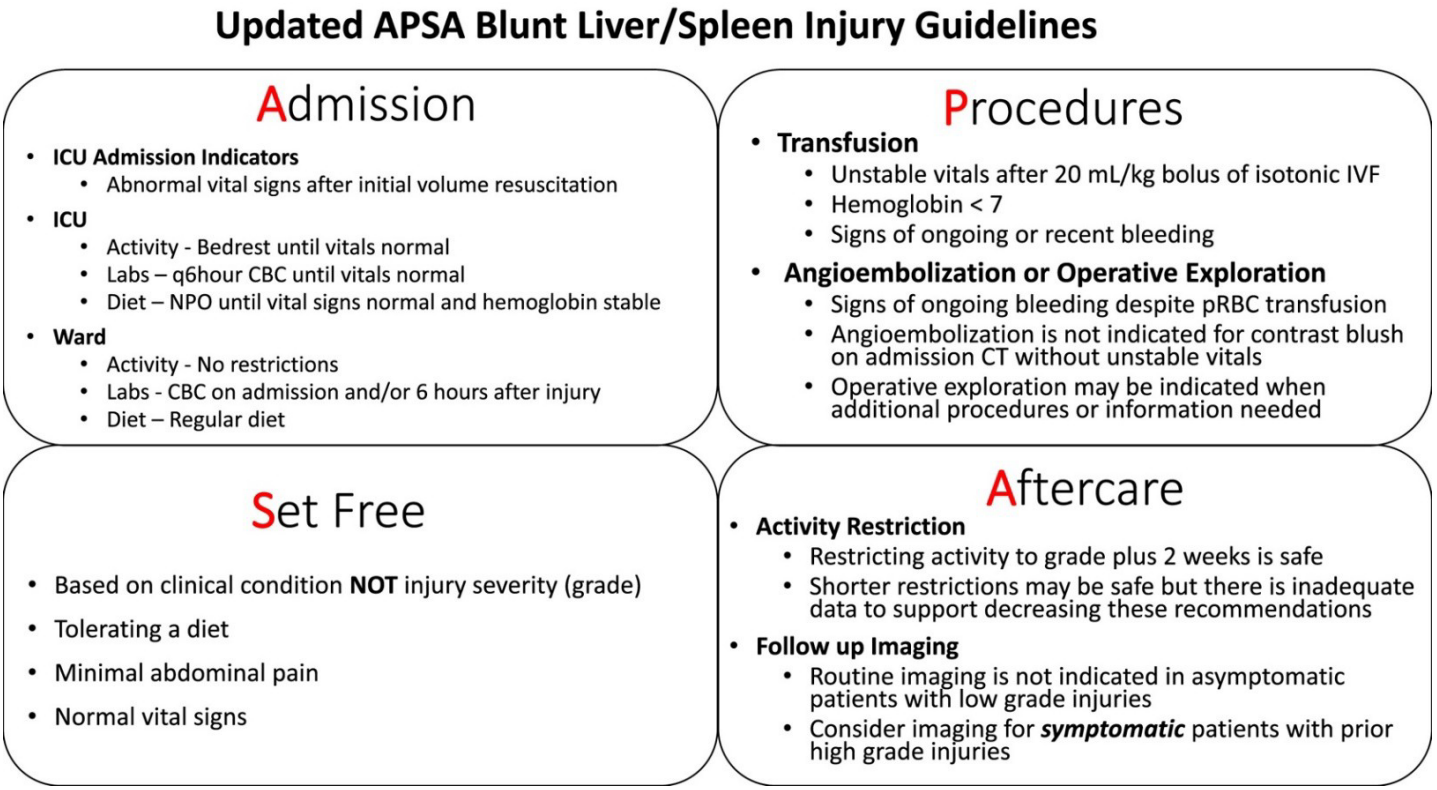
Follow Up:
Patients with Grade 1 and 2 injuries can follow up on an as needed basis
Patients with Grade 3 and above injuries should follow up in 2 weeks with a CBC and BMP for kidney injuries and hepatic function panel for liver injuries prior to the appointment.

Vaccination:
Only patients who undergo splenectomy require vaccination for encapsulated organisms.

Special Populations:
Consideration for earlier intervention, operative, or angiographic should be given to patients who:

- Decline blood transfusion.
- Geriatric patients, as the failure rate of nonoperative management is higher in older patients.

Patients < 18 Years of Age with Blunt Liver/Spleen Injury



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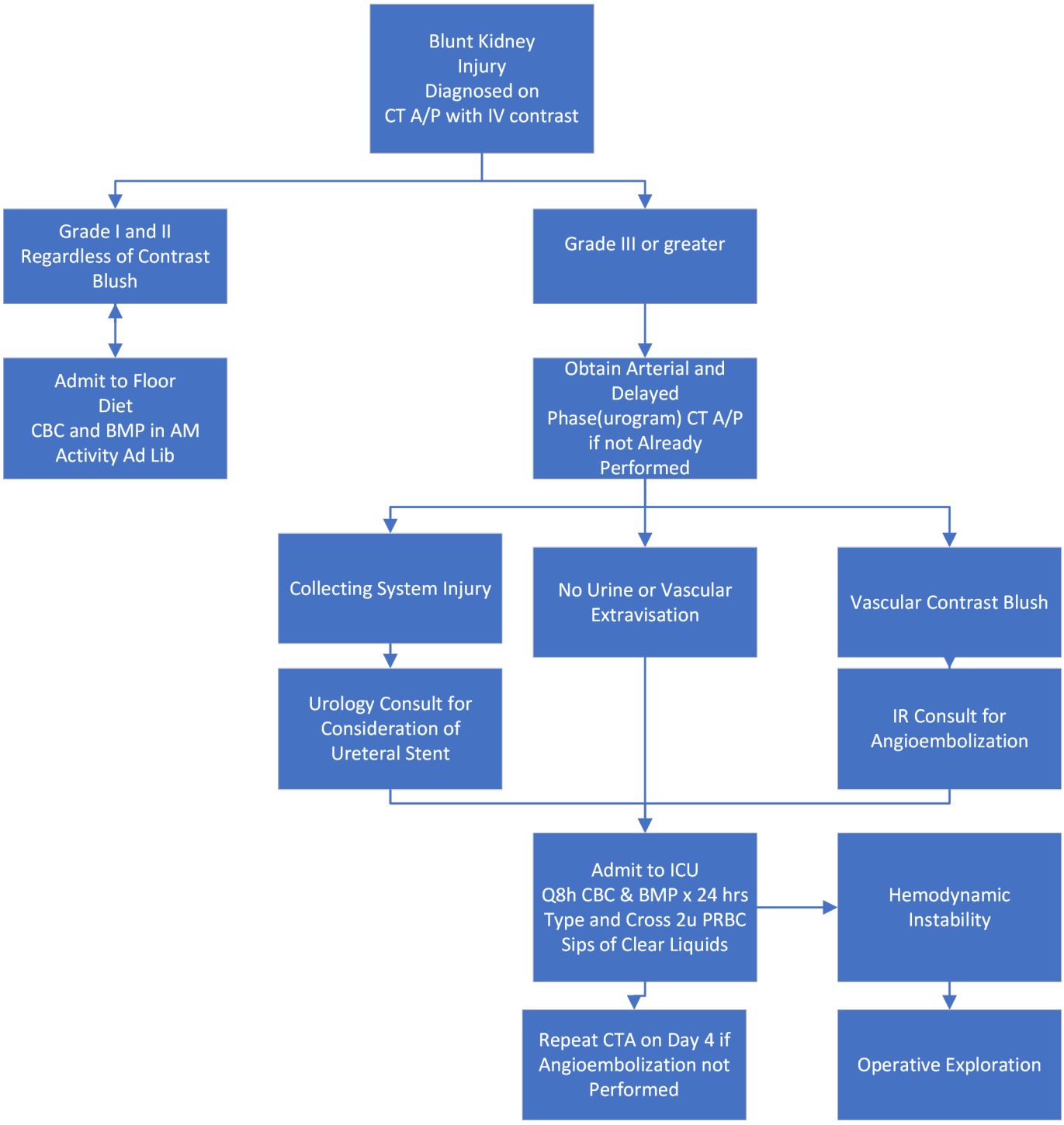
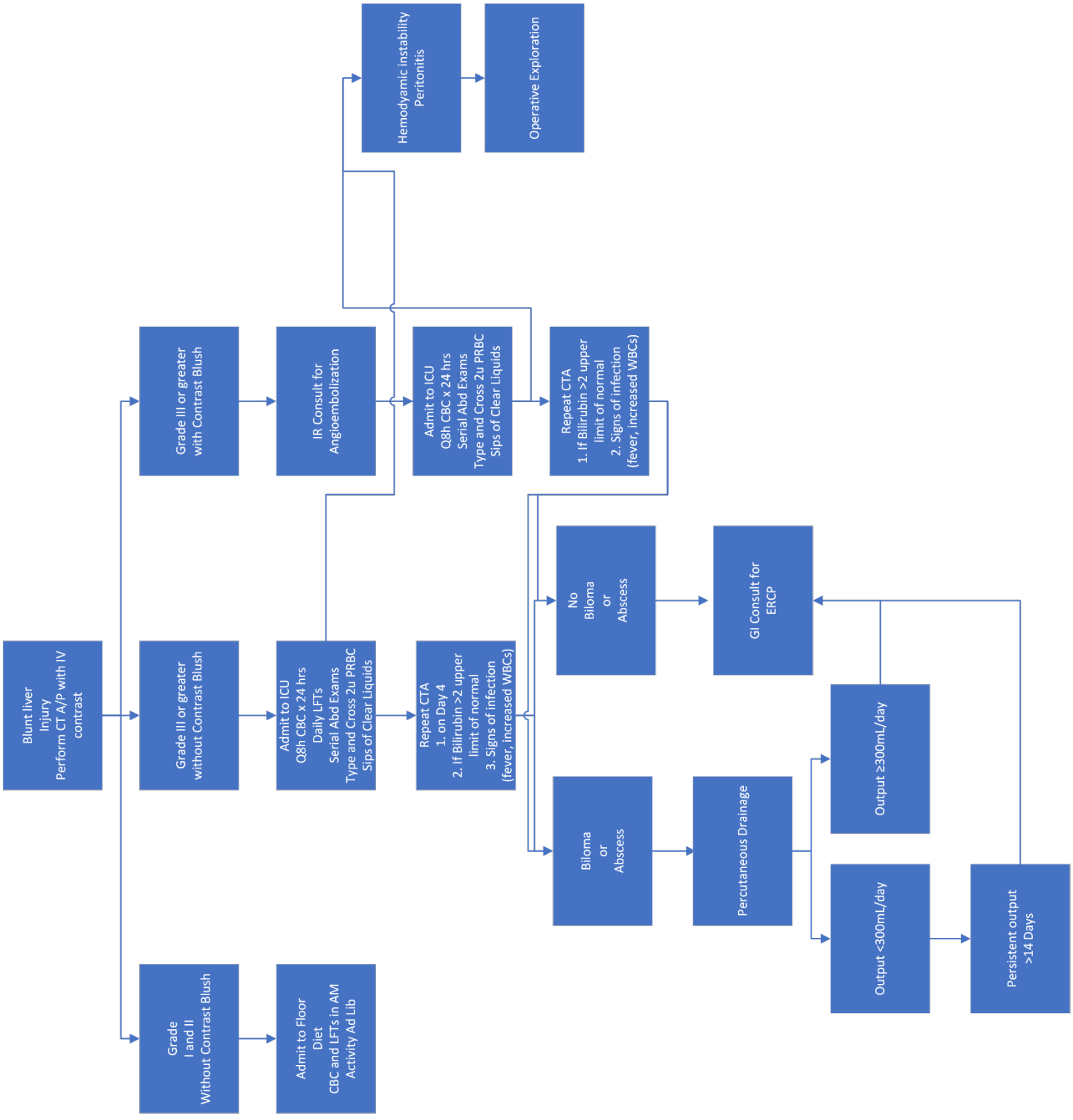
5. SOLID ORGAN INJURY



AAST Kidney Injury Scale (2018 revision)

Grade I	Subcapsular hematoma and/or parenchymal contusion without laceration
Grade II	Perirenal hematoma confined to Gerota fascia
	Parenchymal laceration ≤ 1 cm depth without urinary extravasation
Grade III	Parenchymal laceration > 1 cm depth without collecting system rupture or urinary extravasation
	Any injury in the presence of a kidney vascular injury or active bleeding contained within Gerota fascia
Grade IV	Parenchymal laceration extending into urinary collecting system with urinary extravasation.
	Renal pelvis laceration and/or complete ureteropelvic disruption.
	Segmental renal vein or artery injury.
	Active bleeding beyond Gerota fascia into the retroperitoneum or peritoneum.
	Segmental or complete kidney infarction(s) due to vessel thrombosis without active bleeding.
Grade V	Main renal artery or vein laceration or avulsion of hilum.
	Devascularized kidney with active bleeding.
	Shattered kidney with loss of identifiable parenchymal renal anatomy.

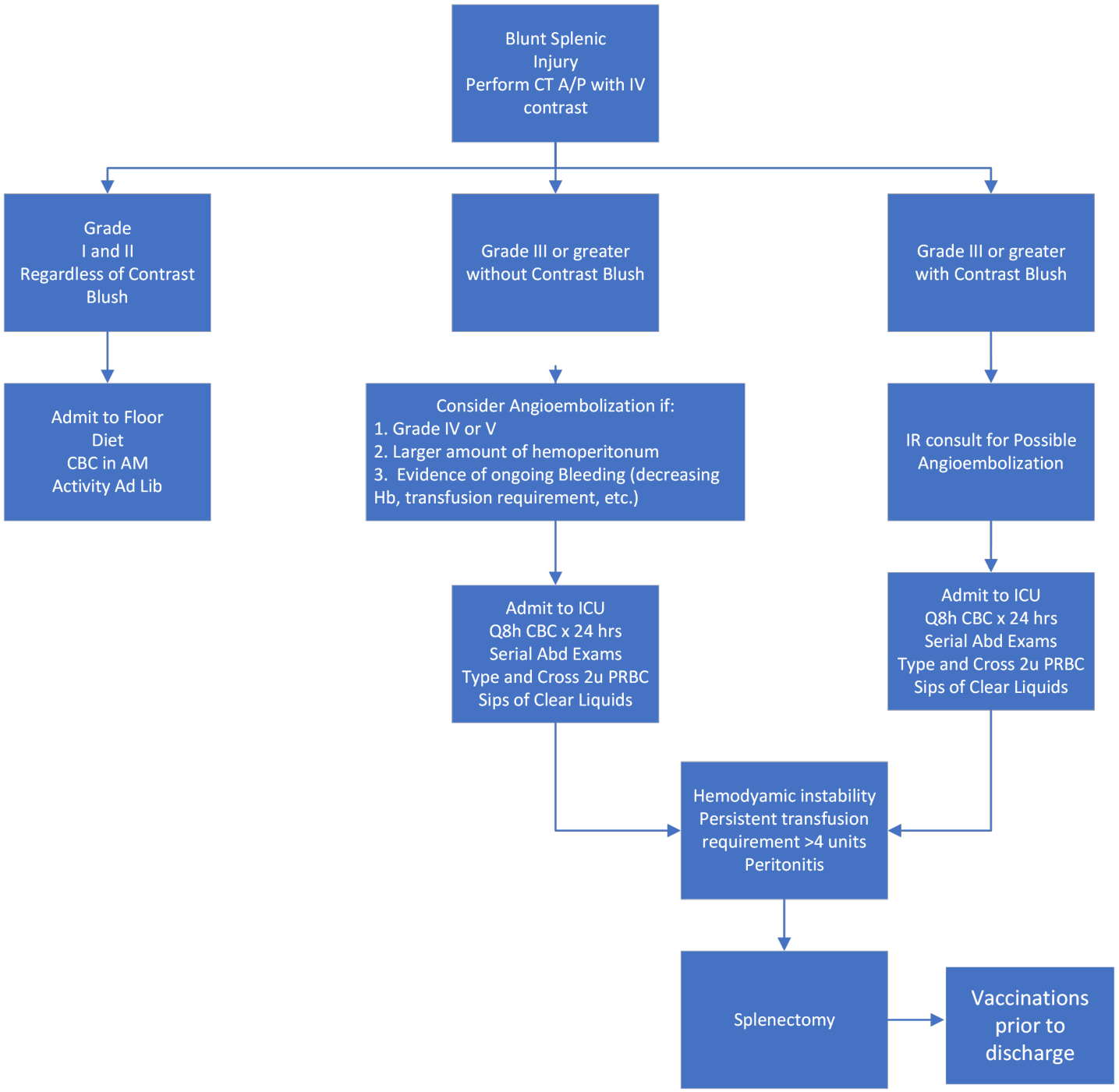
5. SOLID ORGAN INJURY



AAST Liver Injury Scale (2018 revision)

Grade I	Subcapsular hematoma < 10% surface area.
	Parenchymal laceration < 1 cm in depth.
Grade II	Subcapsular hematoma 10-50% surface area.
	Intraparenchymal hematoma < 10 cm in diameter.
	Parenchymal laceration 1-3 cm in depth and ≤ 10 cm length.
Grade III	Subcapsular hematoma > 50% surface area or expanding.
	Ruptured subcapsular or parenchymal hematoma.
	Intraparenchymal hematoma > 10 cm.
	Parenchymal laceration > 3 cm in depth.
	Any injury in the presence of a liver vascular injury or active bleeding contained within liver parenchyma.
Grade IV	Parenchymal disruption involving 25-75% of a hepatic lobe.
	Active bleeding extending beyond the liver parenchyma into the peritoneum.
Grade V	Parenchymal disruption involving > 75% of hepatic lobe.
	Juxtahepatic venous injuries to include retrohepatic vena cava and/or central major hepatic veins.

5. SOLID ORGAN INJURY



AAST Splenic Injury Scale (2018 revision)

Grade I	Subcapsular hematoma, < 10% surface area.
	Parenchymal laceration < 1 cm in depth.
	Capsular tear.
Grade II	Subcapsular hematoma, 10-50% surface area.
	Intraparenchymal hematoma < 5 cm in diameter.
	Parenchymal laceration 1-3 cm in depth.
Grade III	Subcapsular hematoma, > 50% surface area or expanding.
	Ruptured subcapsular or intraparenchymal hematoma ≥ 5 cm.
	Parenchymal laceration > 3 cm in depth.
Grade IV	Any injury in the presence of a splenic vascular injury or active bleeding confined within splenic capsule.
	Parenchymal laceration involving segmental or hilar vessels producing > 25% devascularization.
Grade V	Any injury in the presence of a splenic vascular injury with active bleeding extended beyond the spleen into the peritoneum.
	Shattered spleen.

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TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 6

EXTREMITY INJURY

6. EXTREMITY INJURY
A. Open Fracture

OBJECTIVE: To define the initial management of open fractures based on the Gustilo and Anderson classification of open fractures**.**

Guidelines: This system uses the amount of energy, the extent of soft-tissue injury and the extent of contamination for determination of fracture severity. Progression from grade I to IIIC implies a higher degree of energy involved in the injury, higher soft tissue and bone damage and higher potential for complications. It is important to recognize that grade IIIC fracture implies vascular injury.

Grade	Description
I	Open fracture, clean wound, wound < 1 cm in length
II	Open fracture, wound > 1 cm in length without extensive soft tissue damage, flaps, or avulsions.
III	Open fracture with extensive soft tissue laceration, damage, or loss or an open segmental fracture. Also includes open fractures from farm injuries, fractures requiring vascular repair, or fractures that had been open for 8 hours before treatment.
III A.	Grade III fracture with adequate periosteal coverage of the fractured bone despite extensive soft tissue laceration or damage.
III B.	Grade III fracture with extensive soft tissue loss, periosteal stripping, and bone damage. Usually associated with massive contamination. These will often need a further soft-tissue coverage procedure such as free or rotational flap.
III C.	Grade III fracture associated with an arterial injury requiring repair, regardless of the degree of soft-tissue injury.

Saving the patient's life must take precedence over saving the patient's limb. Life over limb. Once the patient is stabilized, the fracture will be evaluated, and a Neurovascular assessment of the extremity should be performed. All gross contamination should be removed using sterile saline, and the wound covered with sterile dressings soaked in saline. The extremity should be imaged with AP and lateral images, including the proximal and distal joints to the fracture site.

For grade I and II Gustilo open fractures:

- Cefazolin 2 grams IV immediately in the trauma resuscitation area (Level 1)
    - Must be given within 6 hours
- Continue Cefazolin q8h
- Duration of antibiotics for Grade I and II will be 24 hours after the wound is closed

For contaminated and grade III wounds:

- Ceftriaxone 2 g every 24 hrs.
- Vancomycin 15-20 mg/kg (typical dose 1 g).
- Duration of Antibiotic therapy with Grade III open fractures will be 24 - 72 hours after soft tissue closure (Level 2).

Special Situations:

- Open fracture wounds contaminated by soil, freshwater, and seawater will require adjustments to antibiotic therapy (See table below).
- Adult renal dosing adjustments can be found in table below.
- Immobilization of the extremity should be followed by debridement and washout in the OR.
- For Grade III C injuries, with a pulseless distal extremity or an ABI less than 0.90, the patient should initially undergo a CTA of the extremity and/or intraoperative angiogram if limb salvage is planned.
- Tetanus prophylaxis should be included as indicated, but it is not needed if the patient has a history of tetanus immunization and is under 50 years old.
- For patients at risk for MRSA, vancomycin should be added to all regimens.
- For patients > 120 kg, cefazolin dosing consists of 3 g IV every 8 hrs.
- For further guidance, please call Antimicrobial Stewardship via Tiger Text or consult infectious diseases.

Preventive antibiotic regimens for patients with open fractures in adult patients:

	Absence of potential soil or water contamination	**Presence of soil contamination** (Absence of water contamination)	**Presence of water Contamination**
Gustilo – Anderson Fracture Type I or II			
Preferred Regiment	Cefazolin 2 g IV q8h	Levofloxacin 750 mg IV q12 PLUS Metronidazole 500 mg IV q8h	No modification needed
Alternate regiment with beta lactam hypersensitivity	Vancomycin 15-20 mg/kg q12h OR Clindamycin 900 mg IV q8h	Clindamycin 900 mg IV q8h	No modification needed
Gustilo – Anderson Fracture Type III			
Preferred Regiment	Ceftriaxone 2 g IV q24h PLUS Vancomycin 15-20 mg/kg once	Ceftriaxone 2 g IV q24h PLUS Metronidazole 500 mg IV q8h PLUS Vancomycin 15-20 mg/kg once	Freshwater contamination: Piperacillin – tazobactam 4.5 g q6h Salt water contamination: Piperacillin – tazobactam 4.5 g q6h PLUS Doxycycline PO/IV 100 mg q12h
Alternate regiment with beta lactam hypersensitivity	Vancomycin 15-20 mg/kg PLUS Clindamycin 900 mg IV q8h OR Levofloxacin 750 mg IV q12h	Levofloxacin 750 mg IV q12h PLUS Metronidazole 500 mg IV q8h PLUS Vancomycin 15-20 mg/kg once	Fresh *or* Salt water contamination: Levofloxacin 750 mg IV q12h PLUS Metronidazole 500 mg IV q8h PLUS Vancomycin 15-20 mg/kg once

Renal Adjustments for Cefazolin, Levofloxacin, and Piperacillin/tazobactam

Cefazolin IV	> 50	2gm	Q8 Hours	Given the 3gm dose after HD prior to weekend (i.e Mon-2gm, Wed-2gm, Fri-3gm)
	10-50	2gm	Q12 Hours	
	< 10	2gm	Q24 Hours	
	Hemodialysis	2gm, 2gm, 3gm	TIW after HD	
	CAPD	500mg	Q12 Hours	
	CRRT	2gm	Q12 Hours	
Levofloxacin IV/PO (750mg dose)	≥ 50	750mg	Q24 Hours	Supplemental doses are not required following dialysis
	20-49	750mg	Q48 Hours	
	10-19	750mg load, then 500mg	Q48 Hours	
	Hemodialysis	750mg load, then 500mg	Q48 Hours	
	CAPD	750mg load, then 500mg	Q48 Hours	
	CRRT	500mg	Q24 Hours	
Piperacillin/ tazobactam IV	>40	3.375gm-4.5gm	Q6 Hours	Use 4.5gm dosing for treatment pf Pseudomonas or other nosocomial infections. Add0.75gm after HD, if next dose at 10pm.
	20-40	2.25gm-3.375gm	Q6 Hours	
	<20	2.25gm	Q6- Q8 Hours	
	Hemodialysis	2.25gm	Q8- Q12 Hours	
	CAPD	2.25gm	Q8- Q12 Hours	
	CRRT	2.25gm-3.375gm	Q6 Hours	
No renal adjustments required for ceftriaxone, clindamycin, metronidazole and doxycycline				

Risk Factors for methicillin-resistant *Staphylococcus aureus* (MRSA) infection

Health care-associated risk factors include:
• Recent hospitalization • Residence in a long term care facility • Recent surgery • Hemodialysis
Additional risk factors for MRSA infection include:
• HIV infection • Injection drug use • Prior antibiotic use
Factors associated with MRSA outbreaks include:
• Incarceration • Military service • Sharing sport equipment • Sharing needles, razors, or other sharp objects

Orthopedic Surgery Response Criteria < 30 minutes:

- Hemodynamically unstable, secondary to pelvic fracture
- Suspected extremity compartment syndrome
- Fractures/dislocations with risk of avascular necrosis (e.g. femoral head or talus)
- Vascular compromise related to a fracture or dislocation
- Trauma surgeon discretion

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OBJECTIVE: To define the diagnosis, prognosis, and management of a "mangled" extremity.

Guidelines: A "mangled extremity" is defined as a combination of vascular, bony, soft tissue, and/or nerve injury jeopardizes the viability of the limb. Mangled extremities include Gustilo III B or III C injuries. When considering limb preservation vs amputation, amputation should seriously be considered as a potentially better alternative. This is especially true when the risk of systemic complications is high or when the salvaged limb will be less functional than prosthesis. Despite the availability of many predictive models, the estimation of successful limb salvage in terms of patient morbidity and long-term limb function has been limited by the lack of class I data. Additionally, all the scoring systems are based on only data from lower extremity injuries. Johansen et al.[1] proposed the use of the Mangled Extremity Severity Score (MESS). This includes four primary risk elements:

1. Soft tissue injury
2. Limb Ischemia
3. Shock
4. Patient Age

With this model, a score ≥ 7 was 100% predictive of amputation. A subsequent study by McNamara et al. used nerve injury, ischemia, soft tissue injury, skeletal injury, shock, and the patient's age (NISSSA) score to predict the need for amputation[2]. *However, all scoring systems have not been validated in larger prospective studies.*

Mangled Extremity Severity Score (MESS)

			Score
Limb Ischemia for > 6 hours		No = 0 Yes = 1	
Limb Ischemia	Reduced Pulse but normal perfusion	+1	
	Pulseless; paresthesias, slow capillary refill	+2	
	Cool, paralyzed, numb/insensate	+3	
Patient Age	< 30 yrs.	0	
	30 – 50 yrs.	+1	
	≥ 50 yrs.	+2	
Shock	SBP > 90 mm/ Hg	0	
	Transient Hypotension	+1	
	Persistent Hypotension	+2	
Mechanism	Low Energy: Stab, Pistol GSW, Simple Fracture	+1	
	Medium Energy: Dislocation, Open or Multiple Fractures	+2	
	High Energy: High-Speed MVA, Rifle GSW	+3	
	Very High Energy: High-speed trauma with gross contamination	+4	

Total ☐

Predictive of Limb Salvage ≤ 6
Low Likelihood of Limb Salvage ≥ 7

DIAGNOSIS AND MANAGEMENT:

Stop the Bleeding:

The initial evaluation of a patient with a mangled extremity does not differ from any other patient with multiple injuries. The ABCs take precedence; the only immediate life-threatening aspect of a mangled extremity is external blood loss that must be controlled. As part of the primary survey, attention must be directed at controlling active bleeding from a mangled extremity. Direct control of the bleeding should be obtained either by manual pressure. If manual pressure fails to control the bleeding, then a proximal tourniquet can be used. It is important to apply appropriate inflation pressure above systolic blood pressure. This helps to avoid a venous tourniquet effect, allowing continued arterial bleeding and compromised venous outflow. If the bleeding cannot be controlled by these two maneuvers, or if the patient remains hemodynamically unstable, the patient must be taken to the operating room for emergent exploration and vascular control. If the tourniquet cannot be removed within an hour, this is another indication to take the patient to the operating room.

If there is no active bleeding, evaluate for vascular injury or compromise:

The first priority is to restore the anatomic alignment of the extremity and try to identify a pulse. If a pulse cannot be identified, the next step would be to proceed with a Doppler assessment. If the pulse in the injured extremity is perceived to be not equal to the pulse on the uninjured side, if possible, obtain an Ankle-Brachial Index (ABI) or Brachial-Brachial index (BBI). An ABI or BBI of less than 0.9 requires further operative or radiographic investigation. It's important to keep in mind that both the ABI and BBI can be affected by a variety of factors, which include obesity, hypotension, hypothermia, hemorrhage, and chronic vascular disease. Additionally, an inappropriate cuff size may affect the ABI and TBI indices as well. The patient must be warm to improve the reliability of these Doppler indices. If there was a concern for vascular injury, the patient should undergo a CTA of the extremity when the patient has been stabilized.

Amputation:

Sometimes, based on the magnitude of the injuries sustained, the decision to amputate can be simple. If the patient can be stabilized, decision to amputate should be made with the input from the consulting physicians from other services. If possible, the decision should be made by at least two Attending Surgeons from different services.

6. EXTREMITY INJURY
B. Mangled Extremity

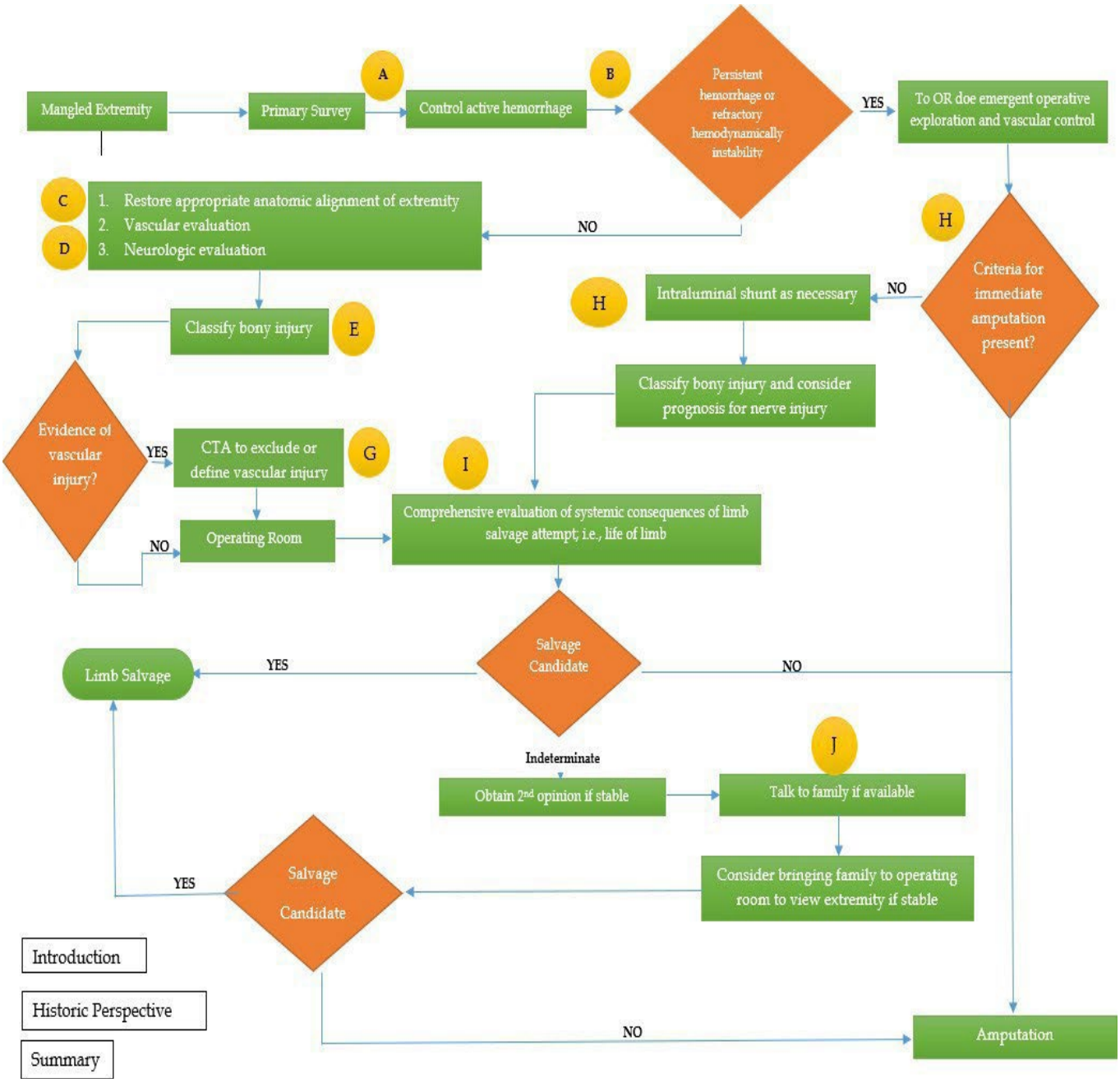

TABLE 4. Peripheral Nerve Injury Findings

- Lower extremity
  - Femoral nerve
    - Motor: inability to extend the lower extremity at the knee
    - Sensory: numbness over distal 1/3 of the anteromedial aspect of the thigh
  - Peroneal nerve injury
    - Motor:
    - Common peroneal: weakness or inability to dorsiflex foot and toes, as well as foot eversion ("foot drop")
    - Deep peroneal: weakness or inability to dorsiflex foot and toes
    - Superficial peroneal: inability to evert foot
    - Sensory:
    - Deep peroneal: decreased or absent sensation dorsal web space between 1st and second toes
    - Superficial peroneal: decreased or absent sensation remainder of dorsal foot
  - Tibial nerve injury
    - Motor: weakness or absence of toe plantar-flexion or foot inversion (foot plantar flexion by Achilles-gastroc-soleus)
    - Sensory: numbness over sole and heel of the foot
- Upper extremity
  - Median nerve
    - Motor: weak or absent flexion of thumb and index finger IP joints against resistance
    - Sensory: decreased or absent sensation palmar surface of thumb, index and middle fingers
  - Radial nerve
    - Motor: weak or absent dorsiflexion of wrist and/or thumb
    - Sensory: decreased or absent sensation in dorsal web space between thumb and index fingers
  - Ulnar nerve
    - Motor: weakness or absence of finger abduction and adduction
    - Sensory: decreased or absent sensation little finger and ulnar half of ring finger

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To be Reviewed: 1/2027

OBJECTIVES: To define the diagnostic and treatment approach to penetrating extremity trauma.

Definitions of types of arterial vascular injuries:

- Intimal Injuries (flaps, disruption or sub intimal)
- Intramural hematoma
- Complete wall defects with pseudoaneurysm or hemorrhage
- Complete transection with occlusion or hemorrhage
- Arterio-venous fistulas

Definitions of types of venous vascular injuries:

Venous Injury	Grade
Laceration of < 50% of the vein wall	I
Disruption > 50% vein wall	II
Complete transection or venous thrombosis, including AV fistula	III
Greater than 50% vein wall disruption or venous thrombosis with significant soft tissue injury	IV

Guidelines:

1. Follow the ABCs.
2. Perform a rapid physical exam, noting the nature of distal pulses and neurologic findings (see algorithm).
3. If the patient arrives with a tourniquet applied by EMS at the scene and the patient is stable, release the tourniquet and control bleeding within the Trauma Bay.
4. If bleeding is uncontrollable, reapply the tourniquet and take the patient to the OR for control of the bleeding and resuscitation. If the patient is unstable and has other priorities, reapply the tourniquet, note the time, and treat other issues accordingly.
5. If the base deficit is greater than negative 6, be ready to control the possible exsanguinating hemorrhage initially by direct pressure and then by applying the appropriate tourniquet available in the Trauma Bay. Note the time it was applied and then take the patient to the OR.
6. Rapidly obtain X-ray of extremity, including entry and exit wounds; use wound markers.
7. "Hard Signs" Take the patient immediately to the OR for the following findings :
    a. Exsanguinating hemorrhage from the injury.
    b. Pulsatile Arterial Bleeding
    c. Rapidly expanding hematoma.
    d. Rapidly developing compartment syndrome.

8. "Soft Signs" Identifiable injuries < 10% Case
    a. Neurological injury in proximity of the vessel
    b. Small to moderate size hematoma
    c. Unexplained hypotension
    d. Large blood loss at scene
    e. Injuries in proximity to major vessel (penetrating mechanism, fracture, dislocation)

9. Indication for a CTA in stable patient, not in shock and Pulse < SBP
    a. Diminished or absent distal pulses.
    b. ABI < 0.9 (for leg injury).
    c. Difference in upper extremity SBP > 20 mmHg with upper extremity injury.
    d. Continued bleeding from wounds.
    e. Major nerve injury.
    f. Proximity penetrating injury

*The incidence of arterial injuries in such patients ranges from 3% to 25%

An imaging study that documents the presence of extravasation, an acute pulsatile hematoma or early pseudoaneurysm, occlusion, or an arteriovenous fistula of a major named artery will require repair. In the upper extremity, this pertains to major named arterial injuries, and in the lower extremity, it pertains to arterial injuries proximal to the anterior tibial artery and tibioperoneal bifurcation, excluding the profunda femoris. In the hemodynamically stable patient, an imaging study that documents a wall defect with extravasation, occlusion, or the presence of an arteriovenous fistula in the profunda femoris, anterior tibial, posterior tibial, or peroneal arteries is followed by observation in the case of occlusion or therapeutic embolization in the case of extravasation or of an arteriovenous fistula). A repeat arteriogram or duplex ultrasonography may be performed 3 days to 5 days later in patients with occlusion to rule out the presence of an acute pulsatile hematoma or pseudoaneurysm developing from distal backflow[1].

10. If neurologic deficit is present:
    a. Document the level of deficit.
    b. Obtain orthopedic or neurosurgical consult. Penetrating injuries without vascular injury on diagnostic studies and without neurologic injury can have the wound locally treated and the patient may be discharged.

11. Administer one gram of cefazolin IV for Stab wounds (SWs). Gunshot wounds (GSWs) do not require antibiotics.

12. Debride foreign material.

13. Administer tetanus IM as needed if the patient does not have a prior immunization history or is above the age of 50 years.

14. Debride wound edges and close or treat with dressings, depending on clinical conditions.

15. Splint joints above and below the injury with a bulky dressing.

Questions to Answer in the Trauma Bay:

1. Is there an isolated arterial or venous injury or a combined arterio-venous injury?
2. Is there an associated bony injury?
3. Should I take the patient immediately to the OR, or is there time for a diagnostic study?

Sequence and Priorities for the Treatment of Vascular Injuries

1. Temporary control of bleeding
   - ✓ Digital pressure
   - ✓ Tourniquet
   - ✓ Balloon catheter in transition zones
2. Obtain appropriate "Extensile" exposure
3. Obtain definitive control
   - ✓ Proximal control is sometimes useful
   - ✓ Do not violate anatomic barriers that help contain the bleeding
   - ✓ Use balloon occlusion for control of back-bleeding
4. Decide on the type of repair: simple or complex
   - ✓ Simple for laceration from a stab wound
   - ✓ Complex: patch, interposition graft, end-to-end anastomosis for transection after stab wound
5. Consider selective fasciotomy

When to Consider Damage Control: Ligation or Temporary Shunts

1. If the patient is unstable or actively bleeding in another cavity
2. If you do not have "adequate" help
3. If you do not have the experience required for the repair
4. When you have multi-cavity injuries

Considerations for Fasciotomy

1. Prolonged hypotension
2. Extensive soft tissue damage
3. Combined venous and arterial injury
4. Combined bony and arterial or venous injury
5. Delay between injury and repair
6. Documented compartment pressure > 35 mmHg
7. Long ischemic time
8. No back bleeding during repair

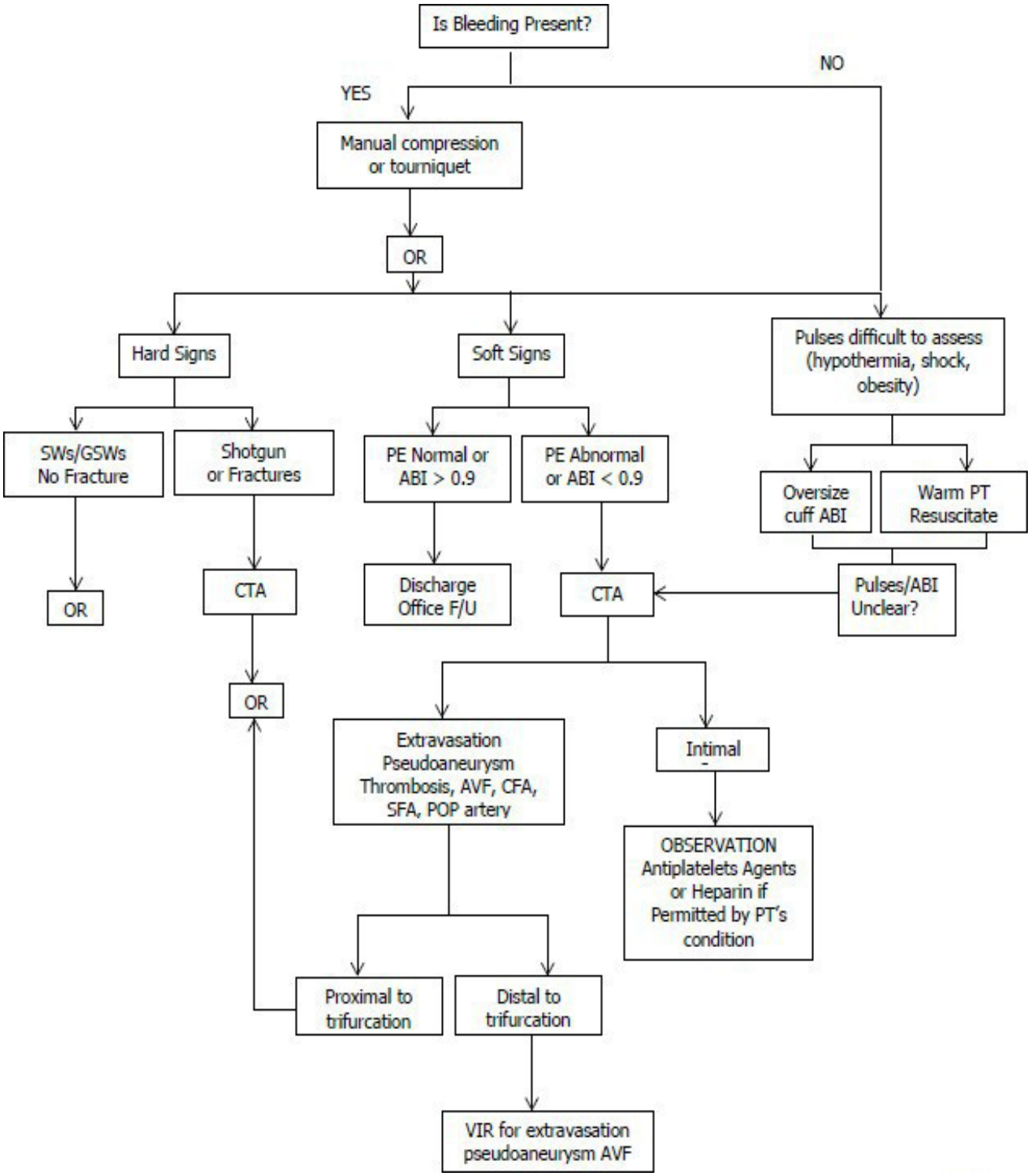
Useful Principles for OR Management

1. Always establish adequate exposure
2. Establish proximal then distal arterial control
3. Use a shunt if the bones need to be fixed first to buy some time
4. Use local heparin flush
5. Make the arterial repair tension-free
6. If possible, use autogenous vein, but PTFE is safe to use
7. Repair concomitant venous injury if the patient is stable but be ready to ligate the venous injury
8. If dealing with an isolated venous injury, attempt repair in grade I and II injury, ligate the vein for grade III, if you cannot perform a tension-free end-to-end reconstruction, and for all grade IV injuries. Anticoagulate the patient if possible, since 70% of patients with vein ligation will develop DVT[2-4].

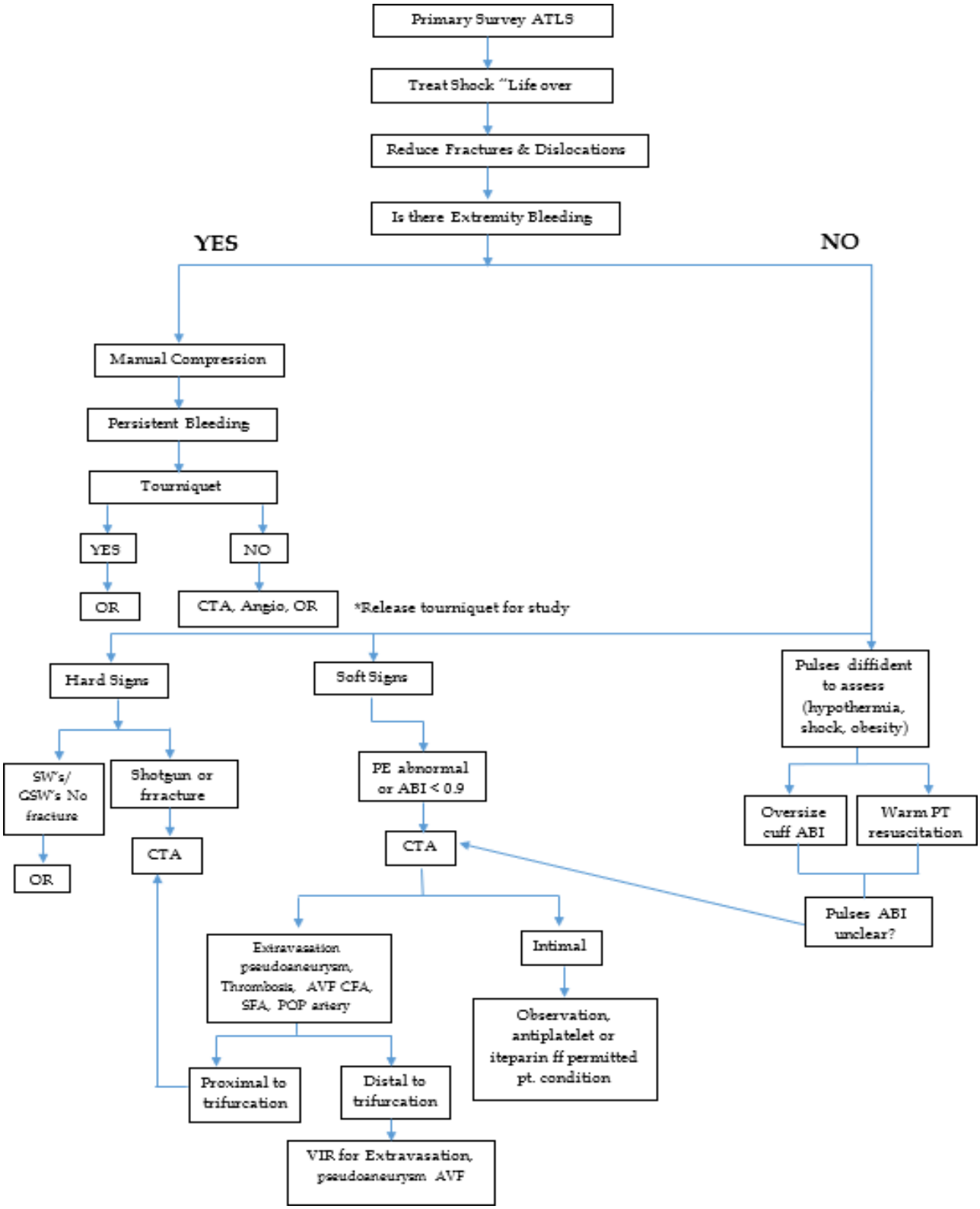
Sequence and Priorities for the Treatment of Vascular Injuries

1. Temporary control of bleeding
   - ✓ Digital pressure
   - ✓ Tourniquet
   - ✓ Balloon catheter in transition zones
2. Obtain appropriate "Extensile" exposure
3. Obtain definitive control
   - ✓ Proximal control is key
   - ✓ Do not violate anatomic barriers that help contain the bleeding
   - ✓ Always begin in virgin territory
   - ✓ Use balloon occlusion for control of back-bleeding
4. Decide on the type of repair: simple or complex
   - ✓ Simple: lateral repair
   - ✓ Complex: patch, interpose

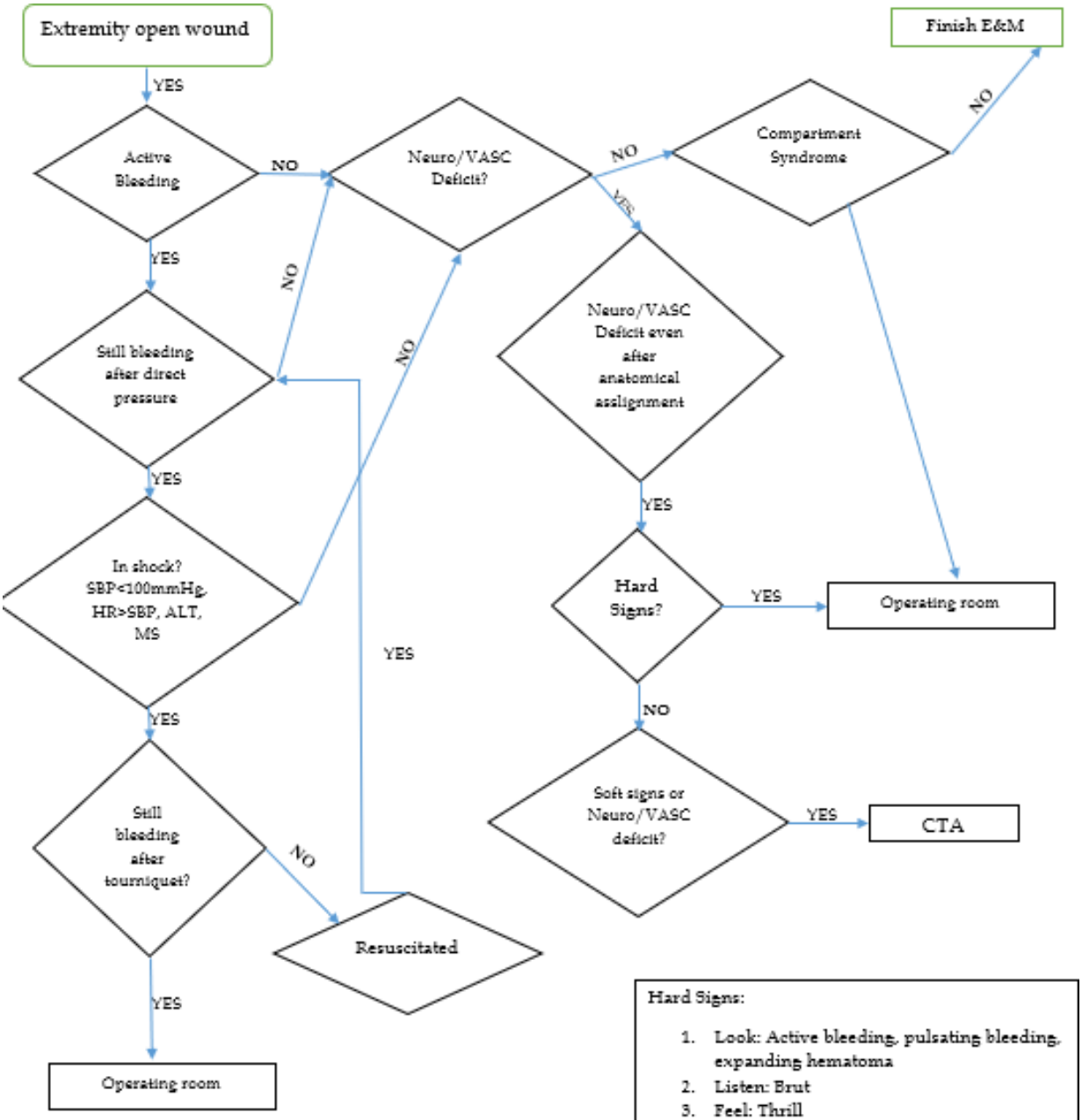
PENETRATING EXTREMITY INJURIES



6. EXTREMITY INJURY
C. Penetrating Extremity



6. EXTREMITY INJURY
C. Penetrating Extremity



Hard Signs:

1. Look: Active bleeding, pulsating bleeding, expanding hematoma
2. Listen: Brut
3. Feel: Thrill

Soft signs:

1. History of shock
2. Excessive blood on clothes
3. Large hematoma
4. Splatter pattern

Vascular Deficit on exam

1. AAI, BBI, ABI <0.9

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OBJECTIVE: To define the diagnosis, prognosis, and management of compartment syndrome

Guidelines: Compartment syndrome is a condition in which increased pressure within a limited space compromises the circulation and function of the tissues within that space. This condition is a cause of major loss of function, limb, and even life. The most common cause of compartment syndrome is related to trauma. Both blunt trauma, with or without fractures, and penetrating injuries can all cause compartment syndrome. Compartment syndrome can happen in any extremity; however, it is more common in the lower extremities. Tissue necrosis can occur in eight hours and sometimes even sooner. Prompt recognition and treatment are critical for successful outcomes.

Diagnosis and Management

Diagnosis of compartment syndrome is mainly a clinical one which requires a good physical exam.

Classically, the hallmark signs include the 5 P's:

1. Pain (specifically with passive range of motion)
    a. Most sensitive finding prior to onset of ischemia
2. Paresthesia
    a. Indicative of nerve ischemia
3. Paralysis
4. Pallor
5. Pulselessness
    a. Late sign, usually poor prognosis, and may need amputation

Diagnosis can be guided by pressure measurement.

- absolute ICP > 30 mmHg
- Δ pressure (diastolic blood pressure - ICP) < 30 mmHg

Treatment will always be operative decompression of the affected compartment with fasciotomy.

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TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 7

SPECIAL POPULATIONS / MISC.

OBJECTIVE: Provide guidelines for the diagnosis and management of the trauma patient with genito-urinary injuries.

DEFINITIONS:

Gross hematuria: Blood in the urine that can be seen as a change in the urine color.
Microhematuria: Urine that appears normal but has tested positive for blood by either a dipstick technique or by microscopic examination.
Renal contusions: Defect(s) in perfusion of the kidney on CT or IVP that is consistent with a parenchymal contusion.
Renal fracture: A parenchymal defect of the kidney associated with hematoma or urinoma around the kidney.
Reno-vascular injuries: Occlusion(s) of the renal artery as evidenced by lack of perfusion to a kidney on CT, IVP, or angiogram.

Kidney Injuries
AAST Kidney Injury scale

Grade	Type of injury	Description of injury	AIS-90
I	Contusion	Microscopic or gross hematuria, urologic studies normal	2
	Hematoma	Subcapsular, non-expanding no parenchymal injury	2
II	Hematoma	Non-expanding perirenal hematoma confined to renal urethral peritoneum	2
	Laceration	< 1 cm parenchymal that of renal cortex without urinary extravasation	2
III	Laceration	< 1 cm parenchymal laceration of renal cortex without injury to the collecting system or urinary extravasation	3
	Laceration	Parenchymal laceration extending to renal cortex, medulla, and collecting system	4
IV	Vascular	Main renal artery or vein injury with contained hemorrhage	4
V	Laceration	Completely shattered kidney	5
	Vascular	Avulsion of renal hilum with devascularized kidney	5

1. All hemodynamically unstable patients with either isolated kidney injury and without associated intra-abdominal injuries should be taken directly to the operating room for the appropriate treatment.
   a. If a nephrectomy is necessary and the patient has not had any confirmation of the presence and/or the function of the contralateral kidney before the laparotomy, a one-

shot IVP to confirm the presence of the contralateral kidney and its function should be performed before performing the nephrectomy[2] (Level 3).
- The one-shot IVP is done by giving the patient 2 mL/kg (150 mL) of 50% contrast as a bolus and by obtaining a single shot flat-plate film within 5 minutes of completion of the bolus.

b. Non-pulsatile, non-expanding retroperitoneal hematomas, and perirenal hematomas from blunt injuries should not be explored at the time of the laparotomy. In contrast, all retroperitoneal hematomas, including perirenal hematomas from penetrating injuries, should be explored.
c. Partial nephrectomy should be considered in patients with penetrating injuries localized to upper or lower pole of the kidney. Mid-pole injuries can be treated with closure of the collecting system and individual ligation of the vessels in non-vascularized kidneys. An omental pedicle flap can be rotated to cover the defect after closure of the collecting system. With this approach one can expect a kidney salvage rate of 85% (Level 3).

2. Stable patients with grade I, II, and III renal trauma by CT scan can be observed with serial hematocrits, physical examination, and vital signs (Level 2). The presence of contrast blush/extravasation on CT scan should prompt strong consideration for angiography. If these patients develop fever, increasing abdominal pain and/or hypertension, they should undergo a repeat CT scan or alternatively an ultrasound.

3. Patients with grade IV kidney injury without vascular pedicle injury can be observed while placed on bed rest. An interval CT scan at 72 hours should be done to reassess the injury for the presence of an urinoma. If a urinoma is present, it should undergo percutaneous drainage; if conversely, there is no urinoma, the patient can undergo continued observation.

4. If the patient with grade IV kidney injury becomes unstable, he should be taken to the operating room for exploration. Patients with grade IV kidney injury involving the pedicle should undergo diagnostic angiography with possible angioembolization and/or stenting as appropriate. Of note, patients with shattered but perfused kidneys can be treated nonoperatively as long as they are hemodynamically stable[3] (Level 2). Nonoperative management of these patients is associated with fewer complications, which can be managed with an endo-urological or a percutaneous approach when required (Level 2).

Hemodynamically stable patients with penetrating renal injuries, including GSWs, who have been completely staged by CT scan can be managed nonoperatively as long as the workup has excluded ureteral and associated intra-abdominal injuries[4-5] (Level 3).

Ureteral Injuries

Classification of Ureteral Injuries	
Grade	Description of injury
I	Hematoma only
II	Laceration < 50% of circumference
III	Laceration > 50% of circumference
IV	Complete tear < 2 cm of the de-vascularization
V	Complete tear > 2 cm of the de-vascularization

Ureteral injuries from trauma constitute less than 1% of all urinary tract injuries. Greater than 95% are caused by gunshot wounds. Urine analysis, IVP, as well as operative exploration may miss ureteral injuries; therefore, a high index of suspicion is required during laparotomy to avoid missing these injuries. A CT scan with delayed images between 5 and 8 minutes after infusion of contrast will increase the sensitivity in diagnosing ureteral disruption from blunt trauma. Of note, hematuria is not a consistent finding with ureteral injuries; therefore, the absence of blood in the urine does not exclude a ureteral injury. The treatment options are guided by the location and the extent of the injury.

Principles of Repair of Grade III-V Injuries

1. Debride both ureteral ends to fresh tissue
2. Spatulate the ureteral ends
3. Place an internal double-J stent
4. Reconstruct the ureter with a watertight closure using 4-0 Vicryl
5. Drain the site with a JP
6. Isolate the injury, if possible, with either peritoneum or omentum

<u>Stable patients</u>

Injury to the lower third of the ureter can be treated easily by direct re-implantation of the ureter into the bladder or with the use of a psoas hitch, if necessary, to decrease the tension on the suture line. Mid-ureteral injuries can be treated with resection and primary anastomosis over a double- J stent as long as the segment injured is less than 2 cm. An alternate technique for injuries at this level includes the creation of a Boari bladder flap. A third technique is to perform a transuretero-ureterostomy. Injuries to the proximal third of the ureter can be treated with ureteropyelostomy, ureterocalycostomy, or, if necessary, within ileal segment interposition. In a very stable patient, an autotransplantation is always feasible[6].

<u>Unstable patients</u>

If the patient is unstable and has suffered a high-grade ureteral injury, you should either ligaate the ureter and then proceed with a percutaneous nephrostomy, or establish temporary external drainage. If you can, avoid a cutaneous ureterostomy.

Bladder injuries

Classification of bladder injury	
Type	Description
1	Bladder contusion
2	Intraperitoneal rupture
3	Interstitial bladder injury
4	Extra peritoneal rupture: A. Simple B. Complex
5	Combined injury

The diagnosis of bladder injury cannot be made with conventional CT alone even if the Foley is clamped and the bladder is distended (Level 2). The diagnosis of bladder injury in patients at risk of injury, which typically includes patients with pelvic fractures and complex acetabular fractures, is made by either conventional cystography or by CT cystography (Level 2).

Extraperitoneal rupture of the bladder can be generally managed nonoperatively with a Foley catheter in place for 7-10 days with a repeat cystography to confirm healing. Contraindications to nonoperative management of extraperitoneal bladder injuries include:

a. Associated injuries to the urethra, rectum, and vagina
b. Presence of bone fragments in the bladder
c. Open reduction internal fixation of the pubic symphysis with hardware
d. Open pelvic fractures
e. Inadequate bladder drainage via the Foley catheter
f. Penetrating injuries

Intraperitoneal bladder rupture requires operative intervention and repair. The bladder repair consists of a 2 layer repair with a Vicryl or Chromic suture. Suprapubic cystostomy is not necessary since bladder drainage via Foley catheter is sufficient for adequate bladder decompression[7]. A cystogram done 7 -10 days after the repair is necessary to confirm healing before the removal of the Foley catheter. Continued antibiotic regimen is not necessary while the Foley is in place (Level 2).

Urethral Injuries

AAST Grading

Type	Description	Appearance
I	Contusion	Blood at the urethral meatus; normal urethrogram
II	Stretch injury	Elongation of the urethra without extravasation on urethrogram
III	Partial disruption	Extravasation of contrast at injury site with contrast visualization of the bladder
IV	Complete disruption	Extravasation of contrast at injury site without visualization of the bladder; < 2 cm of urethral separation
V	Complete disruption	Complete transection with > 2 cm urethral separation, or extension into the prostate or vagina

The diagnosis of urethral injury should be suspected in all patients with pelvic fractures and, in particular, in patients with anterior and posterior pelvic ring fractures (Level 2). Although blood at the urethral meatus, gross hematuria, and a high-riding prostate are suggestive of urethral injury in the setting of pelvic fracture, their absence does not exclude a urethral injury. While the female urethra is more resistant to injury in patients with pelvic fractures, still, the presence of vaginal bleeding and/or external genitalia injury in female patients with pelvic fractures should raise suspicion of urethral injury.

The posterior urethra is injured in males and females in association with pelvic fractures. In contrast, the male anterior urethra may be injured in penetrating injuries or in straddle-type injuries, causing a crush on the bulbar urethra against the pubic ramus. A retrograde urethrogram is indicated in patients with blunt pelvic trauma and inability to void, blotted the urethral meatus, a high-riding prostate, and ecchymosis at the base of the penis involving the scrotum. Injuries to the posterior urethra are managed with bladder decompression via a suprapubic cystostomy. Primary repair is contraindicated due to the high incidence of complications, including incontinence, impotence, and stricture formation. Anterior urethral injury can be managed with endoscopic or fluoroscopic urethral catheter placement followed by pericatheter urethrogram 10- 14 days later to assess for healing before removal of the catheter.

Scrotal injuries

All penetrating scrotal injuries must be explored surgically and may require a Urology consultation. Blunt scrotal injuries require evaluation via ultrasound examination and exploration when there is testicular rupture, torsion, presence of a large hematocele, and testicular dislocation.

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To be Reviewed: 12/2026

Chemical VTE Prophylaxis Guidelines for Patients with Traumatic Injuries
All Trauma Patients Except Special Populations Discussed Below:

Weight-Based Dosing:
Dose: 0.5 mg/kg BID.
Check Anti Factor Xa at extremes of weight:
BMI < 20
BMI > 35

Anti-Factor Xa Levels and Adjustments:
Draw level at 4 hours after 3rd dose (4-6 hours).
Target peak levels:
Prophylactic dose: 0.2 – 0.4 units/mL
Therapeutic dosing: 0.5 – 1 units/mL

Enoxaparin Anti-Xa Titration for Prophylaxis Dosing (target 0.2-0.5 IU/mL)

Anti-Xa Level (IU/mL)	Hold Dose	Dosage Change*	Next Anti-Xa Level
< 0.2	N/A	Increase 25%	4-6 hours after 3rd consecutive dose
0.2 – 0.5	N/A	None	Weekly or as clinically indicated
0.51 – 1	N/A	Decrease 25%	4-6 hours after 3rd consecutive dose
> 1	Until level is < 0.3	Decrease 40% Initiate new dose when level < 0.3	Every 12 hours until level < 0.3

*Round to the nearest 10 mg dose (e.g. 74 mg → 70 mg; 75 mg → 80 mg)

Holding of DVT Prophylaxis Prior to Surgery:
Never on the Trauma/ACS service, unless specifically instructed by a Trauma or ACS Attending. For consultant/subspecialty services, any holds/interruptions must involve discussion with the Trauma/ACS Attending.

Kidney Dysfunction:
Lovenox is safe in patients with renal dysfunction. Dose adjustment based on Creatinine Clearance (CrCl):
CrCl ≥ 30 mL/min -> No Adjustment
CrCl < 30 mL/min -> Reduce to 30 mg daily (from q12h)
If using SQH, use 5,000 units q8h, For BMI ≥ 40 or weight ≥ 120 kg use SQH 7,500 q8h

Obesity:
For BMI ≥ 40 OR weight ≥ 120 kg, use adjusted weight (IBW + 0.4 * (ABW - IBW)) for weight based Lovenox
If using SQH (as with CrCl < 30 mL/min), use 7,500 units q8h or Lovenox 40 mg daily

Pain Catheters:
LMWH Prophylaxis (Lovenox) is considered safe for all types of blocks and indwelling pain catheters.

Types of blocks/catheters:

- Neuraxial (Epidural) / Deep (paravertebral)
  - **Dose: 40 mg to 60 mg, QD**
    - < 50 kg = 0.5 mg/kg daily
    - 50-74 kg = 40 mg daily
    - 75 - 99 kg = 50 mg daily
    - ≥ 100 kg = 60 mg daily
  - **For TBI + Pain Catheter -> max dose of 40 mg Daily**
- ESP/serratus plane, peripheral

No Restriction on Chemical DVT Prophylaxis (Use standard dosing)

Lovenox should be **held 12 hours prior to insertion** and for **12 hours after** removal. Lovenox can be **restarted 12 hours after placement.**
SQH should be **held 4 hours prior to insertion** and for **4 hours after** removal.

For patients with renal dysfunction (CrCl< 30) and obesity, use **SQH 5,000 q8h** in accordance with WMC Dept. Of Anesthesia Neuraxial guidelines (2021)

Traumatic Spine Injury

- Patients with spine fracture waiting for MRI; if MRI not done within 24 hours, then:
  - In patients without neuro deficit - at minimum SQH 5,000 q8h will be started on HD #1, then changed to Lovenox (0.5 mg/kg BID) within 24 hours if no EDH found on MRI.
  - In patients with COMPLETE spinal cord injury/ASIA A - at minimum SQH 5,000 q8h will be started within 24 hours of admission, then changed to Lovenox (0.5 mg/kg BID) within 24 hours if no EDH found on MRI.
  - In patients with INCOMPLETE spinal cord injury and no acute deterioration in neurologic exam - at minimum, SQH 5,000 q8h will be started on HD #1, then changed to Lovenox (0.5 mg/kg BID) within 24 hours if no EDH found on MRI.
- Patients with spine fracture without EDH will receive Lovenox (0.5 mg/kg BID) within 24 hours on the day of admission.
- Patients with spine fracture and epidural hematoma (EDH) will NOT be placed on DVT prophylaxis until cleared by the Spine Service.
- Patients can receive Lovenox (0.5 mg/kg BID) 24 hours after uneventful spine surgery, with appropriate communication between the trauma surgery team and the operative team (Orthopedics or Neurosurgery) to ensure that there are no contraindications. Any deviation will be explicitly documented in the chart by the Spine Service.
- Lovenox should be withheld 12 hours before a planned operative spine procedure.

Traumatic Brain Injury (TBI)
NOTE - Lovenox is preferred compared to SQH.
Lovenox dosing will be* 0.5 mg/kg BID *and shall not exceed 30 mg q12 hours in patients with traumatic brain injury

- BIG 1: can start Lovenox 24 hrs after initial head CT or head injury if date/time of injury is known.
- BIG 2: can start Lovenox 24 hrs after initial head CT and if neurologic exam is unchanged or improved compared to admission exam.
- BIG 3: can start Lovenox 24 hrs after confirmed stability of bleed on repeat head CT by NES.
- Lovenox can be started 24 hrs after placement of EVD/ICP monitor.
    - If post-procedure head CT requested, will wait to start Lovenox until head CT reviewed by NES for new hemorrhage/stability, etc.
- Lovenox can be started 24 hrs after intracranial surgery.
    - If post-procedure head CT requested, will wait to start Lovenox until head CT reviewed by NES for new hemorrhage/stability, etc.

NOTE: If NES attending wants to hold Lovenox or start different agent, then that will be relayed to Trauma service by NES service.

Solid Organ Injury

- Patients with AAST Grade 1-3 solid organ injuries and who undergo angioembolization, splenectomy, or nephrectomy:
    - Chemical VTE prophylaxis should be initiated on admission.

- Patients with AAST Grade 4 and 5 solid organ injuries:
    - Chemical VTE prophylaxis should be initiated 24 hours after hemoglobin levels are stable (+/- 1.5 g/dL in 24 hours) or 48 hours after injury elapses, whichever is sooner.

Additional Considerations:

- Exclude patients actively bleeding or requiring transfusion.
- Exclude patients actively receiving DOACs or therapeutic anticoagulation.
- Exclude patients with specific conditions or injuries as per specialty recommendations (e.g., ocular trauma with recommendations by Ophthalmology, orthopedic injuries with specific Aspirin recommendations).
- Exclude patients with severe coagulopathy INR ≥ 1.5 and/or platelets (PLTs) ≤ 50

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Approved Date: 04/30/2017
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12/01/2023
To be Reviewed: 12/2026

7. SPECIAL POPULATIONS
C. Emergency Blood Release for Level 1 Activations

OBJECTIVE: To have blood available for all Level 1 Trauma Activations within 15 minutes

DEFINITION: Emergency Blood Release will be defined as 2 Units Red Blood Cells

Guidelines:

1. With all Level I trauma activations, the Emergency Department Clerk notifies the Blood Bank by phone of the patient's full name and medical record number. The patient's actual (not assigned) age and sex shall also be provided to the Blood Bank as soon as possible.
2. Blood Bank staff will dispense two (2) emergency release RBC units via pneumatic tube to the trauma bay followed by a phone call to the trauma bay notifying the Trauma/Emergency Department staff of the delivery.
3. Any additional blood components may be requested by a phone call to the Blood Bank.
4. Courier will immediately arrive to trauma bay for each trauma activation. They must follow instructions by Trauma/Emergency Department and Blood Bank teams.
5. In the setting of pneumatic tube failure, the blood components will be delivered by Courier or patient care team member. A completed paper Release Form for Blood and Blood Products labeled with patient's full name and medical record number must be presented to the Blood Bank when picking up blood component(s).
6. Trauma/Emergency Department staff are responsible for retrieving the blood components from the pneumatic tube or Courier.
7. A completed Request for Emergency Release Blood / Massive Transfusion Protocol form signed by the patient's attending physician will be sent to the Blood Bank by fax or Courier. The provision of requested blood components should not be delayed while waiting for the form completion.
8. An appropriately labeled pink or purple top (EDTA) tube specimen shall be sent to the Blood Bank as soon as possible. The provider shall order a Type and Screen test through the CPOE or using the paper Request for Blood Bank Laboratory Tests form. (A second pink/purple EDTA tube shall be requested if the patient has no historical ABO type in the Blood Bank.)
9. Trauma/Emergency Department staff are responsible for sending the blood component(s) back to the Blood Bank immediately if decided by the Trauma/Emergency Department attending to be not used.

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12/2026

OBJECTIVE: To define criteria for the activation of the Massive Transfusion Protocol.

DEFINITION: Massive transfusion can be defined by any one of the following:

a. Transfusion ≥ 10 units of PRBCs in 24 hours
b. Replacement of one blood volume of the patient within 24 hours
c. Transfusion of ≥ 4 units PRBCs per hour
d. Replacement of 50% of the patient's blood volume in 3 hours
e. A rate of blood loss > 150 mL/hr.

Guidelines:

1. Factors predictive of the need for massive transfusion include high magnitude of injury, signs of active bleeding, the presence of hypotension or shock index > 1, and base deficit > 6 mMol/L.

2. The decision to activate the massive transfusion protocol can be made prior to patient arrival by the trauma team leader, the trauma surgery Attending, or the emergency medicine Attending

3. The decision to activate and terminate the massive transfusion protocol is a clinical decision that can be made based on:

    a. Clinician judgment
    b. Endpoints of resuscitation (i.e., lactate and based deficit)
    c. Rotational Thromboelastometry (ROTEM)

4. Tranexamic Acid (TXA) can be administered with the massive transfusion protocol if within 3 hours from the time of injury (1 gram loading dose given over 10 minutes, to be followed by an infusion of 1 gram over 8 hours).

Procedure:

1. Attending/Designee dials ext. 7911 and notifies the Operator to activate a Massive Transfusion Protocol. The operator shall page the Blood Bank and MTP Courier. The dispatcher shall activate the beeper with "MTP – patient location" message.

2. Attending/Designee notifies Blood Bank of the MTP activation at extension at 7610 or 7611 and provides patient's full name, medical record number, pertinent clinical information (i.e., patient diagnosis), and location/phone extension. If the patient has an alias (trauma or stroke identifiers), their actual (not assigned) age and sex should also be provided to the Blood Bank.

3. Attending /Designee shall ensure drawing of blood sample from the patient, labeled with the correct required information for the Blood Bank, and request Type and Screen test either using CPOE or paper Request for Blood Bank Laboratory Tests form.

4. MTP Courier responds to the patient location and obtains patient's demographic label(s) and, if available, appropriately labeled, completed, and signed Request for Emergency Release Blood / Massive Transfusion Protocol form, a specimen (pink or purple top EDTA tube) along with the Request for Blood Bank Laboratory Tests form for Type and Screen, which are then delivered to the Blood Bank.

5. When MTP Courier reaches the Blood Bank, they present a Release Form for Blood and Blood Products labeled with patient's full name and medical record number. They shall pick up and immediately transport two (2) units of "emergency release" RBCs from the Blood Bank to the patient location (if not already transported to the patient's location via pneumatic tube), then return to the Blood Bank. At the discretion of patient's attending, order for emergency released blood components can be repeated until arrival of MTP pack.

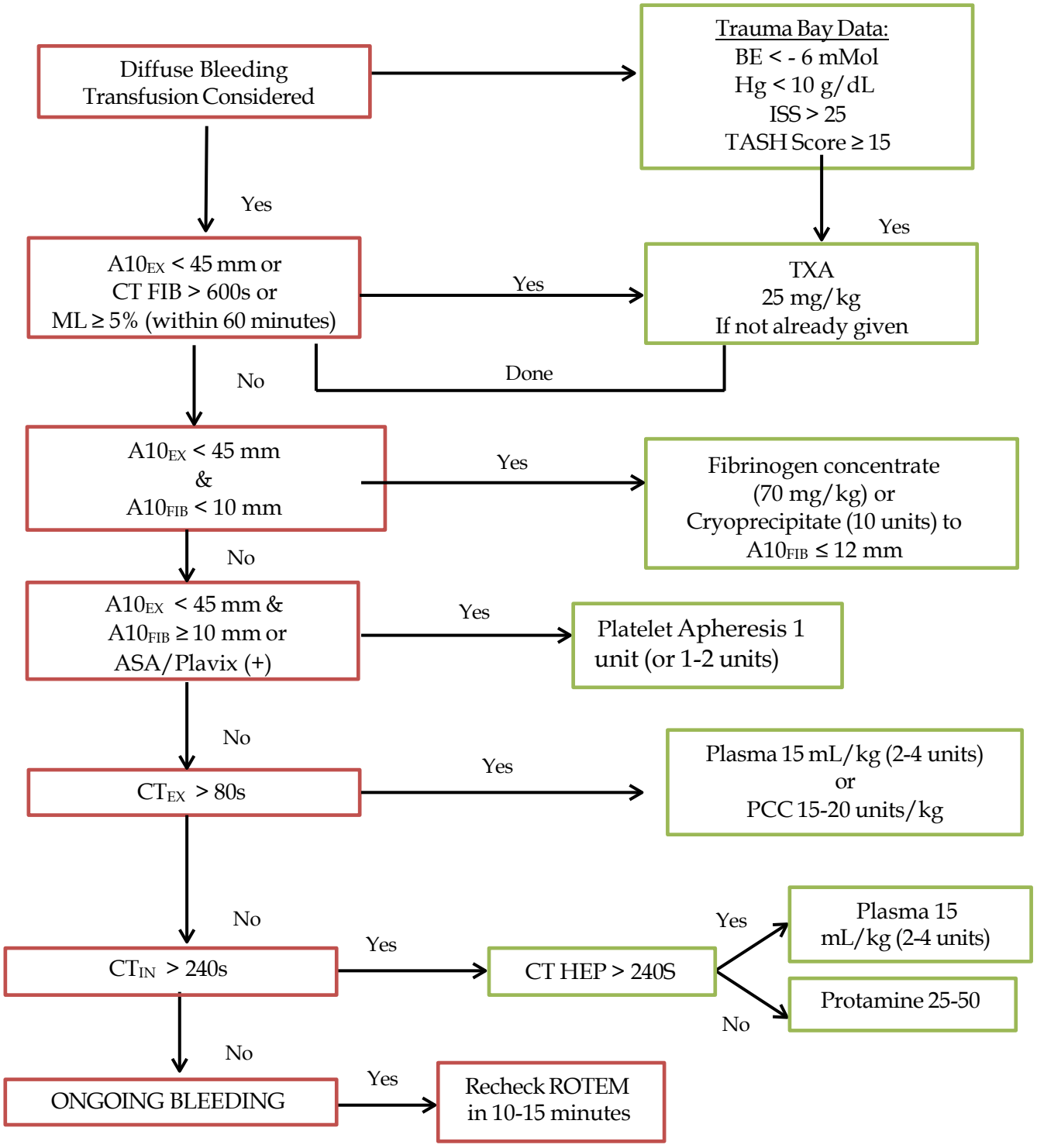
For ADULT MTP

MTP Packs	RBC Units	Plasma Units	Platelet Units	Cryoprecipitate Units	
Pack 1	6	6	1		
Pack 2	6	6	1		
Pack 3*	6	6	1	10	*10 units of cryo should be requested with every 3rd pack if MTP is expected to be continued
Pack 4	6	6	1		
Pack 5	6	6	1		

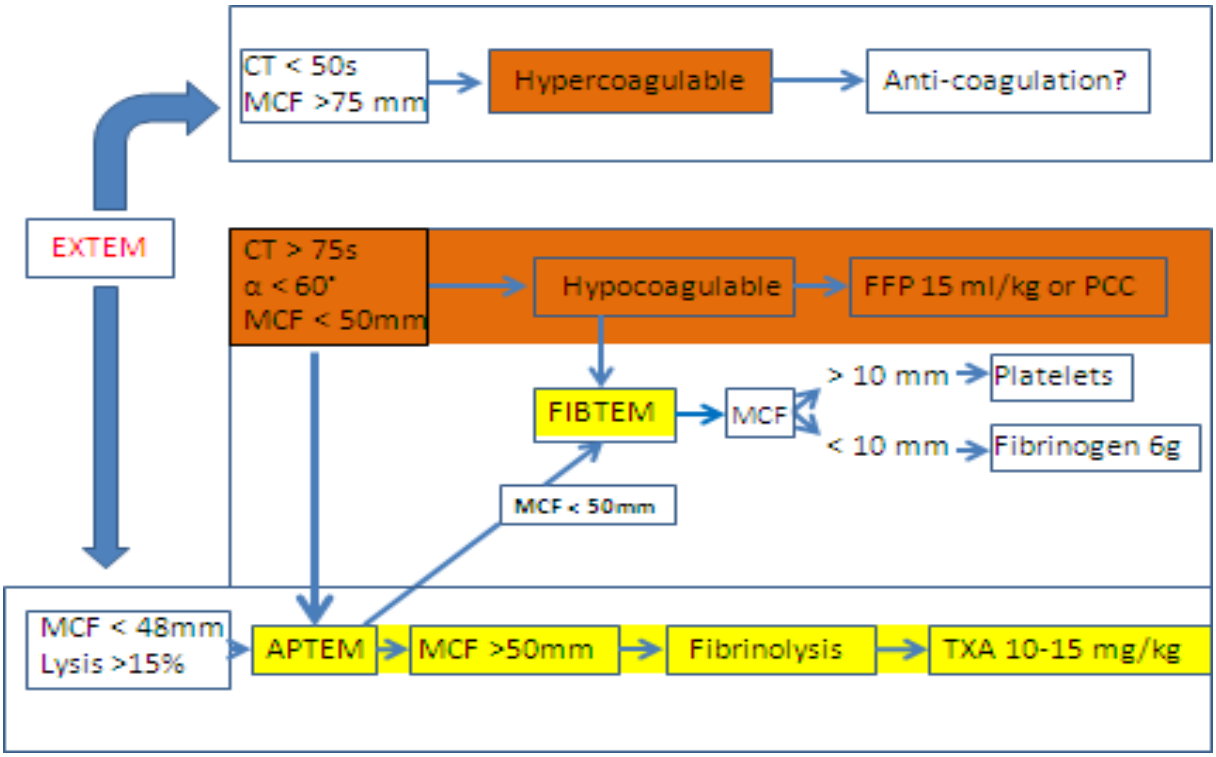
THROMBOELASTOMETRY RESULTS:

- If used and abnormal, targeted transfusion and administration of products will be performed, and the MTP may continue if desired by the Trauma Attending or TTL. If bleeding continues, Prothrombin Complex Concentrate (Kcentra) or recombinant Factor VIIa (NovoSeven) may be considered.

TRAUMA – ROTEM-GUIDED TRANSFUSION MANAGEMENT



ROTEM Guided Transfusion Management



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7. SPECIAL POPULATIONS
E. Communication in Multisystem Injured Patient

OBJECTIVES: To define guidelines for multidisciplinary management and communication of daily care plans for the multi-system injury trauma patient.

GUIDELINES:

- All patients with multi-system injury requiring interaction between multiple medical/surgical disciplines will remain under the care of the Trauma Service.
- Daily attending to attending communication will occur between all involved specialties and sub- specialties.
- Documentation of a comprehensive plan of care will be incorporated into the Trauma Attending and/ or ICU attending's daily progress note.
- Multidisciplinary Rounds, including ICU team, Trauma team, Nursing, Social Work, Case Management, Patient Advocacy, Physical and Occupational Therapy, Pharmacy, and Nutrition, will occur in the ICU to summarize daily care plans as well as discharge dispositions.

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OBJECTIVE: Provide guidelines for the admission of patients with traumatic injuries to non-surgical services.

DEFINITIONS:

Non-Surgical Services: Any admitting service other than Trauma/General Surgery, Orthopedic Surgery, Neurosurgery, Plastic and Reconstructive Surgery, or Otolaryngology

Elderly Hip Fractures: Patients with isolated hip fractures can be admitted to a non-surgical service without Trauma Consultation, with prompt evaluation/consultation by the Orthopedic Surgery service.

Patients with isolated hip fractures will be:

1. Excluded from the tabulation of non-surgical admissions
2. Included in the trauma registry
3. Tabulated each month by the trauma registry and forwarded to the Orthopedic Surgery Liaison and Geriatric Liaison for review of:
    a. Timeliness of consultation and surgery
    b. Any surgical or in-hospital complication (All complications will be discussed with the TMD, TPM, and PI coordinator and included in the PIPS process with presentation at Multidisciplinary Morbidity and Mortality Conference)

NON-SURGICAL ADMISSIONS:

Criteria:

1. Patients with traumatic brain injury will not be admitted to a non-surgical service.
2. Patients may be admitted to a non-surgical service after evaluation during a trauma activation if communicated on an Attending-to-Attending basis.
3. All patients with poly-system trauma will result in a trauma consultation at minimum prior to any potential admission to a non-surgical service.

Concurrent Review:

1. On a daily basis, the trauma registrar will obtain a list from the hospital census for all non-surgical admissions of patients with trauma diagnoses.
2. All non-surgical admissions will be reviewed daily by the TMD and TPM with respect to:
    a. Injuries
    b. Injury Severity Score
    c. Generation of trauma activation and/or trauma consultation
    d. Consultation of appropriate surgical services including timeliness of consultant response
    e. Appropriateness of non-surgical admission

3. Any non-surgical admission deemed to be inappropriate based on this concurrent review will generate:
   a. A Trauma Consultation at minimum, and if appropriate, transfer of service to the Trauma Surgery service
   b. Self-initiated Trauma Consultation based on concurrent review will be preceded by direct Attending to Attending communication between the on-call Trauma Surgeon and the non-surgical service Attending.

PI Process:

1. All non-surgical admissions will be monitored using the PIPS process.
2. In-hospital complications and mortalities will be reviewed by the TMD, TPM, and PI Coordinator and communicated to the Section Chief of Internal Medicine for review.
   a. Upon review, in-hospital complications and mortalities will be reviewed in a multidisciplinary process (PIPS).
   b. Loop Closure will be communicated and documented with the Section Chief of Internal Medicine.
3. Systematic changes in policies, protocols and guidelines pertaining to patients with trauma-related diagnoses will be communicated to the Section Chief of Internal Medicine.

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12/20/2023
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OBJECTIVE: Provide guidelines for the admission of pregnant patients with traumatic injuries.

Guiding principle:

- The best initial treatment for the fetus is the provision of optimum resuscitation of the mother and the early assessment of the fetus (level 3)
- OBGYN consult for confirmed pregnancies

1. Trauma bay procedure modifications
   A. Keep the pregnant patient with gestation > 20 weeks tilted 15 degrees left side down to remove the pregnant uterus off the vena cava and prevent supine hypotension syndrome
   B. All female patients of childbearing age with significant trauma should have a human chorionic gonadotropin (HCG) performed (level 3)
   C. Kleihauer-Betke (Fetal to Maternal RH factor incompatibility) analysis should be performed in all pregnant patients at 12 week-gestation (level 2)
   D. Pregnant wombs should be shielded from X-rays whenever possible (level 3)
   E. Recall the physiologic changes of pregnancy
      - Increased minute ventilation normally reduces $PaCO_2$ to 30, so a normal $PaCO_2$ is a sign of respiratory compromise
      - Gravid women tend towards higher heart rates but lower blood pressures and a left shift on their EKG
      - They have an increased plasma volume, allowing them to compensate longer during hemorrhage, followed by a precipitous crash
      - They have slower GI transit times and are prone to aspiration

2. Imaging
   A. All pregnant women must have an ultrasonographic examination for fetal viability and heart tones by a certified physician, preferably the on-call OB-GYN physician
   B. Consultation with a radiologist should be considered for purposes of calculating estimated fetal dose when multiple diagnostic X-rays are performed (level 3)
      - Exposure to 5 Rad (50 mGy) has not been associated with an increase in fetal anomalies or pregnancy loss and is herein deemed to be safe at any point during the entirety of gestation (level 3)
      - Radiation dose delivered on our scanner –
        - CT head: 55 mGy (due to multiple axes)
        - CT C-spine: 7 mGy
        - CT Chest: 7 mGy
        - CT Abd/Plv: 8 mGy

*Concern about possible effects of high-dose ionizing radiation exposure should not prevent medically indicated maternal diagnostic X-ray procedures from being performed (level 3)
*CT scans of the thoracoabdominal region should be preceded by shared decision-making and discussion of risks/benefits with the patient, whenever feasible, prior to performance of the test.
*Ultrasonography and magnetic resonance imaging are not associated with known adverse fetal effects. However, until more information is available, magnetic resonance imaging is not recommended for use in the first trimester (level 3)

3. Post Activation monitoring
   A. All pregnant women of 20-weeks' gestation who suffer trauma should have cardiotocographic monitoring for a minimum of 6 hours (level 3)
   B. Monitoring should be continued and further evaluation should be carried out if uterine contractions, an abnormal fetal heart rate pattern, vaginal bleeding, significant uterine tenderness or irritability, serious maternal injury, or rupture of the amniotic membranes is present (level 3)
   C. Perimortem cesarean section should be considered in any moribund pregnant woman of 24-weeks' gestation
   D. Delivery in perimortem cesarean sections must occur within 20 minutes of maternal death but should ideally start within 4 minutes of the maternal arrest

References:

1. Barraco RD, Chiu WC, Clancy TV, et al., Practice Management Guidelines for the Diagnosis and Management of Injury in the Pregnant Patient: The EAST Practice Management Guidelines Work Group, J of Trauma V69 (1) July 2010; p 211 – 214 ATLS Course Manual, 9th Ed.

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12/2026

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TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 8

Geriatric Management

OBJECTIVE: Geriatric patients continue to become an increasing proportion of trauma patients as the population ages. This and other accompanying guidelines highlight specific considerations and challenges in this population.

Trauma Activation Criteria: The following criteria pertain specifically to the geriatric population. Full activation criteria (Chapter 1).

ADULT LEVEL 1 TRAUMA ACTIVATION CRITERIA

- High Speed Collision (> 30 MPH) **with** gross injury **AND** age ≥ 65 years

ADULT LEVEL II TRAUMA ACTIVATION CRITERIA

- High Speed Collision (> 30 MPH) **without** gross injury **AND** age ≥ 65 years
- Falls ≥ 10 feet **OR** *any fall with a (+) LOC ≥ 65 years of age*

ADULT LEVEL III TRAUMA ACTIVATION CRITERIA

- Any EMS call involving a traumatic mechanism that may result in injury, but does not meet Level 1 or 2 criteria, with a low threshold to call a Level 3 if the patient is:
  - ≥ *65 years old*
  - AND/OR is taking anticoagulation (including ASA and Plavix)
- Fall from height not meeting Level 1 or 2 criteria, particularly those ≥ *65 years old*
- MVC not meeting Level 1 or 2 criteria, particularly those ≥ *65 years old*
- Pedestrian struck at low speed, particularly those ≥ *65 years old*

Frailty Assessment:

All patients ≥ 65 years of age should have their Trauma Specific Frailty Index (TSFI) documented in the admission H&P if mental status, collateral history providers, and patient status allow. This is available in Cerner with the dot phrase "*BZFraily*."

The Rib Fracture Frailty Index (RFF) may alternatively be used in patients ≥ 65 years old with the primary diagnosis of rib fractures. The RFF score can provide a predicted risk of inpatient mortality, pneumonia, mechanical ventilation, discharge to home, and prolonged hospitalization.

Considerations for Geriatric Medical Care

- Anticoagulation Management
- WMCHealth Anticoagulation Reversal Guideline
- Venous Thromboembolism Prophylaxis: for patients with traumatic injuries
- Consult Physical Therapy/Occupational Therapy
- Consult Social Worker and Case Management
- Delirium Prevention and Management:
  - Assess and address underlying triggers.
    - Medication reconciliation, address polypharmacy, Beers criteria
    - Replete electrolytes
    - Treat underlying infection (UTI, pneumonia, cellulitis, bed sores)
    - Urinary retention and constipation
    - Optimize pain control

  - Discontinue any offending medications.
  - Orient daily (date, day, and time)
  - Promote good sleep/wake cycles.
  - Avoid unnecessary nighttime disruptions unless medically needed.
  - Avoid benzodiazepines or other sedatives unless necessary.
  - Liberalize family/friends visits
  - Avoid tethering: restraints, catheters, cardiac monitor, IV lines, nasal cannula
  - Use of Antipsychotics:
    - First line: Seroquel, risperidone, olanzapine
    - Second line: Haldol, lorazepam
    - Monitor for black box warnings for above antipsychotics
- Medication Management:
  - Review home medication list and restart as appropriate
  - Review Beers Criteria list of medications
  - Ensure home medications are restarted to prevent withdrawal while discontinuing medications that may increase the risk of falling or delirium.
  - Address polypharmacy prior to discharge
- Optimize pain control
- Pressure Ulcer Prophylaxis:
  - Frequent patient repositioning, special mattresses, off-loading; refer to Pressure Injury Incision Wound tab on Cerner.
- Nutrition:
  - Consult nutrition to optimize intake (meals + supplements), consider speech/swallow evaluation to evaluate diet and need for dentures.
- Constipation:
  - Order bowel regimen for patients with or at risk for constipation.
- Miscellaneous:
  - Use vision aids and hearing aids if used at baseline—consider audiology consult if hard of hearing; consult PT/OT; liberalize visitors, especially family members; avoid urinary retention; discontinue Foley; and encourage self-voiding.

Geriatric Co-Management Consultation

Purpose: The Geriatric Trauma Co-Management Initiative was developed to optimize inpatient care of acute and chronic medical problems and to help identify, and if possible, correct underlying medical conditions that may have contributed to the trauma.

Indications:

≥ 55 years old with 2 or more medical comorbidities
≥ 55 years old with concern for a medical cause of their traumatic injury (e.g. syncope)
All patients ≥ 65 years old

Roles and Responsibilities:

1. Patients will be admitted to the surgical services with the hospitalist as a consultant. The hospitalist attending will be the "consultant." Co-management indicates that the consulting team will address

all known issues within their scope of practice as determined by training, experience, privileges, and medicolegal concerns, and have order-writing privileges regarding those issues as described below.

2. Patients will be seen daily by the consulting team and a note will be documented in chart unless prior arrangements have been made between the primary and consulting teams.
3. If the consulting team recommends subspecialty consultation, this should be communicated verbally and in writing to the primary team. The consulting hospitalist will initiate discussions with subspecialty consult teams if requested by the primary team.
4. The consulting team will contact the primary team to ensure all questions and concerns have been adequately addressed prior to 'signing off.' A final note should be placed in the chart addressing any necessary follow-up with the consulting service.

Procedure:

1. Requests for co-management will be made by entering an order for medicine consult in EMR and contacting the on-call clinician. There will be a discussion between the two clinicians about the patient's course and care, specifying the urgency of the consultation.
   a. Indications for consultation are listed above.
   b. At night, consult the medicine service and they will write a consultation and sign out to the co-management attending in the morning.
2. The primary surgical team will remain the main point of contact for nursing, pharmacy, wound care, rehabilitation services, and other services. The primary team will refer inquiries to the consulting team when that team is addressing those issues.
   - *Examples of primary surgical team duties*: ordering imaging, activity orders, routine perioperative antibiotics, wound care, routine perioperative VTE prophylaxis, advancing diet, discussing details of prognosis and biopsy results and resultant plan of care, placing orders recommended by consult service, H&P, and DC summary.
   - *Examples of hospitalist team duties*: perioperative risk stratification and risk reduction, diabetes care recommendations, assistance with medicine reconciliation, management of pre-existing comorbidities, evaluation, and management recommendations of new/emergent medical problems, timing of foley catheter removals, and central lines (in conjunction with the primary team), participation in goals of care conversations, and IDT rounds.
3. The primary team and consulting team will discuss the patient's care daily. There will be availability for attending level conversations whenever needed. At minimum, there needs to be an attending level conversation pre-op, post op, PRN complications, and pre-discharge. Consultant will attend morning report with entire Trauma team daily at 8am, round with the Surgical Attending in the morning, and with APP/house staff each afternoon and PRN.
4. New recommendations made by the consulting team will be communicated verbally to the primary team and documented in their daily note. Primary teams will notify consult teams of any major clinical status changes (e.g., canceled surgery/procedure, results of a surgery/procedure, change in level of care, etc.).
5. The consulting team will document in the medical record the anticipated discharge date (when known) and (as appropriate) recommendations for discharge medications, wound care, activity,

and appropriate follow-up care. The primary team will be responsible for discharge planning and the discharge process. Medication reconciliation for discharge not performed by the pharmacy department will be performed by the primary team. The consulting team will review prior to discharge. The consulting team will bill daily as a consultant.

6. Post-discharge clinic follow-up appointments will be coordinated by primary team for surgical follow up. Medicine-related follow-up appointments will be coordinated by the hospitalist.
7. If a Trauma or Ortho patient needs ICU services, patient will go to the Trauma ICU.
8. Clinical and operational conflicts will be addressed expeditiously by attending physicians and escalated to leadership of each group if unresolved.
9. The leadership of Internal Medicine, Trauma Surgery, and Orthopedic Surgery will determine mutually agreed upon quality and satisfaction metrics and meet quarterly to discuss progress on metrics and operational concerns. Quality metrics attached separately.
10. Until such time as the Hospitalist service has appropriate staffing for a 7/7 service, it will operate as a M-F service, with hospitalist cross coverage on the weekend. Hospitalists will sign out internally and round on the weekend at specified times.
11. Program leadership will review this document periodically and adjust as needed collaboratively

Palliative Care and Advanced Directives

Purpose: Palliative Care Service Consultation is to assist patients and families with coping, symptom management, complex medical decision-making, and goals of care/end-of-life issues. Early involvement of the Palliative Care Service has been associated with decreased interventions and ICU and hospital length of stay.

All geriatric trauma patients admitted to the ICU will have delineation of advance directives and a health care surrogate within 24 hours of admission using the appropriate WMC proxy or surrogate form.

In cases where physician determination of prognosis is not congruent with goals of care, a palliative medicine consultation will be requested within 24 hours of such determination.

OBJECTIVE: Geriatric patients continue to become an increasing proportion of trauma patients as the population ages. Geriatric hip fractures are commonly low impact energy trauma in setting of osteoporosis, frailty, or history of falls. This and other accompanying guidelines highlight specific considerations and challenges in this population.

Purpose: This is a collaborative effort between Hospital Medicine/Geriatrics, Trauma surgery, and Orthopedic surgery to streamline pre-operative risk stratification and medical optimization for OR in all patients being admitted to WMC for isolated hip fractures, and to use evidence-based guidelines for perioperative management.

Goals:

- Decrease admission to OR time; goal < 24 hours in isolated geriatric hip fractures
- Improve patient safety, decrease length of stay, and prevent post-operative complications

Rationale: AAOS guidelines recommend surgery within 48 hours for hip fractures; multiple studies have shown benefits with reduction in mortality and post-operative complications if hip fracture surgery done < 24 hours versus > 24 hours.

Admission Guidelines

Patients with isolated hip fractures can be admitted to a non-surgical service without a Trauma Service consultation. Patients ≥ 55 years of age with medical comorbidities and all patients ≥ 65 years of age will be admitted to the medicine service with orthopedic consultation. Younger and non-medically complex patients will be admitted to the orthopedic surgery service.

Emergency Department

ED providers to:

- Stabilize patient
- Labs
- Imaging
- EKG
- Consults: Ortho/ Medicine as per above admission guidelines
- The need for perioperative reversal of anticoagulants should be made at the discretion of the Orthopedic Surgery Attending (WMC Trauma Anticoagulation Reversal Guideline)

Preoperative Medical Evaluation

- Acute hip fracture surgery is considered an "urgent" surgical procedure (not emergent or elective for the purpose of this protocol) therefore should be performed within 6-24 hours
- Urgent procedures: only identify patients with unstable cardiac, pulmonary, or medical conditions that have an impact perioperatively
- Avoid diagnostic studies preoperatively that have not shown to benefit patients in the perioperative period and delay urgent surgery

Cardiac Risk Stratification and Assessment

- **Delay OR for the following cardiac conditions only + obtain 2D Echocardiogram (TTE)** and consult cardiology:
  - Active Acute Coronary Syndrome (ACS)
  - Unstable arrhythmia (Hypotension +/- Afib with RVR, SVT, sustained Vtach etc.)
  - Decompensated acute heart failure exacerbation (new or acute on chronic) with new oxygen requirement
  - Known moderate to severe aortic or mitral stenosis without an echocardiogram within the last 12 months or new murmur on examination

Pulmonary Risk Stratification and Assessment

- Preoperative testing:
  - CXR, PFT, ABG: not indicated prior to urgent hip fracture repair.
  - Routine pre-op CXR in asymptomatic patients is not indicated; if signs and symptoms of new or unstable cardiopulmonary disease (pneumonia, pulmonary edema, pulmonary embolism, COPD exacerbation) on physical exam, then can do imaging regardless of the procedure.
- Reactive Airway Disease: Asthma/COPD –
  - Medications: continue inhaled beta-agonists, anticholinergics, leukotriene inhibitors. Theophylline: check levels; consider holding due to risk of arrhythmia.
  - If acute exacerbation occurs, consider delaying surgery and treating with steroids.
- Postoperative pulmonary complications (PPC) risk indices may be utilized to indicate which patients are at risk. Screening for PPC is not mandatory and should not delay surgery.
  - ARISCAT index
  - Gupta (only pneumonia or respiratory failure)

  ➔ For patients at increased risk:

  - Recommend minimizing opioids and sedatives, initiating early and frequent mobilization and non-supine positioning while in bed, and encouraging postoperative lung expansion with incentive spirometry, deep breathing techniques, and CPAP.

Hematologic Assessment

- Anemia: adhere to a restrictive strategy for PRBC transfusion for hemoglobin < 7 g/dL

Endocrine: Diabetes

- In patient with uncontrolled hyperglycemia, evaluate for DKA/HHS and cancel/delay surgery if has DKA or has symptoms of DKA/severe dehydration.
- No HbA1c threshold should cancel or delay surgery.

Patients with Advanced Dementia

- Advanced dementia + hip fracture = poorer outcomes
- Ensure realistic expectations are set with family/proxies and involving palliative care team for goals of care discussions

Frailty

- Associated with increased mortality and postoperative complications
- Use of the Trauma Specific Frailty Index may help guide family discussions regarding treatment options and goals of care.

Considerations for Geriatric Medical Care

- Anticoagulation Management
- WMCHealth Anticoagulation Reversal Guideline
- Venous Thromboembolism Prophylaxis: for patients with traumatic injuries
- Consult Physical Therapy/Occupational Therapy
- Consult Social Worker and Case Management
- Delirium Prevention and Management:
    - Assess and address underlying triggers.
        - Medication reconciliation, address polypharmacy, Beers criteria
        - Replete electrolytes
        - Treat underlying infection (UTI, pneumonia, cellulitis, bed sores)
        - Urinary retention and constipation
        - Optimize pain control
    - Discontinue any offending medications.
    - Orient daily (date, day, and time)
    - Promote good sleep/wake cycles.
    - Avoid unnecessary nighttime disruptions unless medically needed.
    - Avoid benzodiazepines or other sedatives unless necessary.
    - Liberalize family/friends visits
    - Avoid tethering: restraints, catheters, cardiac monitor, IV lines, nasal cannula
    - Use of Antipsychotics:
        - First line: Seroquel, risperidone, olanzapine
        - Second line: Haldol, lorazepam
        - Monitor for black box warnings for above antipsychotics
- Medication Management:
    - Review home medication list and restart as appropriate
    - Review Beers Criteria list of medications
    - Ensure home medications are restarted to prevent withdrawal while discontinuing medications that may increase the risk of falling or delirium.
    - Address polypharmacy prior to discharge
- Optimize pain control
- Pressure Ulcer Prophylaxis:
    - Frequent patient repositioning, special mattresses, off-loading; refer to Pressure Injury Incision Wound tab on Cerner.
- Nutrition:
    - Consult nutrition to optimize intake (meals + supplements), consider speech/swallow evaluation to evaluate diet and need for dentures.
- Constipation:
    - Order bowel regimen for patients with or at risk for constipation.

- Miscellaneous:
  - Use vision aids and hearing aids if used at baseline—consider audiology consult if hard of hearing; consult PT/OT; liberalize visitors, especially family members; avoid urinary retention; discontinue Foley; and encourage self-voiding.

Discharge Guidelines

Osteoporosis Management

- Start calcium carbonate 1250 mg daily on discharge.
- Check Vitamin D levels and treat if deficient.
- Measure serum 25 (OH) D concentration.
  - < *12 ng/mL* (30 nmol/L):
    - Start oral vitamin D3 50,000 IU once a week for 8 weeks, then 800 IU daily.
  - ≥ *12 to* < *20 ng/mL* (30 to 50 nmol/L):
    - Start oral vitamin D3 800-1000 IU daily.
  - ≥ *20 to 30 ng/mL* (50 to 75 nmol/L):
    - Start oral vitamin D3 600- 800 IU daily.
  - If ≥ *30 ng/mL* (75 nmol/L):
    - No supplementation needed, continue with recommended dietary allowance.

Outpatient Follow up:

- PCP: follow up with their own PCP if does not have use the "Post DC Follow up appointments" role on Tiger Text to facilitate outpatient scheduling.
- Orthopedic surgery.
- Endocrine/Osteoporosis Clinic if patient has osteoporosis.

Post op Instructions:

- Weight bearing status and wound care/dressing changes will be at the discretion of the Orthopedic Surgeon.
- The Hospitalist will coordinate discharge disposition, DME, and home health aides.

References

1. AAOS Management of Hip Fractures in Older Adults Evidence Based Clinical Practice Guideline 2021
2. SHM: Management of Patients with Hip Fractures
3. UCSF Hip Fracture Protocol
4. America Geriatrics Society: Geriatrics Review Syllabus
5. UNM Hip Fracture Protocol
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PURPOSE:

- Geriatric population at higher risk of rib fractures compared to younger adults.
- Geriatric rib fractures associated with higher mortality and complications.
- For each rib fractured, mortality increases by 19% and pneumonia increases by 27%.
- Anatomical position of rib fracture is key.

GUIDELINE:

Diagnosis:

- History and Physical Exam for:
  - Underlying lung disease
  - Paradoxical motion
  - Persistent clicking/popping sound
  - Pain and cough assessment
  - Incentive spirometry
- Imaging: X-ray alone is not sufficient to define injury pattern and may miss > 50% of fractures.
  - All patients ≥ 65 years of age would have a CT chest if there is clinical suspicion for rib/sternal injury or if a fracture is demonstrated on X-ray.

Risk Assessment on Admission:

- ≥ 65 years of age with ≥ 4 rib fractures:
  - Stratified according to the presence or absence of pulmonary contusion, concomitant hemo/pneumothorax with chest tube, and/or flail chest (FC).
  - Admitted to intensive care unit
  - Treatment: Multimodal analgesia, including narcotics; evaluated by the regional anesthesia team for neuraxial block (paravertebral, erector-spinae, or epidural) if pain is not adequately controlled with enteral, topical, and parenteral analgesia.
- < 4 rib fractures or for whom > 24 hours have elapsed since the trauma:
  - May be admitted to the floor or stepdown unit at the discretion of the trauma attending.

Analgesia:

- Multimodal analgesia with scheduled acetaminophen and lidocaine patch
- Use of NSAIDs, muscle relaxants, and gabapentin are also recommended (adjust for age and renal function)
- Oral/IV opioids can also be used for moderate to severe pain (monitor for respiratory depression and constipation)
- Early Acute Pain Service Consultation is recommended for patients with severe pain, oxygen requirements, and larger numbers of rib fractures. In general, erector spinae and paravertebral catheters are preferable to thoracic epidurals for neuraxial analgesia due to an improved side effect profile without difference in efficacy. The exception may be in patients with bilateral fractures.

Non-Pharmacologic Management:

- Pulmonary hygiene is essential
    - Incentive spirometry use
    - Early ambulation/mobilization
    - Out of bed to chair
    - Physical and Occupational Therapy
    - Elevated head of bed > 30 degrees (unless contraindicated)

Palliative Care:

- All patients greater than 65 or who have a positive frailty index who are intubated for respiratory failure secondary to thoracic trauma should have a Goals of Care discussion with the ICU team and/or a Palliative Care Service Consultation as needed
- All patients admitted to the ICU for rib fractures should have goals of care and code status documented within 24 hours of admission.

Surgical Management:

- Age and/or frailty alone *is not* a contraindication to surgical stabilization of rib fractures.
- The following patients should be evaluated for surgical stabilization of rib fractures by one of the Center for Thoracic Trauma core faculty:
    - All patients with radiographic or clinical flail chest or clinical chest wall instability
    - Patients with:
        - Hospitalization with ≥ 3 severely displaced (≥ 50% of rib width) acute rib fractures AND
        - Two or more of the following pulmonary physiologic derangements (despite optimization of multimodal analgesia):
            - Respiratory rate > 20 breaths per minute
            - Incentive spirometry < 50% predicted (Attachment 3)
            - Numeric pain score > 5
            - Poor cough (as documented by respiratory therapy service)
    - An intubated patient without flail chest for which there is concern for rib fracture instability/pain limiting attempts at extubation
    - Patients with persistent clicking or popping with respiration
    - Patients requiring thoracoscopic procedures for retained hemothorax or diaphragmatic injury may be selectively considered for rib fracture fixation "on the way out"