



**Westchester
Medical Center**

Westchester Medical Center Health Network



Westchester Medical Center

**THE DIVISION OF TRAUMA,
SURGICAL CRITICAL CARE
AND ACUTE CARE
SURGERY**

**TRAUMA PRACTICE
MANAGEMENT
MANUAL**

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TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 1

INITIAL ASSESSMENT AND RESUSCITATION

1. INITIAL ASSESSMENT AND RESUSCITATION
A. Trauma Team Assignment

1. Trauma Team Leader (TTL): Surgical resident (PGY 4 or 5), fellow or PA: 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 PA: performs primary survey and secondary survey may perform/ assist with invasive procedures (central venous assess, chest tube insertion, wound explorations, etc.)
4. Primary Airway MD (PAMD): ED Attending, Anesthesia resident with Anesthesia Attending: 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 / Thermacor.
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 be 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.

1. INITIAL ASSESSMENT AND RESUSCITATION
B. Adult Trauma Activation Criteria

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 Nurse | Immediately |
| Orthopedic Resident | Immediately Available by Phone |
| Radiology Resident | Immediately Available by Phone |
| X-Ray Technician | Immediately |
| Blood Bank | Immediately Available by Phone |
| Blood Product Courier | Immediately |
| STAT Lab | Immediately Notified |

ADULT LEVEL 1 TRAUMA ACTIVATION CRITERIA

Mechanism of Injury:

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

Physiologic Criteria

- Traumatic Cardiopulmonary arrest
- GCS :S 12 OR **GCS < 14 currently taking anticoagulants (ASA and Plavix included)**
- **Any confirmed SBP :S 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 -I0
- **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 trauma injury (including inhalation injury)
- Spinal Cord injury /paralysis

Physician Discretion:

- The Emergency Department or Trauma Attending initiates a Level 1 Activation
- The Emergency Department or Trauma Attending will notify Neurosurgery Resident to respond immediately for closed/open head injuries

1. INITIAL ASSESSMENT AND RESUSCITATION
B. Adult Trauma Activation Criteria

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

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

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

ADULT LEVEL II TRAUMA ACTIVATION CRITERIA

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/snow mobile/dirt bike)
- Patient suspected of hanging

- **Physiologic Criteria:**
- GCS 13-15

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

- **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.

1. INITIAL ASSESSMENT AND RESUSCITATION
B. Adult Trauma Activation Criteria

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
Emergency RN

Immediately
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 which 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

1. INITIAL ASSESSMENT AND RESUSCITATION
C. Trauma Resuscitation: Sequential Management

Standard Trauma Resuscitation

Resource Management - Identification

Trauma resuscitation team members should identify themselves by name and roles prior to the arrival of the patient.

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 hi-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. 2 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.

**1. INITIAL ASSESSMENT AND RESUSCITATION
C. Trauma Resuscitation: Sequential Management**

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 and pelvic 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 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 TICU.

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.

Approved Date: 04/30/2013
Revised Date: 2017, 5/2/2021
To be Reviewed: 05/2024

1. INITIAL ASSESSMENT AND RESUSCITATION
D. Trauma Radiology Guidelines

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 X-Rays

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 deemed by clinical judgment to support the test
2. FACIAL CT and CEREBROVASCULAR ANGIOGRAM will not be done at the time of the initial CT traumagram without the approval of the trauma attending.
3. EXTREMITY films should be obtained for:
 - a. pain/deformity/crepitus
 - b. abnormalities in the neurovascular exam
4. CYSTOGRAPHY: Hematuria associated with pelvic fractures requires 2-view cystography with 300 cc of contrast (full and post-void). Abdomino-pelvic CT scan is the method of choice for evaluating blunt renal injury.
5. MRI
 - a. Brain: at the discretion of the Trauma Team Leader
 - b. Spinal cord: Upon approval by the Trauma Team Leader and/or Spine Consultant for gross neurologic deficit leading to a high index of suspicion
6. OUTSIDE CT/ TRANSFERRED PATIENTS: Repeat imaging will be at the discretion of the attending trauma surgeon.

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5/2/2021
To be Reviewed: 02/2024

**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 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 (eg., laparotomy, thoracotomy, neck exploration, etc.).
 - d. The approximate time that the procedure should be performed (now, 5 minutes, 15 minutes, etc.).
 - e. Blood products needs
 - f. Hemodynamic status of patient
4. The OR will be readied in the standard for all trauma patients:
 - 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 GUIDELINES

2. CLINICAL MANAGEMENT GUIDELINE
A. Airway

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

GUIDELINE: The Trauma Attending is responsible for determining the necessity of obtaining a definitive airway. The EM physician 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.

Intubation Indications:

1. Airway obstruction
2. Hypoventilation
3. Persistent hypoxemia (SaO₂ <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

Procedural Options:

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 patients airway may be used, including:
 - a. Direct laryngoscopy
 - b. Blind-insertion supraglottic devices (LMA, Combitube, King Airway)
 - c. Bougie assisted intubation
 - d. Surgical cricothyroidotomy
 - e. Fiberoptic guided intubation

2. CLINICAL MANAGEMENT GUIDELINE
A. Airway

3. Rapid Sequence intubation (RSI) is the preferred method of airway management
4. All patients are considered to have a full stomach
5. All patients are to maintain c-spine immobilization and precautions at all times.
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
8. Surgical airway should be consider if oral intubation attempts fails three times.
9. In patients with complex maxillofacial trauma, a surgical airway may be the first/best choice

Difficult Airway Management

LEMON mnemonic- Assessment tool used to recognize attributes of the difficult airway and allow for preparation in order to prevent adverse consequences. Patients with a high airway assessment score have poor laryngoscopic views compared to those patients with low airway assessment scores. Early use of video laryngoscopy for endotracheal tube placement may be beneficial in these patients.

L- Look externally (facial trauma, facial hair, large teeth, dentures, etc.)

E- Evaluate 3-3-2 rule

Incisor distance < 3 fingers, hyoid-mental distance < 3 fingers, thyroid to mouth <2 fingers

M- Mallampati score

O- Obstruction or impending obstruction

N: Neck mobility (most trauma patients will require cervical in-line stabilization)

2. CLINICAL MANAGEMENT GUIDELINE
A. Airway

Patients with higher Cormack-Lehane classification grades may require a surgical airway

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. End-tidal carbon dioxide detector/Continuous waveform capnography
- b. Auscultation of bilateral breath sounds
- 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

References:

1. Mayglothling J et al. emergency tracheal intubation in immediately following traumatic injury: An Eastern Association for the Surgery of Trauma practice management guideline. *J Trauma* 2012; 73: S333-S340.
2. Practice guidelines for the management of the difficult airway. An updated report by the American Society of Anesthesiologists task force on management of the difficult airway. *Anesthesiology* 2013; 118: 251-270
3. Wilson WC. Trauma: Airway management. ASA Difficult Airway Algorithm Modified for Trauma and Five Common Trauma Intubation Scenarios. American Society of Anesthesiologists newsletter. November 2005; 69 (11); 9-16.
4. Yentis, S.M.; Lee, D.J. (1998). Evaluation of an improved scoring system for the grading of direct laryngoscopy. *Anesthesia*. 53 (11): 1041-4
5. Wilson, WC Smith, CE. Trauma airway management. *Trauma Anesthesia*. (2008). New York Cambridge University Press 9-54

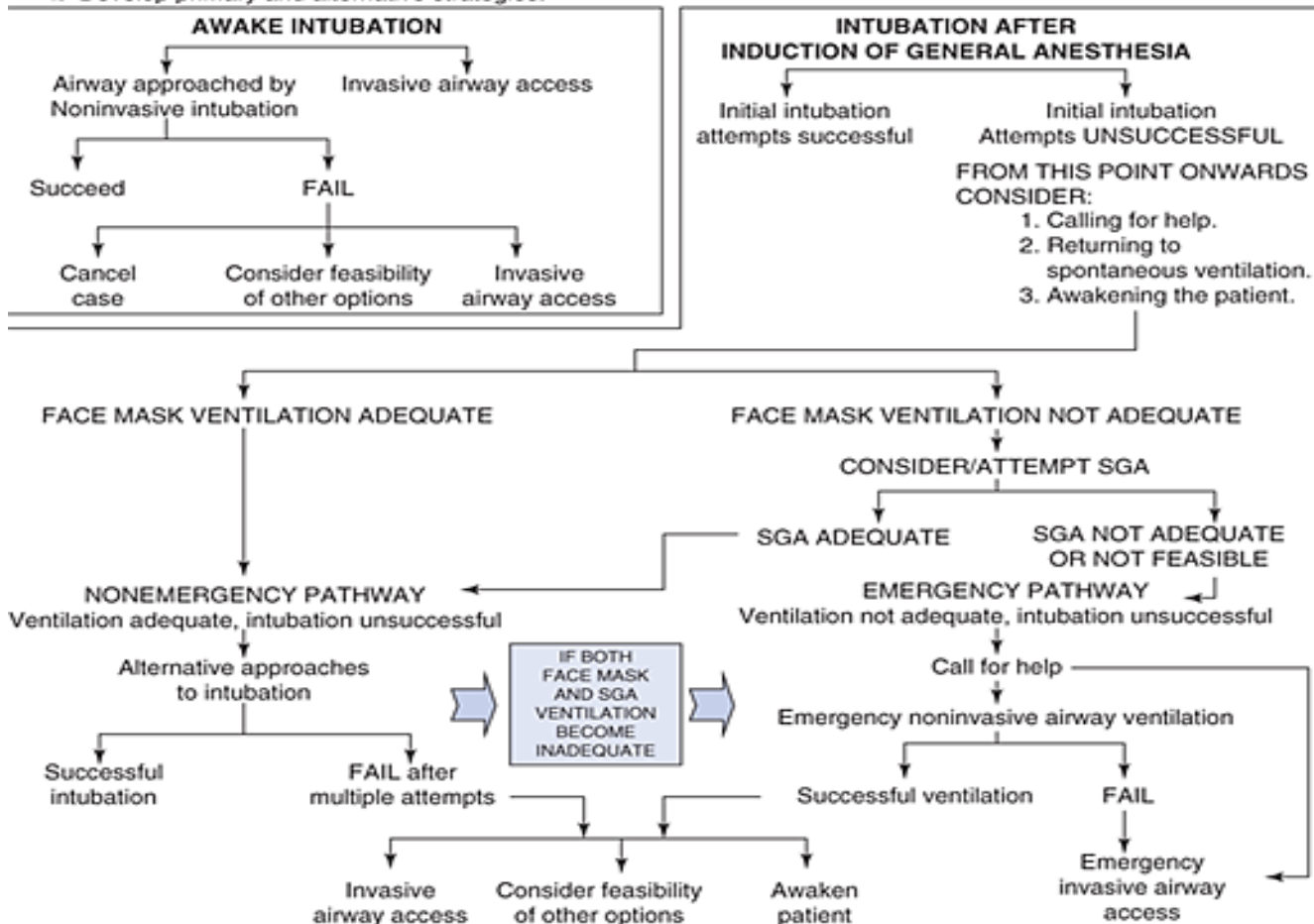
2. CLINICAL MANAGEMENT GUIDELINE
A. Airway

Supplementary Material/References:

American Society of
Anesthesiologists®
DIFFICULT AIRWAY ALGORITHM

1. Assess the likelihood and clinical impact of basic management problems:
 - Difficulty with patient cooperation or consent
 - Difficult mask ventilation
 - Difficult supraglottic airway placement
 - Difficult laryngoscopy
 - Difficult intubation
 - Difficult surgical airway access
2. Actively pursue opportunities to deliver supplemental oxygen throughout the process of difficult airway management.
3. Consider the relative merits and feasibility of basic management choices:
 - Awake intubation vs intubation after induction of general anesthesia
 - Noninvasive technique vs invasive techniques for the initial approach to intubation
 - Video-assisted laryngoscopy as an initial approach to intubation
 - Preservation vs ablation of spontaneous ventilation

4. Develop primary and alternative strategies:



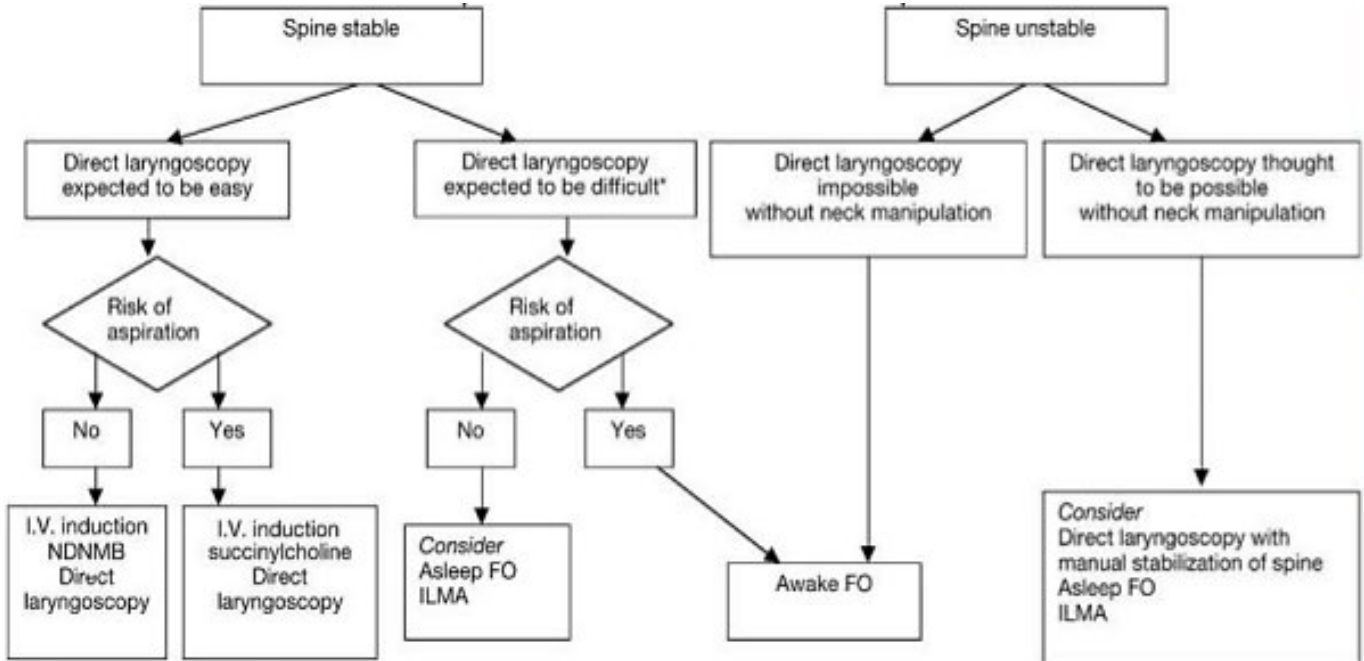
2. CLINICAL MANAGEMENT GUIDELINE
A. Airway

RSI Medications

| Medication | Drug Class | Onset | Duration | IV Dose | Side Effects |
|-----------------------------------------|---------------|------------|-------------|---------------------------------------------------------------------------------|--------------------------------|
| Premedications | | | | | |
| Atropine | Premedication | 30 min | Up to 4 hr | 0.02 mg/kg (minimum 0.1 mg, maximum 0.5 mg in children and 1 mg in adolescents) | Increased HR Mydriasis |
| Lidocaine | Premedication | 3 min | — | 1.5 mg/kg | Decreased BP |
| Sedatives | | | | | |
| Etomidate | Sedative | 5-15 sec | 5-15 min | 0.2-0.4 mg/kg | Adrenal suppression |
| Ketamine | Sedative | < 2 min | 10-15 min | 1.5-2 mg/kg | Bronchodilation |
| Propofol | Sedative | 10-20 sec | 10-15 min | 1.5-3 mg/kg | Lactic acidosis |
| Midazolam | Sedative | 1-5 min | 30-60 min | 0.1-0.2 mg/kg | Anticonvulsant Decreased RR |
| Fentanyl | Sedative | 1-2 min | 30 min | 2-4 µg/kg | Analgesia Decreased BP |
| Morphine | Sedative | 3-5 min | 4-6 hr | 0.1-0.2 mg/kg | Analgesia Decreased BP |
| Depolarizing Paralytic Agent | | | | | |
| Succinylcholine | Paralytic | < 1 min | 4-6 min | 1-2 mg/kg | Rhabdomyolysis Decreased HR |
| Nondepolarizing Paralytic Agents | | | | | |
| Rocuronium | Paralytic | < 1 min | 45 min | 1 mg/kg | Increased HR Increased BP |
| Vecuronium | Paralytic | 90-120 sec | 20-60 min | 0.15-0.3 mg/kg | — |
| Pancuronium | Paralytic | 2-5 min | 120-150 min | 0.1 mg/kg | Increased HR Increased BP |

2. CLINICAL MANAGEMENT GUIDELINE
A. Airway

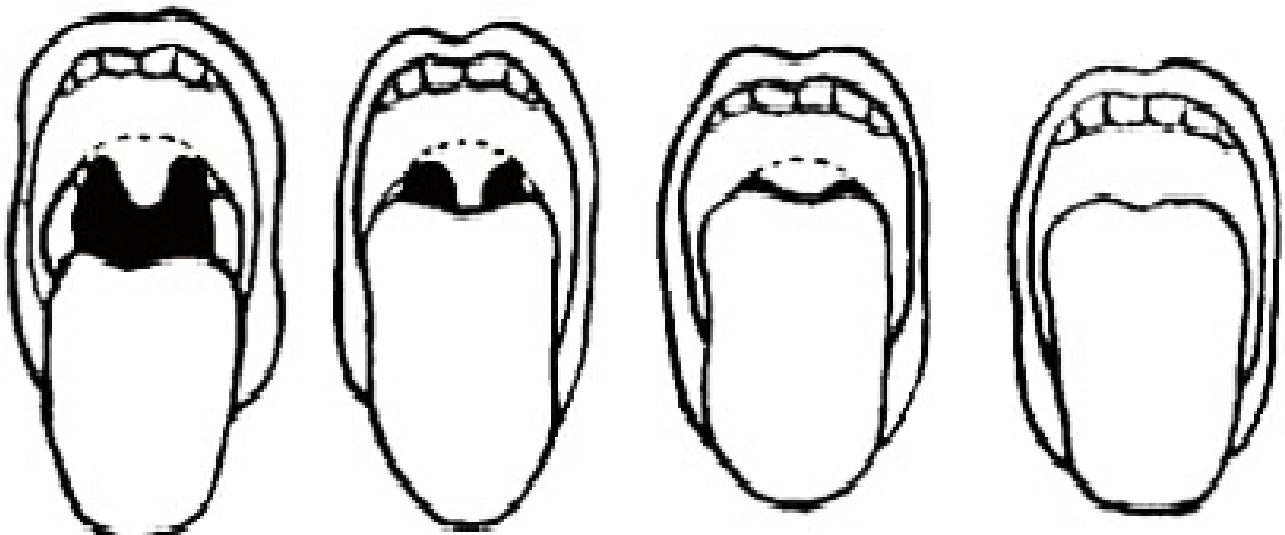
Intubation in patients with known or suspected cervical spine injury



2. CLINICAL MANAGEMENT GUIDELINE
A. Airway

Mallampati Score

| | |
|---------|---------------------------------------------|
| Class 1 | Complete visualization of the soft palate |
| Class 2 | Complete visualization of the uvula |
| Class 3 | Visualization of only the base of the uvula |
| Class 4 | Soft palate is not visible at all |

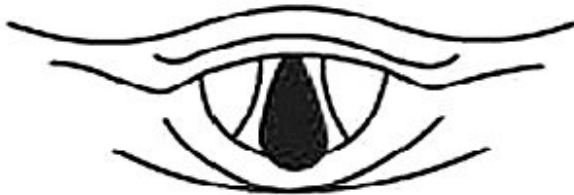


2. CLINICAL MANAGEMENT GUIDELINE
 A. Airway

Cormack-Lehane Classification:

| | |
|----------|-------------------------------|
| Grade 1 | A full view of the glottis |
| Grade 2a | Part of the cords are visible |
| Grade 2b | Only arytenoids visible |
| Grade 3 | Only epiglottis visible |
| Grade 4 | No glottis structure visible |

Grade I



Grade II



Grade III

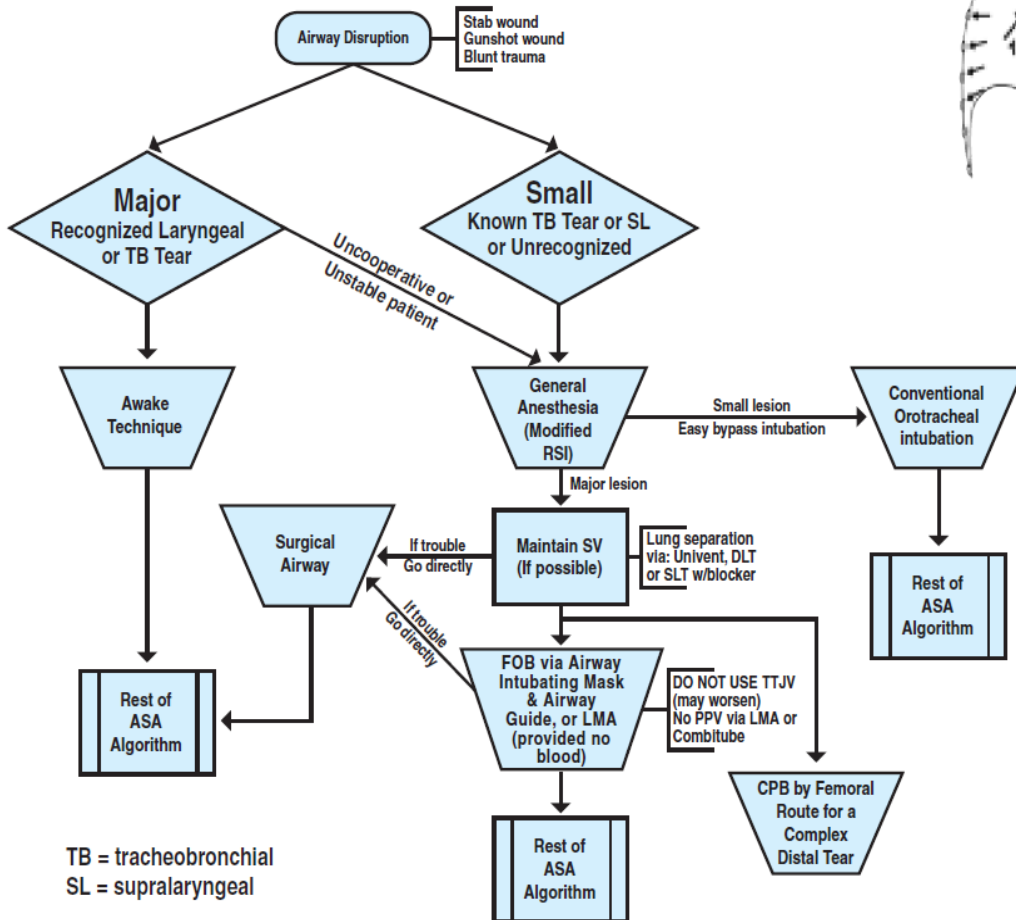


Grade IV



2. CLINICAL MANAGEMENT GUIDELINE
A. Airway

Tracheobroncheal Injury



TB = tracheobronchial
SL = supralaryngeal

Key Management Points:

- A. Maintain SV even with modified RSI technique.
- B. Get ETT below tear.
- C. Do not pressurize airway proximal to tear.
- D. No TTJV, LMA, etc.
- E. Consider DLT, Consider CPB.

2. CLINICAL MANAGEMENT GUIDELINE
A. Airway

Maxillofacial Trauma

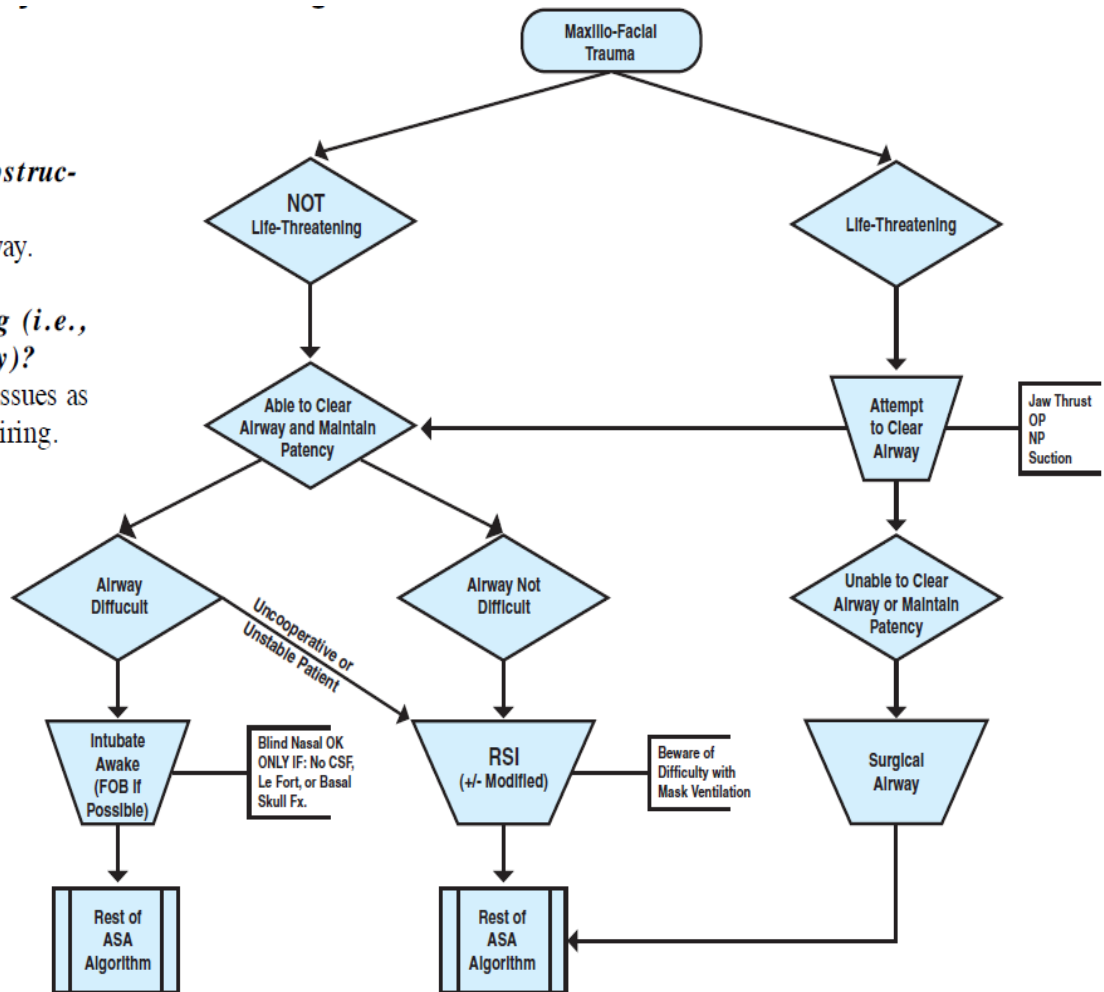
Key Questions:

Life-threatening obstruction?

If yes, surgical airway.

Not life-threatening (i.e., able to clear airway)?

Then consider DA issues as well as need for jaw wiring.



N.B. May need to convert from oral to nasal or trach later (for jaw wiring considerations).

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TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 3

HEAD AND NECK GUIDELINES

3. HEAD AND NECK
A. Cervical Spine

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 current 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 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. younger than age 65
 - b. non-dangerous mechanism of injury
 - c. normal level of alertness
 - d. no evidence of intoxication
 - e. no painful distracting injury
 - f. no focal neurologic deficit / paresthesias
 - g. no midline cervical spine tenderness
 - h. no pain on active rotation of the neck
 - i. no history of Ankylosing Spondylitis or cervical spine anomalies
 - j. no history of Rheumatoid Arthritis
2. All other trauma patients should undergo radiographic evaluation:
 - a. Axial CT scans with reconstruction should be the primary method of radiographic clearance for bony injury. Plain radiographs of the cervical spine may be a reasonable alternative for select patients with minor mechanisms of injury.
 - b. Awake patients should undergo flexion-extension films of the cervical spine if specific point tenderness / pain on range-of-motion is present and the CT scans are unremarkable.
 1. It may be reasonable to delay flexion-extension films if range-of-motion is significantly limited to less than 30 degrees.
 2. MRI may also be used to evaluate for ligamentous injury.

3. HEAD AND NECK
A. Cervical Spine

- c. 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, 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 48 hours should undergo the following studies:

- 1. Axial CT scan of cervical spine (see B.2.a. above).
- 2. An MRI of the cervical spine should be performed to rule out ligamentous injury. This should be done within 72 hours of admission, if clinically possible.
- 3. If injuries are identified using these additional studies, immobilization should be maintained and spine service should be consulted.
- 4. If no injury is identified by CT or MRI, the cervical spine should be considered to be stable and immobilization (cervical collar) may be discontinued.

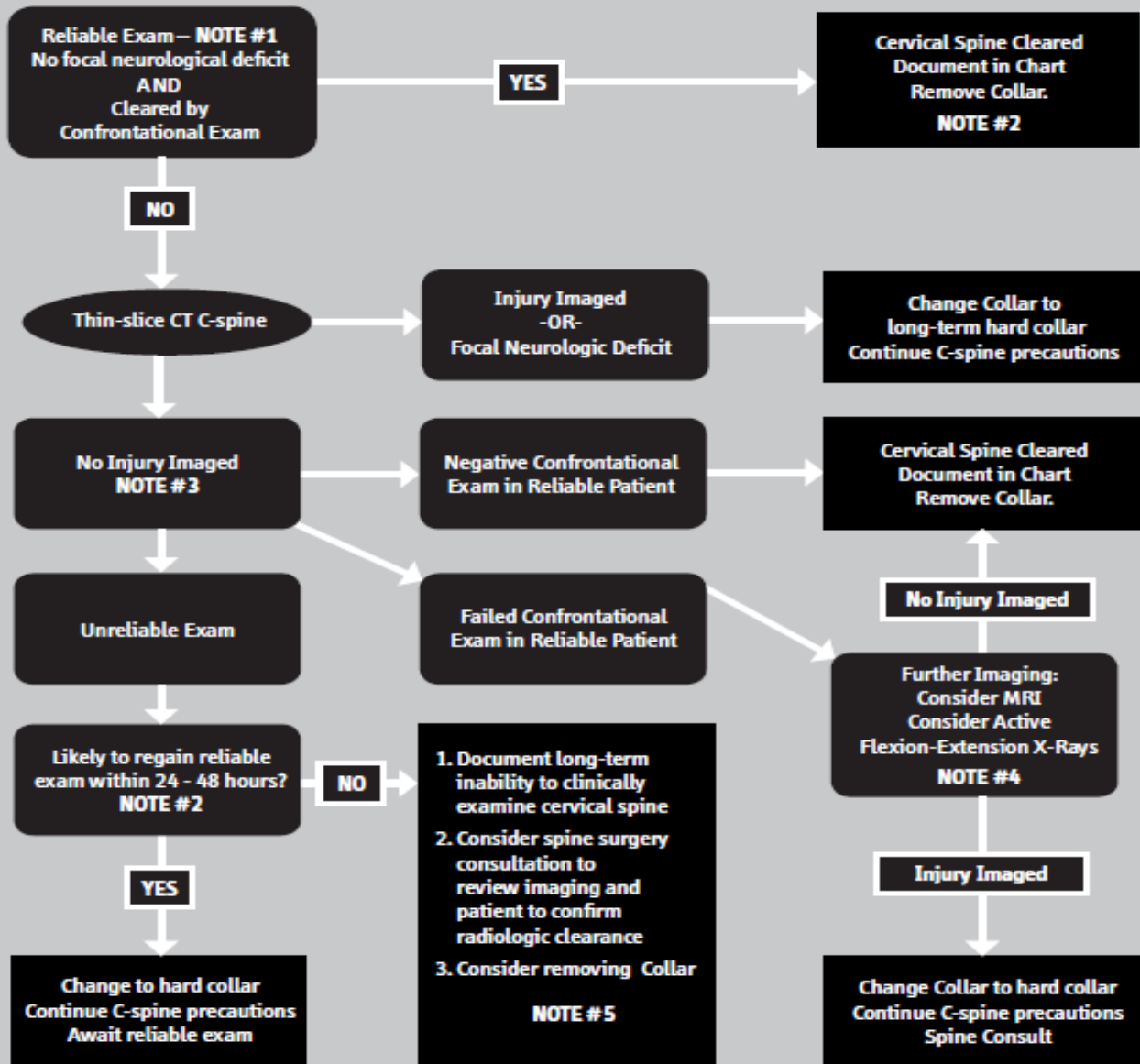
**3. HEAD AND NECK
A. Cervical Spine**

REFERENCES

1. Stiell IG, Clement CM, McKnight RD, et al. The Canadian c-spine rule versus the NEXUS low-risk criteria in patients with trauma. *NEJM* 349:2510-2518, 2003.
2. Hoffman JR, Mower WR, Wolfson AB, et al. Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. *NEJM* 343:94-99, 2000.
3. Marion D, Domeier R, Dunham CM, et al: Practice management guidelines: Determination of cervical spine stability in trauma patients - 2000 update. Eastern Association for the Surgery of Trauma. www.east.org
4. Griffen MM, Frykberg ER, Kerwin AJ, et al. Radiographic clearance of blunt cervical spine injury: Plain radiograph or computed tomography scan? *J Trauma* 55:222-227, 2003.
5. Berne JD, Velhamos GC, El-Tawil Q, et al. Value of complete cervical helical CT scanning in identifying cervical spine injury in the unevaluable blunt trauma patient with multiple injuries: A prospective study. *J Trauma* 47:896, 1999.
6. Barba C, Taggart J, Morgan AS, et al. A new cervical spine clearance protocol using CT. *J Trauma* 51:652-657, 2001.
7. Schenarts PJ, Diaz J, Kaiser C, et al. Prospective comparison of admission CT scan and plain films of the upper cervical spine in trauma patients with altered mental status. *J Trauma* 51:663-669, 2001.
8. NEW YORK STATE IN-HOSPITAL CERVICAL SPINE CLEARANCE GUIDELINES IN BLUNT TRAUMA, STAC Evaluation Subcommittee, Authors: Jamie S. Ullman, MD FACS, Matthew Bank, MD, FACS, Nelson Rosen, MD, FACS, Robert Madlinger, DO, FACOS, Palmer Q. Bessey, MD, FACS., David L. Cornell, MD

3. HEAD AND NECK
 A. Cervical Spine

APPENDIX: New York State Inpatient Cervical Spine Clearance Guidelines



3. HEAD AND NECK
 A. Cervical Spine

New York State Inpatient Cervical Spine Confrontational Exam Protocol



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3. HEAD AND NECK
B. Maxillofacial Injuries

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 followed by immediate securing of the airway.
3. **Circulation:** Severe bleeding can occur from lacerations associated with maxillofacial fractures. Scalp bleeding should be promptly controlled with a 2-0 Prolene 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 either staples or 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 should be subjected to a CTA of the head and neck to exclude blunt cerebrovascular injuries.

If the patient has multiple facial lacerations, give 1 g of cefazolin IV before repairing them (no evidence available). 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 gm IV amoxicillin clavulanate¹ (Level 3). Basilar skull fractures with or without CSF leak do not require antibiotic prophylaxis^{2,3}(Level 1).

References

1. Lauder a et al. Antibiotic prophylaxis in the management of complex midface and frontal sinus trauma. Laryngoscope 2010; 120:1940-45;
2. Villalobos T et al. Antibiotic prophylaxis after basilar skull fractures: a meta-analysis. Clin Infect Dis 1998; 27:364-369.
3. Ratilal B et al. antibiotic prophylaxis for preventing meningitis in patients with basilar skull fractures. Cochrane Database Syst Rev 2006 25 (1)

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3. HEAD AND NECK
C. Blunt Cerebrovascular Injury

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 \geq 16.

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

1. Neurologic abnormality that is not explained by the diagnosed injury
2. Epistaxis from a suspected arterial source after maxillofacial trauma
3. Near hanging with anoxia
4. Asymptomatic patients with significant blunt head trauma defined by:
 - GCS \leq 8
 - Closed head injury with diffuse axonal injury
 - Fracture of the petrous bone
 - Basilar skull fracture extending into carotid foramen
 - Cervical spine fracture with/ without fracture extending to the foramen transversarium
 - Lefort II and III facial fractures

The following grading system should be used (Denver grading system⁴):

- Grade I: Intimal irregularity or dissection < 25% narrowing
- Grade II: Dissection or intramural hematoma with \geq 25% narrowing
- Grade III: Pseudoaneurysm
- Grade IV: Occlusion
- Grade V: Transection with extravasation

Unless there are specific contraindications, BCVI are treated with antiplatelet agents or with anticoagulation. 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.

References

1. Bromberg WJ et al. blunt cerebrovascular injury practice management guidelines: The Eastern Association for the Surgery or Trauma. J Trauma 2010; 68 (2): 471-477
2. Biffi WL et al. The unrecognized epidemic of blunt carotid arterial injuries: early diagnosis improves neurologic outcome. Ann Surg. 1998; 228:462- 470.
3. Biffi WL et al. Noninvasive diagnosis of blunt cerebrovascular injuries: a preliminary report. J Trauma. 2002; 53:850-856.
4. Biffi WL et al. Treatment-related outcomes from blunt cerebrovascular injuries: importance of routine follow-up arteriography. Ann Surg. 2002; 235:699 -706; discussion 706-707. Are
5. Mutze S et al. Blunt cerebrovascular injury in patients with blunt multiple trauma: diagnostic accuracy of duplex Doppler US and early CT angiography. Radiology 2005; 237: 884-892.
6. Biffi WL et al. Blunt carotid arterial injuries: implications of a new grading scale. J Trauma. 1999; 47:845- 853.

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3. HEAD AND NECK
D. Severe Traumatic Brain Injury

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 |
| LOC | Yes/No | Yes/No | Yes/No |
| Neurologic exam | GCS \geq 14 | GCS \geq 14 | GCS \leq 13 |
| Intoxication | No | No/Yes | No/Yes |
| CAMP/DOAC | No | No | Yes |
| Skull Fracture | No | Non-displaced | Displaced |
| SDH | \leq 4mm | 5 - 7 mm | \geq 8 mm |
| EDH | \leq 4mm | 5 - 7 mm | \geq 8 mm |
| IPH | \leq 4mm, 1 location | 5 - 7 mm, 2 locations | \geq 8 mm, multiple locations |
| SAH | Trace | Localized | Scattered |
| IVH | No | No | Yes |
| Midline Shift | None or $<$ 2mm | None or $<$ 2mm | \geq 2mm |
| 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; CAMP, 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.

3. HEAD AND NECK
D. Severe Traumatic Brain Injury

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 cm³) 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.
- ICP should be avoided in patients age greater than 70.
- External Ventricular drain placement is the preferred means of monitoring ICP because of low cost, reliability and the ability to treat elevated ICP.
- 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
 - Fosphenytoin 20 mg/kg x 1 over 30 min and then 100-150 mg q 8 hours
 - Fosphenytoin levels in the high therapeutic range (15-20) are most beneficial

Keppra 1000 mg load followed by 500 mg IV/PO BID is an acceptable alternative to Phenytoin (4th Edition BTF Guidelines)

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.

3. HEAD AND NECK
D. Severe Traumatic Brain Injury

- Every patient should have a morning sedation holiday with documented neurologic exam off sedation at least every 24 hours.
- Benzodiazepines, such as midazolam or lorazepam, are Tier 3 use for refractory ICPs
- Barbiturate prophylactic use should be avoided.
- May be used only to managed refractory ICP (only after consultation with neurosurgery regarding initiating use en liu 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.
- Subcutaneous low-dose heparin (5000 units TID) or dose appropriate lovenox, may be initiated within 24 hours after stable CT Brain, unless contraindicated due to evidence of bleeding, need for surgery, is post-operative from major spinal or torso surgery or indwelling intracranial monitor with hemorrhage related to placement.

F. Nutrition:

- Tube feedings initiated within 24 hours unless contraindicated.
- If the patient is intubated and has ICP less than 9 then feedings should be started as soon as logistically available.
- 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 50-65 mm Hg.
- As a general rule, systolic blood pressure less than 200 mm Hg should not be iatrogenically reduced after TBI because this increased risk of cerebral ischemia.
- The ICH literature, which suggests a higher range of CPP as optimal, should not be extrapolated to TBI. Exceptions may be considered if there is evidence of active extravasation on imaging.
- 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 mm Hg, 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:

3. HEAD AND NECK
D. Severe Traumatic Brain Injury

- Every patient receiving hypertonic/hyperosmolar therapy needs serum sodium and osmolality order q 6 hours.
- In the absence of ICP elevation, normal serum sodium (135-145 mEq/ml) should be maintained.
- Continuous infusion of 3 or 5% 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 or 5% saline infusions that exceed a rate of 50 ml/hr must be administered via a central line. Bolus dosing of 3 or 5% 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 gm/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.

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 C
- Tylenol for T > 38.3 C, Cultures for T < 38.5 C
 - consider Arctic Sun for sustained temperature > 38.5 C not relieved with Tylenol and less invasive cooling measures.
- Warming Blanket for Temperature < 35.5 C
- Early (within 2.5 hours) or Short-Term (48 hours) prophylactic hypothermia not recommended

K. Infection Prophylaxis:

3. HEAD AND NECK
D. Severe Traumatic Brain Injury

- 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 are the most efficient means for increasing oxygen delivery if that was 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:

- PaCO₂ goal of 35-40 mm Hg unless otherwise instructed.
In patients requiring ICP monitoring consider an end-tidal CO₂ monitor.
PaO₂ goal of > 70 to 90 mm Hg (hyperoxia PaO₂ >100 can be detrimental and should be avoided)
- Do not hyperventilate patient without signs of herniation.
- Low PaCO₂ values are harmful especially in the first 24 hours of injury and when sustained. Initial target should be pCO₂ 35-40.
- Lower levels of PCO₂ can be effective in lowering the ICP but should only be targeted if there is concurrent PbtO₂ or JVO₂sat 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:

- Patients should not be treated with therapies to lower ICP prophylactically (e.g. cooling, sedation, paralysis or hyperosmolar therapy)
- ICP treatment threshold is 22 mm Hg (4th Ed BTF Guidelines)
- 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. PaCO₂/ EtCO₂ evaluation (goal 35- 40)
 4. Osmotic therapy (see Serum Electrolytes/osmolality above)
 5. If above medical management fails to lower ICP- STAT Neurosurgery notification

3. HEAD AND NECK
D. Severe Traumatic Brain Injury

- If ICP cannot be controlled, every effort should be made to maintain an acceptable CPP
- 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 less than 8 in 24 hours with CT scan demonstrating TBI.
- Early is defined as 48-96 hours of ICU admission.

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3. HEAD AND NECK
E. Reversal of Anti Platelet Agents in Traumatic Brain Injury

OBJECTIVE: To provide recommendations for the evaluation and rapid reversal of patients on clopidogrel or aspirin who present with acute traumatic intracranial hemorrhage.

GUIDELINE: Aspirin (ASA) and clopidogrel (Plavix) are used either as single agents or in combination therapy to decrease the risk of atherothrombotic events such as myocardial infarction and stroke. Patients older than 50 years on single or dual antiplatelet therapy at the time of TBI have a significantly higher mortality rate (23% versus 9% in the control group, $p = 0.016$)¹. Elderly trauma patients (>65 years) receiving clopidogrel alone have also been reported to have a higher mortality compared to a matched control group (29% versus 14%)². The presence of platelets inhibition by ASA and clopidogrel is assessed by the VerifyNow tests. The VerifyNow ASA assay utilizes arachadonic acid converted to thromboxane A2 to initiate platelet activation. The results of the ASA assay are reported as aspirin reaction units (ARU). Patients not receiving ASA or non-responders have values ranging from 550 to 700 ARU (sensitivity 91.4%, specificity 100%) in contrast, users and/or responders have values of 350 - 549 ARU³. The VerifyNow P2Y12 assay assesses the impact of clopidogrel on platelet function. This assay assesses the rate of platelet activation by ADP binding to the P2Y12 receptor. Results are reported as P2Y12 reaction units (PRU). A result of < 194 PRU is indicative of inhibition of platelet function by clopidogrel as opposed to a result of 194-418 PRU which indicates normal platelet aggregation⁴.

1. The ASA and Plavix assay should be submitted on all patients with suspected traumatic ICH.
2. Patients with known h/o of ASA/Plavix use should receive one unit of pheresis platelets after submission of blood for the ASA/Plavix assay.
3. One hour after completion of the platelets transfusion the ASA and/or Plavix assay should be repeated to check for reversal of the platelets inhibition.
 - a. Reversal achieved based on assay- repeat CT of the head in 4 hours.
 - b. Reversal not achieved- additional unit platelets transfused and a repeat assay in one hour
 - c. If reversal achieved after the second unit of platelets- repeat CT of the head immediately.
 - d. If the CT scan in this subset of patients shows progression of the ICH, DDAVP 0.3 µg/kg should be given; if conversely, there is no progression a third CT scan should be obtained in 6 hours (See attached algorithm).

References:

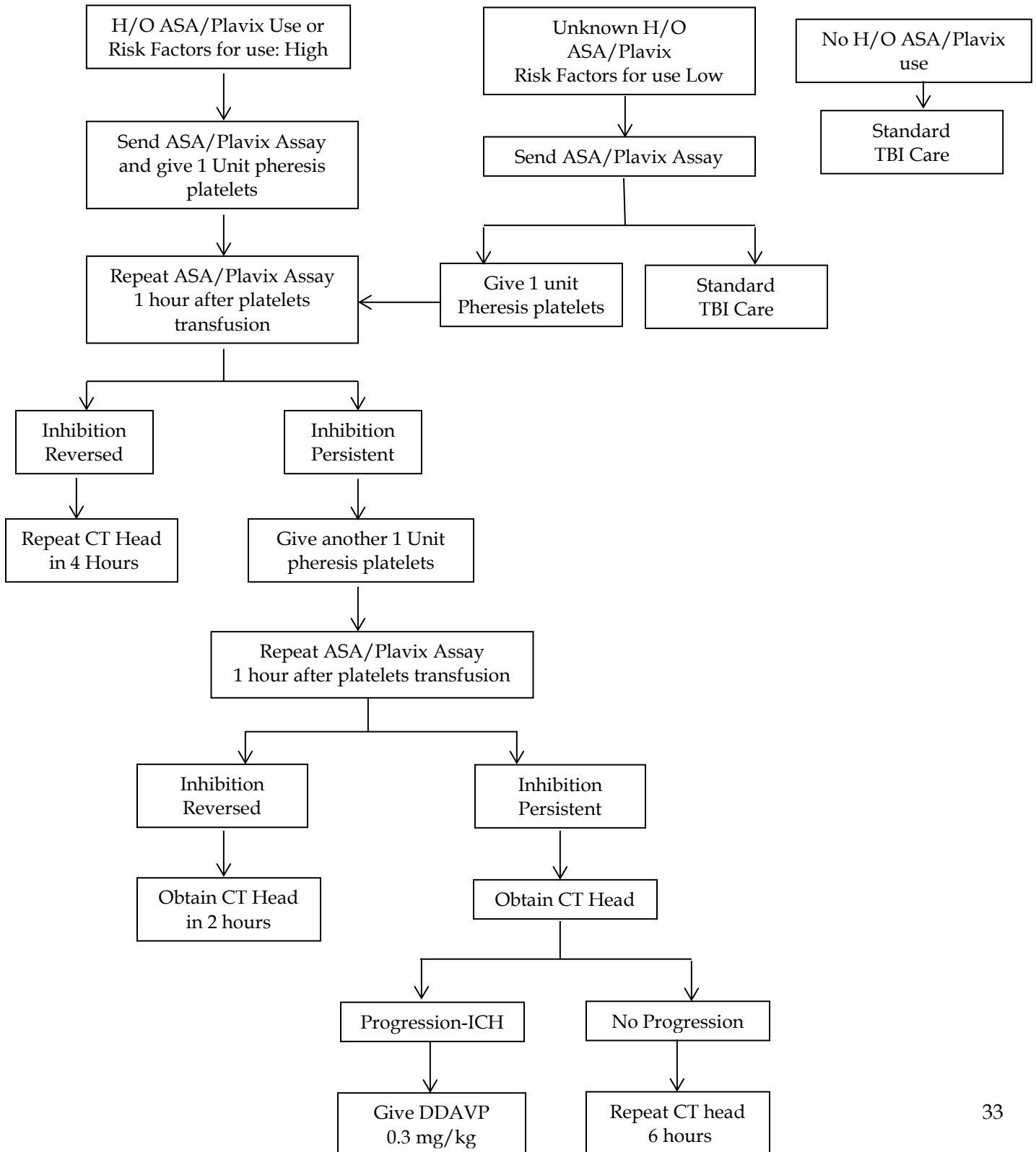
1. Ohm C, Mina A, Howells G, et.al. Effects of antiplatelet agents on outcomes for elderly patients with traumatic intracranial hemorrhage. *J Trauma*. 2005; 58: 518-22.
2. Wong DK, Lurie F, Wong LL. The effects of clopidogrel on elderly traumatic brain injured patients. *Trauma*. 2008; 65:1303-8.
3. Pakala R, Waksman R. Currently available methods for platelet function analysis: advantages and disadvantages. *Cardiovasc Revasc Med*. 2011;12(5):312-22.
4. Bansal V, Fortlage d, Lee J, et.al. A new clopidogrel (Plavix®) point-of-care assay; rapid determination of antiplatelet activity in trauma patients. *J Trauma*. 2011; 70:65-70.

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3. HEAD AND NECK
E. Reversal of Anti Platelet Agents in Traumatic Brain Injury

To be Reviewed: 02/2024

TBI-POSSIBLE PLATELETS DYSFUNCTION



3. HEAD AND NECK
F. Reversal of New Oral Anticoagulants in Traumatic Brain Injury

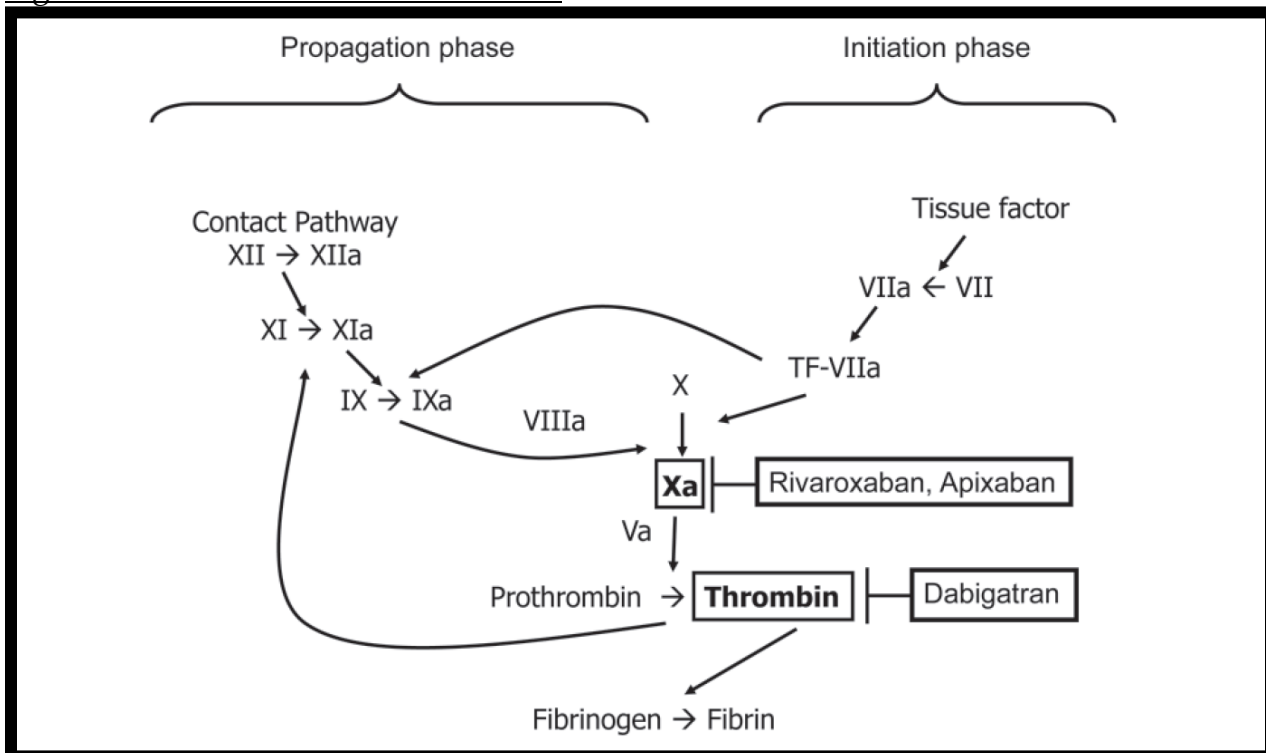
OBJECTIVE: To provide recommendations for the evaluation and rapid reversal of patients receiving the New/Non-vitamin K Oral Anticoagulants (NOACs) who present with acute life threatening hemorrhage.

GUIDELINE: Recently, new/ non- vitamin K oral anticoagulants (NOACs) have become available in the prevention of stroke as well as thromboembolism in patients; Dabigatran (Pradaxa) Thrombin Inhibitor, Rivaroxaban (Xarelto) Factor Xa Inhibitor, and Apixaban (Eliquis) Factor Xa Inhibitor (figure 1). [1] In emergent circumstances, such as intracranial hemorrhage resulting from traumatic brain injury, immediate reversal of their anticoagulation effect is necessary. Management has been challenging as effects of these agents on the coagulation profile is not defined (figure 2) and current therapeutic strategies are unpredictable and include administration of prothrombin complex (PCC), fresh frozen plasma (FFP), cryoprecipitate, vitamin K and recombinant factor VIIa or in the case of dabigatran, renal replacement therapy (figure 3) [1,2].

Currently, most authorities recommend the use of 4 factor PCC for the management of life threatening bleeding associated with NOACs [3]. A drug specific antidote, Idarucizumab (Praxbind), is currently available and is targeted to reverse the direct thrombin inhibitor, dabigatran (Pradaxa).

Future direction will involve additional drug specific antidotes currently in development. Andexanet alfa is targeted to reverse the oral direct factor Xa inhibitors as well as the indirect inhibitor, enoxaparin. Ciraparantag is a universal antidote targeted to reverse the direct thrombin and factor Xa inhibitors as well as the indirect inhibitor, enoxaparin [3].

Figure 1: Mechanism of Action NOACs



3. HEAD AND NECK
F. Reversal of New Oral Anticoagulants in Traumatic Brain Injury

Figure 2: Effects of NOACs on blood coagulation tests

| Test | Dabigatran etexilate | Rivaroxaban or apixaban |
|----------------------------------------------------------------|----------------------------------------|----------------------------------------|
| Activated partial thromboplastin time | Prolongation, variation among reagents | Prolongation, variation among reagents |
| Prothrombin time (Quick method) ^a | Prolongation | Prolongation |
| Prothrombin time (Owren method) ^a | Prolongation | Prolongation |
| Fibrinogen (Clauss method) | Moderate to marked underestimation | Minimal effect |
| Thrombin time | Marked prolongation | Minimal effect |
| Hemoclot thrombin inhibitor assay | Prolongation | Not applicable |
| International normalized ratio (point-of-care) | Elevation | Elevation? ^b |
| Activated factor X (FXa) activity | Minimal effect | Marked overestimation |
| HepTest assay for monitoring heparin in plasma and whole blood | Not applicable | Marked, dose-dependent overestimation |

Figure 3: Potential Role for Reversal

| Agent | Doses tested in human studies | Dabigatran etexilate | Rivaroxaban or Apixaban ^a |
|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|-----------------------|--------------------------------------|
| Four-factor prothrombinase complex concentrate (Beriplex, Octaplex) | 12.5 to 100 IU/kg 50 IU/kg is the only dose tested <i>in vivo</i> in humans | Possibly beneficial | Probably beneficial |
| Activated four-factor prothrombinase complex concentrate (FEIBA) | 20 to 160 IU/kg | Probably beneficial | Probably beneficial |
| Recombinant activated factor VII (Novoseven, Niasase) | 20 to 500 µg/kg | Possibly beneficial | Possibly beneficial |
| Fresh frozen plasma | Not applicable | Probably ineffective | Probably ineffective |
| Cryoprecipitate | Not applicable | Probably ineffective | Probably ineffective |
| Three-factor prothrombinase complex concentrate | No data available | No available evidence | No available evidence |
| Antifibrinolytic agents (Aminocaproic acid-Amicar; Tranexamic acid-Cyklokapron) ^b | No data available | No available evidence | No available evidence |

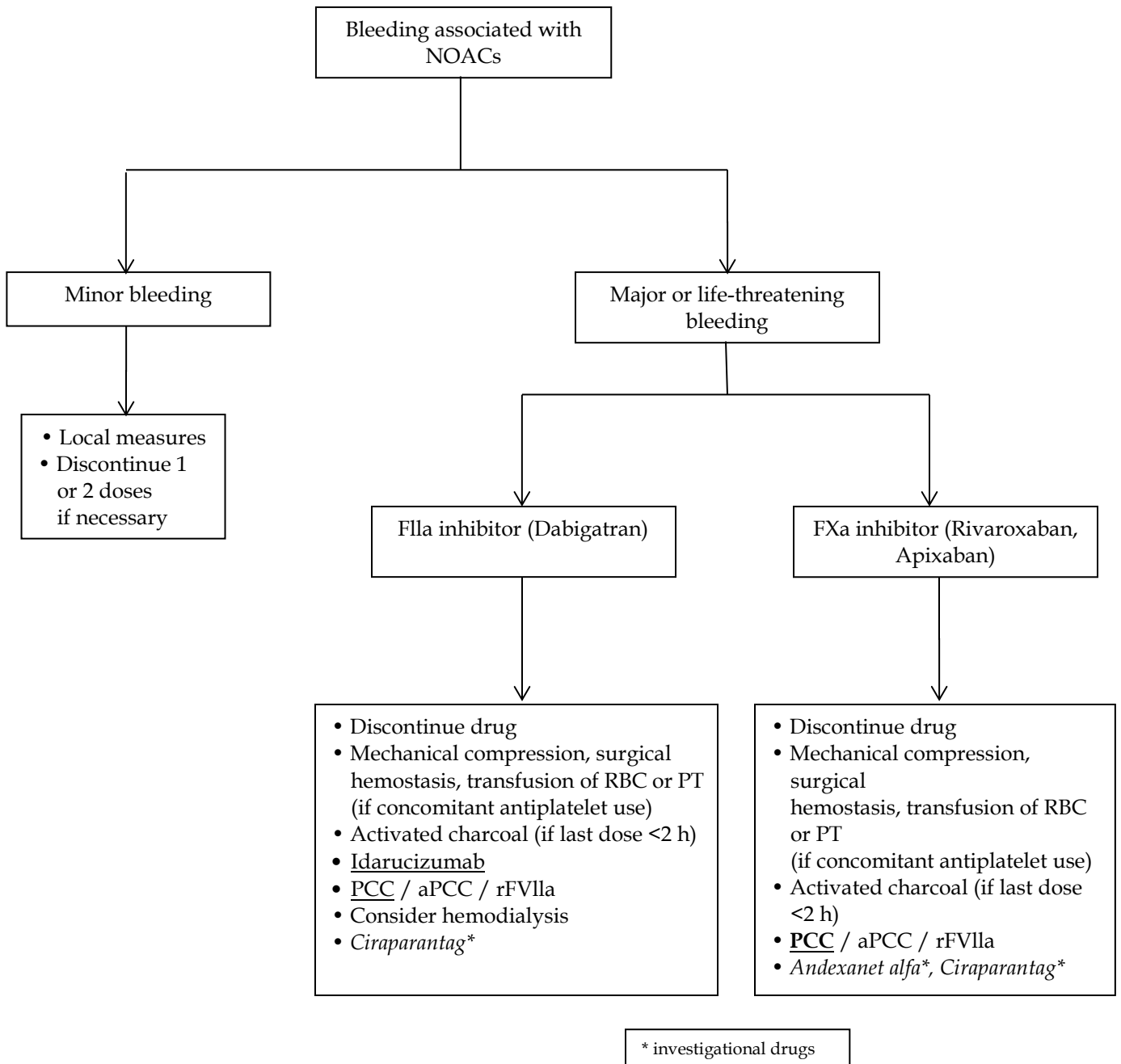
3. HEAD AND NECK
**F. Reversal of New Oral Anticoagulants in
Traumatic Brain Injury**

References:

1. Mazur MD, Sivakumar W, Taussky P, Park MS. New Reversal Agents for Oral Anticoagulants on the Horizon. *World Neurosurgery* 2015; 84:1506- 1507.
2. Enriquez A, Lip GYH, Baranchuk. Anticoagulation reversal in the era of the non-vitamin K oral anticoagulants. *Europace* 2015; 26. pii: euv030.
3. Ansell JE. Universal, class specific and drug specific reversal agents for the new oral anticoagulants. *Journal of Thrombosis and Thrombolysis*. 2016 Feb;41(2):248-52.

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3. HEAD AND NECK
F. Reversal of New Oral Anticoagulants in Traumatic Brain Injury





**Westchester
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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 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.

Disposition and Management

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 with 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). 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 TICU 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 admitted to the intensive care unit. Patients with PC and FC will be treated with epidural analgesia based on their pain rating using a combination of anesthetics and narcotics independent of their VC. Patients without PC and/or FC will be initially evaluated by assessing their VC. Patients with a VC ≥ 15 mL/kg will be initially treated with IV narcotics and lidocaine patch and they will undergo serial measurement of their VC. If the VC remains above 15 mL/kg, they'll be kept on the same analgesia regimen; if their VC decreases below 15 mL/kg, they will be transitioned to epidural analgesia.
4. All patients with multiple rib fractures showing signs of respiratory failure will be treated with high flow oxygen via nasal canula, CPAP, or BiPAP with progression to endotracheal intubation and support with mechanical ventilation as needed.
CPAP has been shown to be very effective in patients with FC by decreasing the incidence of pulmonary complications and decreasing the requirement for invasive mechanical ventilation (3). More recently, Gunduz, in a prospective randomized control trial comparing patient-controlled analgesia with CPAP to endotracheal intubation for patients with FC has shown improved survival and a decreased incidence on nosocomial infection in the patients treated with CPAP (4) (Level 1).

4. THORACIC INJURY
A. Rib Fractures

5. Patients with flail chest but without pulmonary contusion requiring mechanical ventilation will be considered on an individual basis for rib plating (Level 3).
6. Patients with survivable injuries who have severe respiratory failure will be evaluated for extracorporeal membrane oxygenation (ECMO).

References

1. Simon BJ et al. Pain management guidelines for blunt thoracic trauma. J Trauma 59 (5):1256-1267, 2005
2. Simon BJ et al. Management of pulmonary contusion and flail chest: An Eastern Association for the Surgery of Trauma practice management guideline. J. Trauma 73: s 351 - s361, 2012.
3. Tanaka H et al. pneumatic stability sedation for flail chest injury: An 11 year study. Surg Today 31: 12-17, 2001.
4. Gunduz M et al. A comparative study of continuous positive airway pressure and intermittent positive pressure ventilation in patients with flail chest. Emerg Med J 22 (5): 325-329, 20

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4. THORACIC INJURY
B. Occult Pneumothorax

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 between 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. 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 require placement of either a pigtail catheter or a small size CT.^{2,3}

References:

1. MA de-Moya et al: Occult Pneumothorax in Trauma Patients: Development of an Objective Scoring System J Trauma 1999;46:987-990
2. Moore FO et al: Blunt Traumatic Occult Pneumothorax: Is Observation Safe? Results of a Prospective, AAST Multicenter Study J Trauma 2011; 70:1019 - 1025
3. Wolfman NT et al: Validity of CT Classification on Management of Occult Pneumothorax: A Prospective Study AJR 1998; 171: 1317 - 1320

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September 13, 2021

To: Trauma Faculty

General Surgery Residency Program (Program Director: Jorge Con, MD)

Surgical Critical Care Fellowship Program (Program Director: Peter Rhee, MD)

Advanced Practice Providers, Section of Trauma and Acute Care Surgery (Faculty

Supervisor: Matthew Bronstein, MD)

Re: Tube Thoracostomy for Traumatic Hemothorax

Dear All,

As discussed in the Morbidity and Mortality Conference at the Section of Trauma and Acute Care Surgery weekly conference, the September 2021 Multidisciplinary Trauma M&M, and the Department of Surgery Monthly Kaizen conference, the patient with MR # 1786633 sustained a severe complication after pigtail insertion for traumatic hemothorax.

The patient was elderly with severe cardiomegaly, and placement of an inferiolateral pigtail catheter into the thoracic cavity resulted in a penetrating injury to the heart requiring emergent thoracotomy and cardiorrhaphy.

Based on this complication, the Section of Trauma and Acute Care Surgery will require that all tube thoracostomies for traumatic hemothoraces be performed after cutdown of the chest wall and finger thoracostomy to ensure that catheters are placed into a cleared area of the pleural space free of adhesions and vital organs, with appropriate direct supervision by credentialed providers.

Please do not hesitate to contact us with any questions or concerns.

Sincerely yours,

Kartik Prabhakaran, MD MHS FACS
Trauma Medical Director
Westchester Medical Center
Associate Professor of Surgery
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Peter Rhee, MD MPH FACS FCCM
Chief, Section of Acute Care Surgery and Trauma
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4. THORACIC INJURY
C. Treatment of Hemothorax From Blunt Trauma

OBJECTIVE:

To define a standardized modality for the treatment of blunt traumatic hemothorax (HTX).

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 space⁶.
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; if the patient is penicillin allergic, 600 mg of clindamycin IV².
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 = $d^2 \times L$) schedule VATS procedure prior to day seven³.
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/24hrs ⁴.

References

1. Does size matter? A prospective analysis of 28–32 versus 36–40 French chest tube size in trauma. JOT 2011; 70:510-518
2. Presumptive antibiotic use in tube thoracostomy for traumatic hemopneumothorax: An Eastern Association for the Surgery of Trauma practice management guideline JOT 2012; 73: S341-S344
3. Practice Management Guidelines for Management of Hemothorax and Occult Pneumothorax. JOT 2012; 72: 11-24
4. Volume Threshold for Chest Tube Removal: A Randomized Controlled Trial. J Injury Violence Res. 2009 July; 1(1): 33-6.
5. When to Remove a Chest Tube? A Randomized Study with Subsequent Prospective Consecutive Validation. JACS 2002; 195: 658-662.
6. A Pilot Study of Chest Tube versus Pigtail Catheter Drainage of Acute Hemothorax in Swine. Journal of Trauma and Acute Care Surgery 2015; 79: 1038–1043.

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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 measure ≥ 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 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 ABC’s 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. Extremely high blood pressures should be treated with a short acting intravenous beta-blocker (e.g., esmolol).
 4. Obtain a CTA of the chest since as it is very sensitive and specific for the diagnosis of TAI¹. If the CTA of the chest shows mediastinal blood or aortic disruption contact immediately the cardiothoracic service to determine whether there is a BAI 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).

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

6. The following are recommended clinical treatment guidelines for the management of BAI based of UW experience²:
- A. All patients with radiographic evidence of BAI should undergo anti-impulse therapy with β -blockade, if tolerated, coupled with antiplatelet therapy (81 mg aspirin) for low grade injuries.
 - B. Observation alone with interval follow-up CTA within 30 days is appropriate for all IT's less than 10 mm.
 - C. Management of LIF's 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. In patients with TAI, endovascular repair should be performed rather than open to minimize mortality, stroke, paraplegia and renal failure when technically feasible³.
 - 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.
 - I. Patients with severe TBI and an aortic external contour abnormality should be considered for earlier repair.

References

1. Dyer DS, et al. Thoracic aortic injury: how predictive is mechanism and is chest computed tomography a reliable screening tool? A prospective study of 1,561 patients. J Trauma. 2000; 48: 673-82.
2. Starnes BW et al. A new classification scheme for treating blunt aortic injury. JVS 55 (1); 47-54, 2012.
3. Evaluation and management of blunt traumatic aortic injury. A practice management guideline from the Eastern Association for the Surgery of Trauma. JOT 2015; 78: 136-146

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4. THORACIC INJURY
E. Management of Blunt Cardiac Injuries

OBJECTIVE:

To define the diagnosis and management of blunt cardiac injury.

Definition:

Blunt cardiac injury (BCI) includes a spectrum of injury 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

4. THORACIC INJURY
E. Management of Blunt Cardiac Injuries

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 ST or T wave abnormalities and patients who are hemodynamically unstable should be evaluated with a transthoracic echo or a transesophageal echo.
3. Patients with ischemic changes on the EKG and elevated cardiac enzymes are treated similarly to patients with acute MI.
4. Asymptomatic cardiac arrhythmias and dysfunction usually resolves within 24 hours. Cardiology should be consulted at the discretion of the attending trauma surgeon.

4. THORACIC INJURY
E. Management of Blunt Cardiac Injuries

References

1. Schultz JM et al. Blunt cardiac injury. Crit Care Clinic 20(1): 57-70, 2004
2. Roy-Shapira A et al. blunt cardiac injury. J Trauma 37; 59 -61,1994
3. Velhamos G, et al. normal electrocardiography and serum troponin I levels preclude the presence of clinically significant blunt cardiac injury. J Trauma 54: 45-51, 2003
4. Rajan G et al. Cardiac troponin I as a predictor of arrhythmia and ventricular dysfunction in trauma patients with myocardial contusion. J Trauma 57: 801-808, 2004
5. Clancy K et al. Screening for blunt cardiac injury: An Eastern Association for the Surgery of Trauma practice management guideline. J Trauma 73: S301-S306, 2012

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4. THORACIC INJURY
F. Clearance of Thoracic and Lumbar Spine

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 radiographs 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 > or equal to 10 feet
 - Ejection from motor vehicle in crash > or equal to 50 mph
 - GCS < or equal to 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.

4. THORACIC INJURY
F. Clearance of Thoracic and Lumbar Spine

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. 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 <24h 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 faculty.

References:

1. Sheridan R, Peralta R, Rhea J, et al. Re-formatted visceral protocol helical CT scanning allows conventional radiographs of the thoracic and lumbar spine to be eliminated in the evaluation of blunt trauma patients. J Trauma 55:665-669, 2003.
2. Hauser CJ, Visvikis G, Hinrichs C, et al. Prospective validation of CT screening of the thoracolumbar spine in trauma. J Trauma 55:228-235, 2003.
3. Brandt MM, Wahl WL, Yeom K, et al. CT scanning reduce cost and time of complete spine evaluation. J Trauma 56:1022-1028, 2004.

4. THORACIC INJURY
F. Clearance of Thoracic and Lumbar Spine

4. Gestring ML, Gracias VH, Feliciano MA, et al. Evaluation of the lower spine after blunt trauma using abdominal CT scanning supplemented with lateral scanograms. *J Trauma* 53:9-14, 2002.
5. Meldon SW, Moettus LN. Thoracolumbar spine fractures: Clinical presentation and the effect of altered sensorium and major injury. *J Trauma* 39:1110-1114, 1995.
6. Frankel HL, Rozycki GS, Ochsner MG, et al. Indications for obtaining surveillance thoracic and lumbar spine radiographs. *J Trauma* 37:673-676, 1994.

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4. THORACIC INJURY
G. Management of Patients with Spinal Cord Injury

OBJECTIVE:

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

Definitions:

Spinal shock: it is defined as 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: it refers to the contraction of the anal sphincter in response to squeezing of the glans of the penis in man, 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 injury 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 to 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: it is 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: this is a hemicord injury with ipsilateral motor paralysis and 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.

4. THORACIC INJURY
G. Management of Patients with Spinal Cord Injury

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 ABC's.
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 subsequently, if needed with norepinephrine titrated to maintain a MBP at 80-90mmHg^{3,4}.
6. Obtain CT scan of the C and TLS spine.
7. Activate the Spine Service
8. Admit to TICU
9. Be aware of pulmonary dysfunction in quadriplegics⁵ (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 O₂
11. Obtain PM&R consult early for referral to SCI Rehabilitation Centers

4. THORACIC INJURY
G. Management of Patients with Spinal Cord Injury

References:

1. Tator CH. Vascular effects and blood flow in acute spinal cord injuries. *J Neurosurg Sci.* 1984; 28(3-4):115-119.
2. Tator CH, Fehlings MG. Review of the secondary injury theory of acute spinal cord trauma with emphasis on vascular mechanisms. *J Neurosurg.* 1991; 75(1): 15-26.
3. Management of acute spinal cord injuries in an intensive care unit or other monitored setting. In: *Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery.* 2002; 50(3 Suppl):S51-S57.
4. Blood pressure management following acute spinal cord injury. In: *Guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery.* 2002; 50(3 Suppl):S58-S62.
5. Como JJ et al: Characterizing the need for mechanical ventilation following cervical spinal cord injury with neurologic deficit. *J Trauma* 2005; 59(4): 912-916.

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4. THORACIC INJURY
H. Penetrating Thoracic Injury

OBJECTIVE:

To provide a guideline 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 ABC's 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 suffered cardiac arrest and has had signs of life (e.g., pulse, EKG activity, cardiac activity on the FAST) at any time (< 10 minutes before arrival) or is in extremis with low blood pressure, proceed directly to a left antero-lateral resuscitative thoracotomy in the 4th 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 ~~≥ 36~~ CF chest tube on the side where breath sounds are absent. If there is no improvement place another chest tube on the opposite ~~hemothorax~~ side. Signs of tension PTX/HTX include:
 - a) Absent breath sounds
 - b) Distended neck veins.
 - c) Shift of the trachea.
5. Hemodynamic instability can be due to massive HTX (one hemothorax can contain ~ 3,000 ml of blood). Signs of massive HTX include:
 - a) Absent breath sounds on the affected side.
 - b) Dullness to percussion the on affected side.
 - c) Distended neck veins.
6. Obtain a CXR.
7. 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 ≥ 200 ml/hr for ≥ 3 hours.

4. THORACIC INJURY
H. Penetrating Thoracic Injury

- c) Massive air leak causing loss of $\geq 40\%$ of TV.
8. 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.
- Unstable patient- OR for **left** anterolateral thoracotomy (preferred) or median sternotomy.
 - Stable patient- perform the subxiphoid portion of the FAST/ Ultrasound for the presence or absence of cardiac effusion – remember- FAST is inaccurate when there is a hemothorax on CXR.
 - If positive **pericardial** FAST, take the patient to the OR for a subxiphoid pericardial window and/or median sternotomy.
 - FAST negative for effusion with negative CXR (no hemothorax)- observation in CDU.
 - FAST negative and CXR with hemothorax- 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.

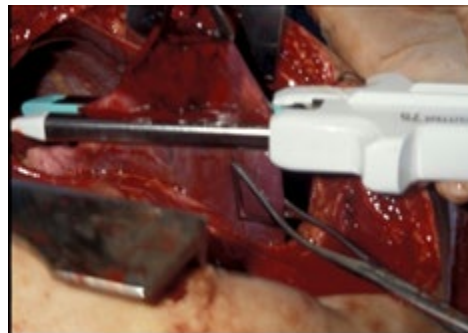
- The diagnosis of tracheobronchial injury is made based on clinical and radiological findings and it is confirmed by bronchoscopy.
- Most injuries should be approached through a right thoracotomy over the 5th rib since the majority of injuries are within 2.5 cm of the carina.
- Left main stem bronchial injuries > 3 cm distal to the carina are best approached through a left posterolateral thoracotomy.
- A dual lumen endotracheal tube (Carlen or Robert Shaw) should be used for intubation.
- 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.

4. THORACIC INJURY
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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 his hemodynamic instability, includes single lung ventilation or independent lung ventilation with small TV for the non-injured lung and jet ventilation of the injured lung. If necessary, extracorporeal veno-venous membrane oxygenation can be done.

Lung parenchyma⁶:

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 ligation of the bleeding vessels with 3-0 Prolene sutures.
3. Most lung injuries that require thoracotomy can be treated via a anterolateral-lateral thoracotomy, 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.

Esophagus⁷:

Esophageal injuries are rare. They are usually caused by penetrating injuries. The approach to the upper and middle thoracic esophagus is via a right postero-lateral thoracotomy in the 4th or 5th ICS, whereas the approach to the lower third is via a left postero-lateral thoracotomy in the 6th ICS. Primary repair in two layers with buttressing with pleural/pericardial flap or muscle flap should be done in all injuries < 24 hours. If necessary, you can use a diaphragmatic flap.

4. THORACIC INJURY
H. Penetrating Thoracic Injury

Great vessels⁸:

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.

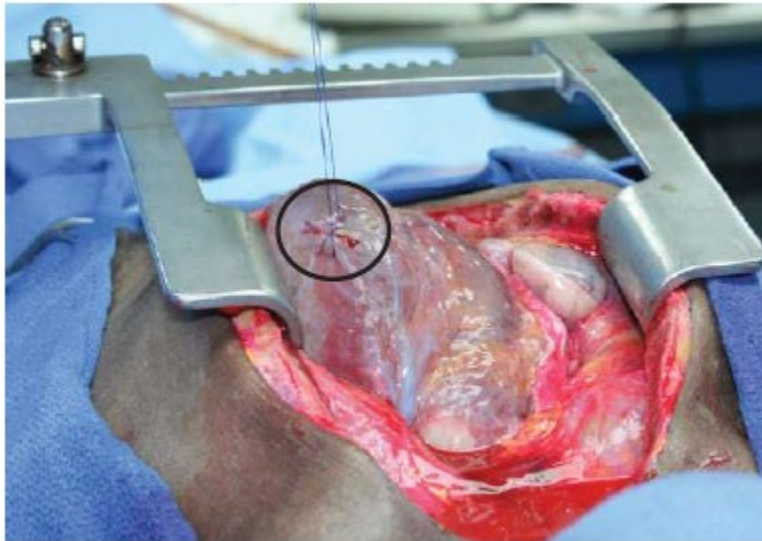
Cardiac⁹:

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

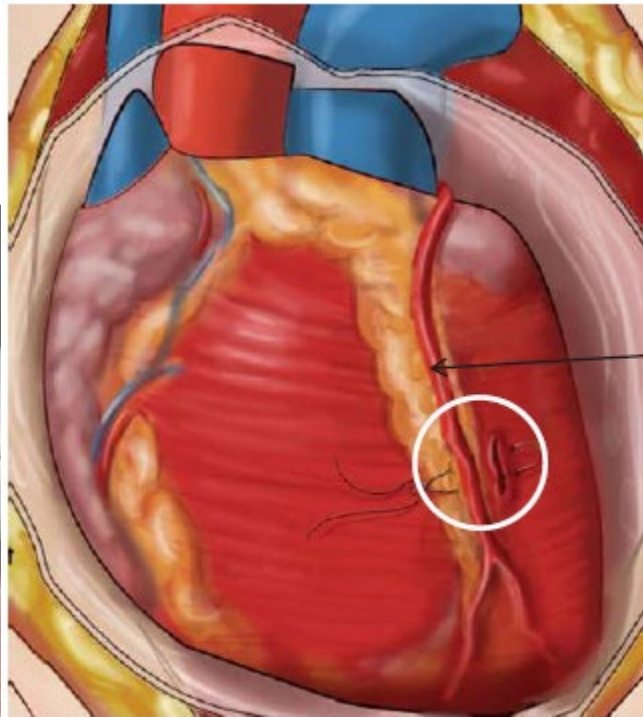
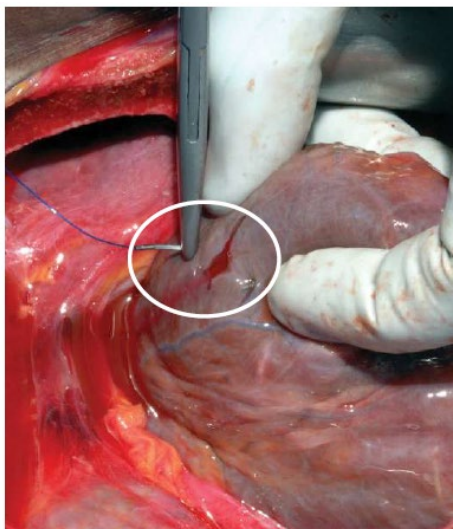
Atrial wounds can be controlled rapidly with a Satinsky clamp and then oversewn with a running 3-0 Prolene suture as shown below.



4. THORACIC INJURY
H. Penetrating Thoracic Injury



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 pledgets, if necessary. Initial control can be obtained with placement of skin staples. 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 below.



4. THORACIC INJURY
H. Penetrating Thoracic Injury

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.

References:

1. Miglietta MA et al: Current opinion regarding indications for emergency department thoracotomy. J Trauma 2001; 51(4):670-6.
2. Ivatury RR et al: Directed emergency room thoracotomy: a prognostic prerequisite for survival. J Trauma 1991; 31(8):1076-81.
3. Bleetman A et al: Review of emergency thoracotomy for chest injuries in patients attending a UK Accident and Emergency department. Injury 1996; 27(2):129-32.
4. Rhee PM et al: Survival after emergency department thoracotomy: review of published data from the past 25 years. J Am Coll Surg 2000; 190(3):288-98.
5. Branney SW et al: Critical analysis of two decades of experience with post-injury emergency department thoracotomy in a regional trauma center. J Trauma 1998; 45(1):87-94
6. Petrone P, Asensio JA. Surgical treatment of penetrating pulmonary injuries. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine 2009, 17:8
7. Asensio JA, Chahwan S, Forno W, et al. Penetrating esophageal injuries: multicenter Study of the American Association for the Surgery of Trauma. J Trauma 2001; 50(2):289-96.

4. THORACIC INJURY
H. Penetrating Thoracic Injury

8. Demetriades D. Penetrating injuries to the thoracic great vessels. *J Card Surg* 1997; 12 (2):173-9.
9. Asensio JA, Stewart BM, Murray J, et al. Penetrating cardiac injuries. *Surg Clin North Am* 1996; 76(4):685–724.
10. “Section 5: Chest.” *Atlas of Surgical Techniques in Trauma*, by Demetrios Demetriades et al., Cambridge University Press, 2020.

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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 travelling at altitude 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 (eg, 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. It is for this reason, that patients with traumatic PTX scheduled to fly must be instructed on the most recent accepted guidelines: Air Transport Committee Guidelines¹ and Level II evidence by Cheatham and Safcsak².

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.

References

1. Air Transport Medicine Committee, Aerospace Medical Association. Medical Guidelines for Air Travel. Av Space Environ Med Practice
2. Cheatham ML, Safcsak K. Air Travel Following Traumatic Pneumothorax: When Is It Safe? Am Surg 1999; 65:1160-1164.

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**Westchester
Medical Center**

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TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 5

ABDOMINAL INJURY

5. ABDOMINAL INJURY
A. Management of Splenic Injury

OBJECTIVE: Define therapeutic guidelines for the non-operative management of splenic injuries.

Guidelines: The following guideline to the non-operative management (NOM) of patients with splenic injuries apply to patients who are either hemodynamically stable on arrival or become hemodynamically stable and hemodynamically normal after the infusion of two liters of crystalloids, score 0-2, using the hemodynamic instability score shown in Table 2. Unstable patients (score 3-5) should have a FAST examination done after the initial ABCs. Patients who stabilize with initial volume loading and require modest ongoing resuscitation (score 3) may be triaged to the CT scanner if readily available. Score 3 patients who are FAST (+) are presumed to have a hemoperitoneum. FAST (+) patients who require vigorous ongoing resuscitation (score 4 and 5 instability) should be triaged to the OR. Angioembolization (AE) cannot be considered a valid treatment option for patients with splenic injury with hemodynamic instability.

Table 1
Grading System

| GRADE | Injury Type | Injury Description | ICD-9 | AIS-90 |
|-------|-------------|-------------------------------------------------------------------------------------------------------------------------|------------------|--------|
| I | Hematoma | Subcapsular, <10% surface area | 865.01 | 2 |
| | Laceration | Capsular tear < 1cm parenchymal depth | 865.11 | 2 |
| II | Hematoma | Subcapsular, 10-50% surface area Intraparenchymal, 5cm in diameter | 865.01 | 2 |
| | Laceration | Capsular tear, 1-3 cm parenchymal depth Not involving trabecular vessel | 865.12 | 2 |
| III | Hematoma | Subcapsular > 50% surface area or expanding; ruptured subcapsular or parenchymal hematoma > % cm or expanding. | 865.03 | 3 |
| | Laceration | >3cm depth or involving trabecular vessels | 865.13 | 3 |
| IV | Laceration | Laceration involving segmental or hilar vessels producing devascularization (<25%) | 865.04 865.13 | 4 |
| V | Laceration | Completely shattered spleen | 865.04 | 5 |
| | Vascular | Hilar vascular injury with devascularized spleen | 865.14 | 5 |

5. ABDOMINAL INJURY
A. Management of Splenic Injury

Table 2
Definition of Hemodynamic Instability Score [1]

| SCORE | Definition |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0 | No SBP < 90 mmHg or HR > 130 |
| 1 | Report of SBP < 90 mmHg by EMS but no hypotension in TB |
| 2 | SBP > 90 mmHg and/or HR > 130 responsive to initial volume loading (30 ml/kg) with no need for ongoing fluid resuscitation or transfusion of PRBC. |
| 3 | SBP < 90 mmHg and HR > 130 responsive to initial volume loading (30 ml/kg) with modest ongoing fluid requirement (< 250 ml/hr) or transfusion of PRBC |
| 4 | SBP < 90 mmHg or HR > 130 only responsive to volume loading (30 ml/kg) and ongoing infusion of > 250 ml/hr and transfusion of PRBC |
| 5 | Hypotension unresponsive to volume loading and transfusion of PRBC |

Guidelines: Grade I-III without contrast blush (CB)

Patients with Grade I-III splenic injury with or without hemoperitoneum and without contrast blush (CB) on contrast CT scan will be admitted to the ICU for a 24-48 hour period of observation. They will be kept at bed rest, undergo hourly monitoring of VS, serial abdominal examination every four hours and Hct check every 6 hours. DVT prophylaxis will be provided with venodynes. They will be kept NPO during the first 24 hours observation. If they remain hemodynamically normal with stable Hct, they will be transferred to the floor on day 2. On day 2, they will remain on bed rest, on clear liquid diet and they will receive DVT chemoprophylaxis with UFH 5,000 U SC every 8 hours. On day 3 they will be allowed to ambulate, have bathroom privileges, and diet will advanced to regular. On day 4, they will be discharged.

Discharge instructions:

1. Solid organ injury card to carry at all times
2. No return to school for one week
3. No physical education activity for six weeks
4. No contact sport for three months (soccer, football, basketball, hockey, etc)
5. Contact immediately discharge Trauma Attending for:
 - I. Dyspnea
 - II. Abdominal pain
 - III. Dizziness
 - IV. Hypotension
 - V. Syncope

5. ABDOMINAL INJURY
A. Management of Splenic Injury

Grade I-III with contrast blush (CB)

Hemodynamically stable patients with Grade I-II splenic injury with a CB < 1cm will be observed. They will undergo AE of proximal main splenic artery (PMSAE) or selective distal splenic artery embolization (SDSAE) if their Hct decreases requiring the transfusion of >1 unit PRPCs. Hemodynamically stable patients with Grade I-II splenic injury with CB > 1cm and patients with Grade III splenic injury with CB of any size will undergo AE with one or both modalities.

Grade IV

Patients with Grade IV splenic injury:

a. Hemodynamically stable and normal without contrast blush with minimal/moderate hemoperitoneum

These patients should be admitted to the ICU for at least 72 hours. They should have hourly monitoring of their VS, serial abdominal examinations every four hours for the first 24 hours and serial Hct every 6 hours for the first 24 hours. They should be kept at bed rest, NPO, on IV fluids at a maintenance rate (LR) and have only venodynes for DVT prophylaxis. If they have a significant decrease in Hct requiring the transfusion of >2 Units of RPCs, they should undergo Angioembolization even if the angiogram does not show a specific bleeding site. If they develop peritoneal findings, they should undergo trauma laparotomy and splenorrhaphy or splenectomy as deemed appropriate by the trauma attending.

On day 4, Grade IV splenic injury patients including those who have had AE, if hemodynamically stable, with stable Hct, can be transferred to the floor. A clear liquid diet and DVT chemoprophylaxis can be started with UFH 5,000 U SC every 8 hours. Lab work will be obtained once/day and ambulation with bathroom privileges will be allowed. Diet will be advanced to regular as tolerated with discharge planning on day 5.

Discharge instructions:

1. Solid organ injury card to carry at all times
2. No return to school for one week
3. No physical education activity for six weeks
4. No contact sports for three months (soccer, football, basketball, hockey, etc)
5. Contact immediately discharge Trauma Attending for:
 - I. Dyspnea
 - II. Abdominal pain
 - III. Dizziness
 - IV. Hypotension
 - V. Syncope

5. ABDOMINAL INJURY
A. Management of Splenic Injury

b. Hemodynamically stable without contrast blush but with large hemoperitoneum

These patients should be admitted to the ICU for at least 48 hours. They should have hourly monitoring of their VS, serial abdominal examinations every four hours for the first 24 hours and serial Hct every 6 hours for the first 24 hours. These patients should undergo AE as soon as feasible. They should be kept at bed rest, NPO, on IV fluids at a maintenance rate (LR) and have only venodynes for DVT prophylaxis. Post AE, care is same as above (grade IV a.)

c. Hemodynamically stable with contrast blush

These patients should undergo AE immediately as the failure rate of NOM of these patients can be decreased from 23% to 3% with preemptive AE. Post AE, care is same as above (grade IV a.)

d. Hemodynamically unstable patients but responders to two liters of crystalloids (grade 2 hemodynamic instability score) with and without CB

These patients should undergo AE since the failure rate of NOM of these patients can be decreased with preemptive AE. Post AE, care is same as above (grade IV a.)

Grade V

a. Hemodynamically stable with or without CB or without hemoperitoneum

These patients should undergo AE immediately since the failure rate of NOM of these patients can be decreased from 63% to 9% with PMSAE. Post AE, care is same as above (grade IV a.)

Immunization:

While the incidence of overwhelming post-splenectomy sepsis (OPSS) is low (0.5%), it continues to have a mortality as high as 50%¹¹. Therefore, trauma patients who have undergone splenectomy or have undergone angioembolization, which has resulted in high degree of the de-vascularization of the spleen (residual functional spleen < 51%), should undergo immunization to prevent the development of infection by encapsulated organisms such as *Streptococcus pneumoniae*, *Haemophilus influenzae* type b, *Neisseria meningitidis* (Level 3). It is suggested that post-splenectomy immunization be done two weeks post-splenectomy or when the patient is considered to be immunocompetent.

5. ABDOMINAL INJURY
A. Management of Splenic Injury

References:

1. Moore FA, McKinley BA, Moore EE, et al. Inflammation and the Host Response to Injury, a large-scale collaborative project: patient-oriented research core-standard operating procedures for clinical care. III. Guidelines for shock resuscitation. *J Trauma*. 2006; 61:82-89.
2. Haan JM, Bochicchio GV, Kramer N, Scalea TM. Nonoperative management of blunt splenic injury: a 5-year experience. *J Trauma*, 2005; 58: 492-498.
3. Blunt Splenic Injuries: Have We Watched Long Enough? *J Trauma* 2008; 64: 656-655.
4. Harbrecht BG, Ko SH, Watson GA, Forsythe RM, Rosengart MR, Peitzman AB. Angiography for blunt splenic trauma does not improve the success rate of nonoperative management. *J Trauma*. 2007;63:44-49.
5. Nonoperative Management of Adult Blunt Splenic Injury With and Without Splenic Artery embolotherapy: A Meta-Analysis. *J of Trauma* 2011; 71:898-903
6. Hann JM, Matmery H, Shanmuganathan K, Mirvis SE, Scalea TM. Experience with splenic main coil embolization and significance of new or persistent Pseudoaneurysm: Reembolize, operate, or observe, *J Trauma*, 2007; 63:615-619.
7. Refining the role of splenic angiographic embolization in high-grade splenic injuries. *J Trauma* 2013; 74: 100-104.
8. Prognostic factors for failure of nonoperative management in adults with blunt splenic injury: A systematic review. *J Trauma* 2013; 74: 546-557.
9. Rutherford EJ et al. Efficacy and safety of pneumococcal revaccination after splenectomy for trauma. *J Trauma*. 1995; 39:448-452.
10. Shatz DV et al. Antibody responses in postsplenectomy trauma patients receiving the 23-valent pneumococcal polysaccharide vaccine at 14 versus 28 days postoperatively. *J Trauma*. 2002; 53:1037-1042.
11. Shatz DV et al. Antibody responses in postsplenectomy trauma patients receiving the 23-valent pneumococcal polysaccharide vaccine at 1 versus 7 versus 14 days after splenectomy. *J Trauma*. 1998; 44(6):760-766.

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5. ABDOMINAL INJURY
B. Management of Liver Injury

OBJECTIVES: Define therapeutic guideline for the non-operative management (NOM) of liver injuries. Outline a step-wise approach to the operative management of liver injuries.

Liver Injury Grading

- Grade I: Capsular avulsion; Parenchymal fracture <1 cm deep
- Grade II: Parenchymal fracture 1-3 cm ; Subcapsular hematoma <10 cm in diameter; Peripheral penetrating wound.
- Grade III: Parenchymal fracture >3 cm ; Subcapsular hematoma >10 cm; Central penetrating wound
- Grade IV: Lobar tissue destruction; Massive central hematoma
- Grade V: Retrohepatic vena cava injury; Extensive bi-lobar disruption
- Grade VI: Hepatic avulsion

GUIDELINES:

1. Patients who are hemodynamically unstable and/or who have diffuse peritonitis should be taken directly to the OR for laparotomy (Level 1).
2. Angioembolization may be considered as first line therapy for patients who are transient responders to resuscitation as an adjunct to operative intervention (level 2).
3. The severity of liver injury (CT grade) or the amount of hemoperitoneum, the neurologic status of the patient, age > 55 and/or the presence of associated injuries are not absolute contraindications to a trial of NOM in the hemodynamically stable patient (Level 2).
4. Patients with a contrast blush from liver injury should undergo AE regardless of their hemodynamic status (Level 2).
5. Patients with grade ≥ 3 liver injury with increasing abdominal pain, jaundice or rising bilirubin may have a biliary leak, biloma or bile peritonitis; therefore, they should undergo a biliary scan (100% sensitive and specific for the diagnosis of biliary leak)². If there is a large leak, they should be treated with ERCP, biliary stenting and PC drainage (Level 3). If there is diffuse peritonitis they should undergo laparoscopic abdominal washout.
6. Patients with significant increases in AST and ALT should undergo re-evaluation by CT scan.
7. AE may be associated with the development of cholecystitis.
8. Time to healing and return to contact sports remains dependent of type and grading of injury (subcapsular hematoma vs. lacerations). Reported median time to healing³:
 - Grade I hematoma: 6 days
 - Grade II hematoma: 16 days
 - Grade III hematoma: 108 days
 - Grade II laceration: 29 days
 - Grade III laceration: 34 days
 - Grade IV laceration: 78 days

5. ABDOMINAL INJURY
B. Management of Liver Injury

9. DVT pharmacologic prophylaxis can be initiated within 24-48 hours of injury in the absence of on-going bleeding (Level 3).
10. Patients with Grade I and II liver injury will be monitored in the ICU for 24-48 hours.
11. Patients with Grade III or higher liver injury will be monitored in the ICU for 72 hours.

NOM Summary:

Grade I and II liver injury:

1. Draw serial Hg/Hct q 6h x 2; if stable stop getting serial Hg/Hct.
2. Allow ambulation
3. Start on po diet.
4. Discharge on day 3

Grade III or higher:

1. Monitor hourly vital signs until normal (e.g., pulse < 100/min) X 3.
2. Bed rest for two days
3. NPO.
4. Draw serial hematocrit and hemoglobin every 6 hours until stable (within 2 %) X 2.
5. When hematocrit is stable and there have been no adverse hemodynamic events:
 - Transfer to regular floor.
 - Advance diet.
 - Hematocrit and hemoglobin daily.
 - Liver enzymes and bilirubin on day 2 to help rule out biloma. If bilirubin elevated, consider a HIDA scan to rule out bile leak.
6. Discharge on day 4

Discharge Instructions:

For grade I and II

1. No school/ work for one week
2. No physical education and contact sports for 6 weeks
3. Follow up in Trauma Clinic in 2 weeks from discharge
4. Return to ED for:
 - Worsening abdominal pain
 - Fever
 - Jaundice
 - Hematemesis

5. ABDOMINAL INJURY
B. Management of Liver Injury

For grade III or higher

1. No school/ work for 2 weeks
2. No contact sport for 3 months
3. Follow up in Trauma Clinic in 2 weeks after discharge
4. Return to ED for:
 - Worsening abdominal pain
 - Fever
 - Jaundice
 - Hematemesis

References

1. Stassen NA et al. Nonoperative management of blunt hepatic injury: An Eastern Association for the Surgery of Trauma practice management guideline. J Trauma 73: S 288-S293, 2012
2. Wahl WL et al. Diagnosis and management of bile leaks after blunt liver injury. Surgery 138: 742-48, 2005
3. Tiberio Ga et al. Evaluation of the healing time of non-operatively managed liver injuries. Hepatogastroenterology 55: 1010-1012, 2008

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5. ABDOMINAL INJURY
C. Free Fluid / Hollow Viscus Injury

OBJECTIVES: To define the diagnostic and management approach to patients with blunt abdominal trauma (BAT) who have free fluid (FF) on the abdomino-pelvic CT scan without solid organ injury (SOI).

Guidelines: The presence of FF on the abdomino-pelvic CT scan following BAT in the stable patient remains a management dilemma. Free fluid without SOI may indicate the presence of either mesenteric injury and/or hollow viscous injury. The incidence is low varying between 2.8 % and 5.7% in a study published in 2014¹⁻³.

Three factors that should raise suspicion for mesenteric or bowel injury, in patients with FF without SOI, include:

1. The presence of seatbelt sign
2. The presence of abdominal tenderness
3. A moderate to large amount of FF.

The following approach is suggested in patients with free fluid without solid got solid organ injury on CT based on literature review¹⁻⁵ (Level 2).

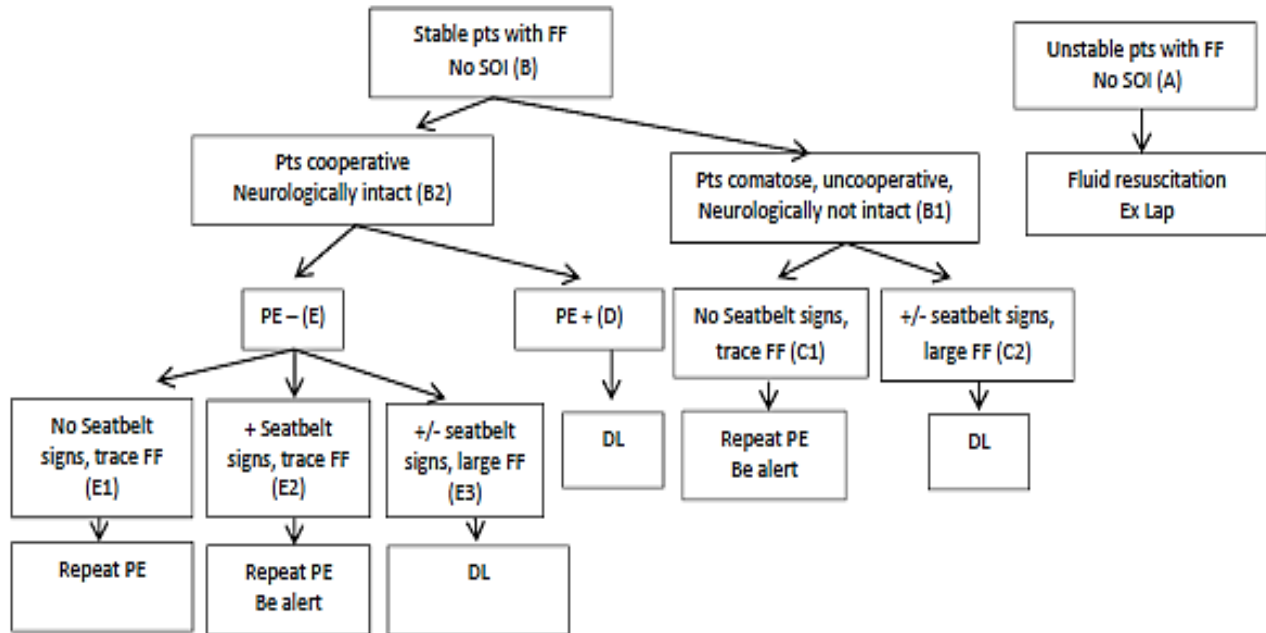
- A. In hemodynamically unstable patients, free fluid in the absence of solid organ injury mandates immediate surgical exploration.
- B. Hemodynamically stable patients with free fluid but without SOI should be stratified in 2 groups: 1. Comatose, uncooperative, and/or neurologically impaired patients who cannot be evaluated clinically; 2. Patients who are cooperative and neurologically intact.
- C. Comatose, uncooperative and neurologically impaired patients are then stratified into 2 subgroups: 1. Patients with no external markings (no seatbelt signs) and trace free fluid; 2. Patients with seatbelt signs and moderate to large free fluid. Subgroup 1 should undergo repeat clinical examination and radiological investigations as frequently as needed with the understanding that one must be extremely careful in not missing a bowel injury. Subgroup 2 should undergo diagnostic laparoscopy.
- D. Cooperative patients who are neurologically intact are stratified according to findings on physical examination. Patients with a concerning PE, regardless of the presence of a seatbelt sign, should undergo diagnostic laparoscopy. This can be converted, as needed, to a formal laparotomy.
- E. Patients with negative PE are stratified in 3 subgroups: 1. Patients with no seatbelt signs and trace fluids; they can be observed clinically (E1); 2. Patients with seatbelt signs and trace of free fluid; these patients can be followed clinically with repeated physical examination by the same examiner every 4 hours (E2); 3. Patients with and without seatbelt signs but with moderate to large amount of free fluid should undergo diagnostic laparoscopy (E3).

5. ABDOMINAL INJURY
C. Free Fluid / Hollow Viscus Injury

References

1. Gonsler-Hafertepen LN et al. isolated free fluid on abdominal computed tomography in blunt trauma: Watch and wait or operate? JACS 291: 599-605, 2014
2. Rodriguez C et al. isolated free fluid on computed tomographic scan in blunt abdominal trauma: A systematic review of incidence and management. J Trauma 53: 79-85, 2002
3. Drasin TE et al. MDCT evaluation of blunt abdominal trauma: Clinical significance of free intraperitoneal fluid in males with absence of identifiable injury. AJR 191: 1821-26, 2008.
4. Brasel KJ et al. incidence and significance of free fluid on abdominal computed tomographic scan in blunt trauma. J Trauma 44:889-892, 1998.
5. Banz VM et al. free abdominal fluid without obvious solid organ injury upon CT imaging: An actual problem or simply over-diagnosing? Journal of Trauma management and Outcomes 3 (10): 1-8, 2009.

Algorithm for FF without SOI on CT scan after BAT



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5. ABDOMINAL INJURY
D. Penetrating Abdominal Injury

OBJECTIVE: To define the management protocol for penetrating injuries to the anterior abdomen, the flanks, the back, and the thoraco-abdominal regions.

DEFINITIONS: The anterior abdomen is the area defined superiorly by a line that traverses both nipples, inferiorly by the groin folds and laterally by the anterior axillary line on each side.

The flanks are the regions delimited superiorly by 6th ICS and inferiorly by the iliac crests between the anterior and posterior axillary lines.

The back is the area delimited by the tips of the scapula bilaterally, laterally by the posterior axillary lines and inferiorly by the gluteal folds.

Guidelines: The following guidelines are extracted from the EAST guidelines ¹.

All trans-abdominal GSWs regardless of the hemodynamic status of the patient should undergo laparotomy unless the trajectory of the bullet is considered to be tangential. In this case, the patient should undergo either a CT scan or laparoscopy to exclude the violation of the peritoneum.

Penetrating anterior abdominal injuries

- a. Patients who are hemodynamically unstable or with diffuse abdominal tenderness should undergo emergently laparotomy (Level 1). This applies to both SWs and GSWs.
- b. Patients with evisceration from SWs should undergo laparotomy² (Level 2).
- c. Patients hemodynamically stable with an unreliable clinical examination (i.e., brain injury, spinal cord injury, intoxication, or need for sedation or anesthesia) should undergo further diagnostic investigation to establish peritoneal penetration (Level 2).
- d. A routine laparotomy is not indicated in hemodynamically stable patients with abdominal SWs without signs of peritonitis or diffuse abdominal tenderness (away from the wounding site).
- e. Hemodynamically stable patients with tangential abdominal GSWs and no peritoneal signs should undergo either diagnostic laparoscopy or interval PEs for 24 hours, if evaluable.
- f. Serial PE is reliable in detecting significant injuries after penetrating trauma to the abdomen when performed by the same experienced clinicians (Level 2).
- g. In patients treated with NOM, CT of the ABD/Pelvis should be considered as a diagnostic tool to facilitate initial management. If there is peritoneal penetration and the patient can be assessed reliably by PE then he should be monitored for 24 hours. If not evaluable, the patient should have a diagnostic laparoscopy.

5. ABDOMINAL INJURY
D. Penetrating Abdominal Injury

- h. Stable patients with SWs to the anterior abdomen, who are cooperative, can undergo local wound exploration (LWE). If the anterior fascia has not been penetrated, the patient may be discharged from the ED. If the anterior fascia has been penetrated, the patient will undergo either 24 hours observation with q4h PE and serial CBC or diagnostic laparoscopy.
- i. The majority of patients with penetrating abdominal trauma with NOM may be discharged after 24 hours of observation in the presence of a reliable abdominal examination and minimal to no abdominal tenderness (Level 3).

Penetrating thoraco-abdominal injuries

The thoraco-abdominal region is the area delimited by a line that traverses the nipples superiorly, by the costal margins inferiorly and extends circumferentially to the back for 360 degrees.

- Unstable patients (SBP < 90 mmHg, base deficit > 6) and patients with peritonitis should undergo laparotomy.
- Hemodynamically stable patients without peritonitis with penetrating injuries to right thoracoabdominal region can be evaluated with CT scan to evaluate the liver. A small laceration to the right diaphragm does not need repair. An injury by either a stab wound or a gunshot wound limited to the liver can be treated with nonoperative management (Level 3).
- Hemodynamically stable patients without peritonitis with penetrating injuries to the left thoraco-abdominal region and hemothorax/pneumothorax requiring tube thoracostomy should undergo thoracoscopy or laparoscopy to evaluate the diaphragm.

Back or flank stab wounds

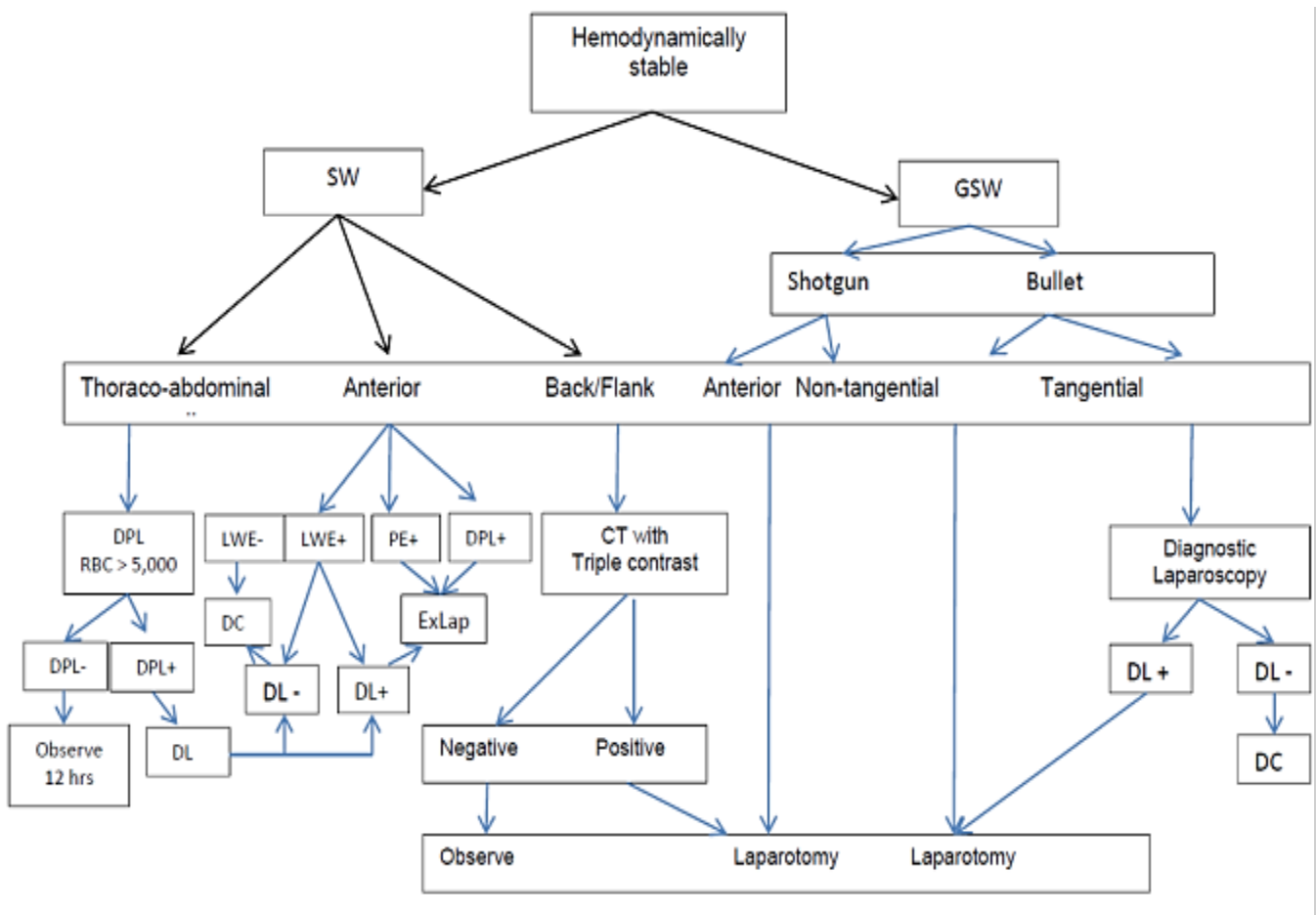
There are two available options for the evaluation and management of these patients:

1. Observation with serial abdominal examinations, serial CBC every 4 hours and vital signs measurement every 2 hours until discharge. The patient can be discharged after 24 hours of observation if there has not been any change in the physical examination, no increased pain and no drop in hemoglobin.
2. Evaluation of the patient with CT scan. If the CT scan is negative the patient may be discharged home. If the CT scan shows penetration into muscle or a retroperitoneal hematoma, not adjacent to a critical structure, the patient can be admitted for observation for a period of 12-24 hours. If the patient presents with hematuria or if there is an injury to the kidney then delayed CT cuts (10 minutes) of the kidneys, ureters, and bladder should be obtained to exclude urinary extravasation.

5. ABDOMINAL INJURY
D. Penetrating Abdominal Injury

If the stab wound track is near the colon and may have penetrated the colon, patient should be considered for laparoscopy or laparotomy.

If the CT scan shows free fluid into the abdominal cavity without solid organ injury, the patient should be evaluated further with laparoscopy or laparotomy. If there is evidence of solid organ injury alone, namely, spleen or liver, then depending on the trajectory and the potential for associated injuries and the extent of the hemoperitoneum, the patient can either be observed or undergo a laparotomy. Observation for this type of patients should occur in the intensive care unit.



*Pneumothorax/Hemothorax -> Laparotomy or laparoscopy

5. ABDOMINAL INJURY
D. Penetrating Abdominal Injury

References

1. Como J et al. Practice Management Guidelines for Selective Nonoperative Management of Penetrating Abdominal Trauma. J Trauma. 2010;68: 721-733
2. Biffl WL et al. Management of Patients with Anterior Abdominal Stab Wounds: A Western Trauma Association Multicenter Trial. J Trauma. 2009; 66: 1294 -1301.
3. Biffl WL et al. Validating the Western Trauma Association Algorithm for Managing Patients with Anterior Abdominal Stab Wounds: A Western Trauma Association Multicenter Trial. J Trauma. 2011;71: 1494-1502

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5. ABDOMINAL INJURY
E. Pelvis Injury

OBJECTIVES: To classify the type of pelvic fracture and to develop a diagnostic and treatment plan.

Classification:

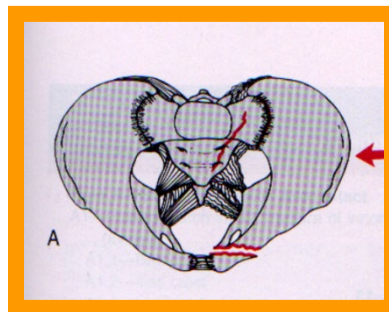
Unstable: disruption of the pelvic ring (rotationally or rotationally and vertically unstable).

Open fracture: Soft tissue injury allowing potential contamination of the fracture, includes perineal lacerations, vaginal tears and rectal tears.

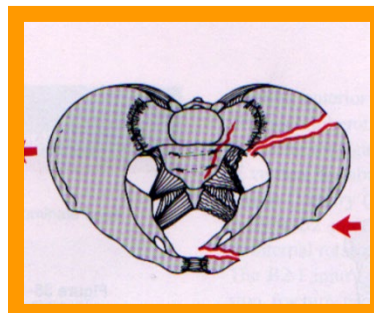
Young - Burgess Classification¹

1. Lateral compression (LC)
2. Antero-posterior compression (APC)
3. Vertical shear (VS)
4. Combined mechanical (lateral compression and vertical shear)

LC Type I: a combination of pubic rami fracture with sacral compression

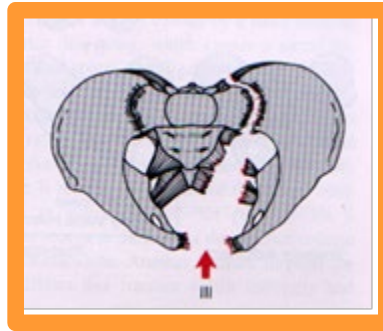


LC Type II: a combination of pubic rami fracture and an ipsilateral iliac wing fracture with intact sacrospinous and sacrotuberous ligaments

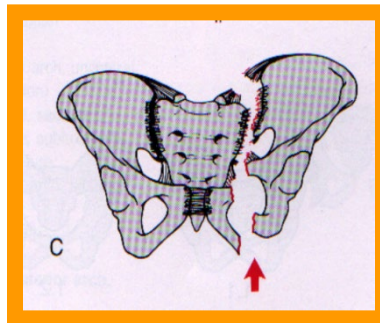


5. ABDOMINAL INJURY
E. Pelvis Injury

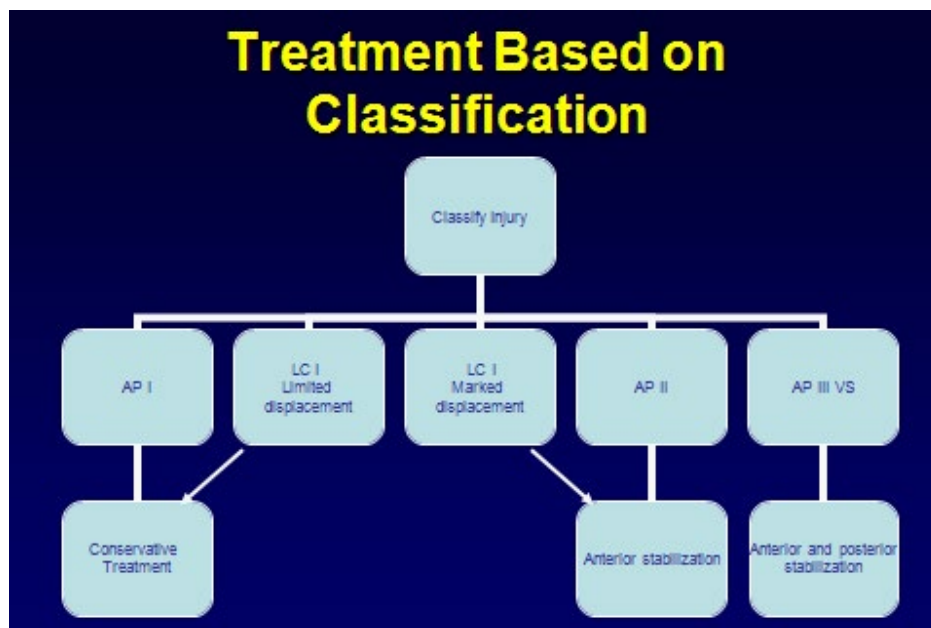
APC Type III: widening pubic symphysis, complete disruption SI joint and disrupted sacrospinous and sacrotuberous ligaments



Vertical shear: pubic rami fracture or symphyseal disruption with SI joint disruption and vertical displacement

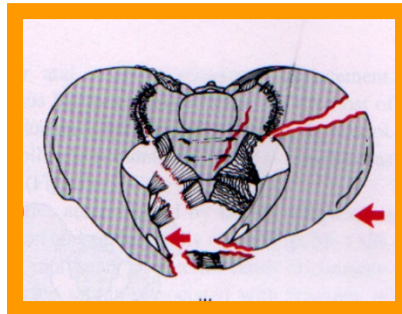


Treatment

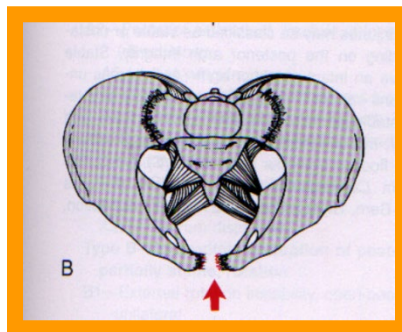


5. ABDOMINAL INJURY
E. Pelvis Injury

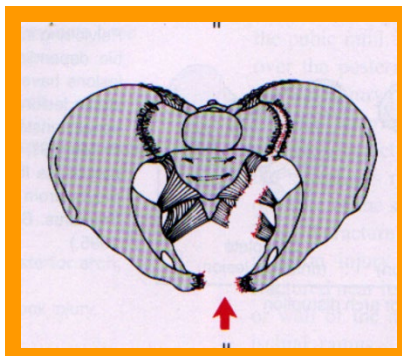
LC Type III: a combination of a type I or II LC on the side of impact and a contralateral anteroposterior compression with torn ligaments (Open book injury)



APC Type I: widening of pubic symphysis and intact SI ligaments



APC Type II: widening of pubic symphysis, disrupted anterior SI, sacrospinous and sacrotuberous ligaments with intact posterior SI ligament (this is the strongest ligament of the pelvis)



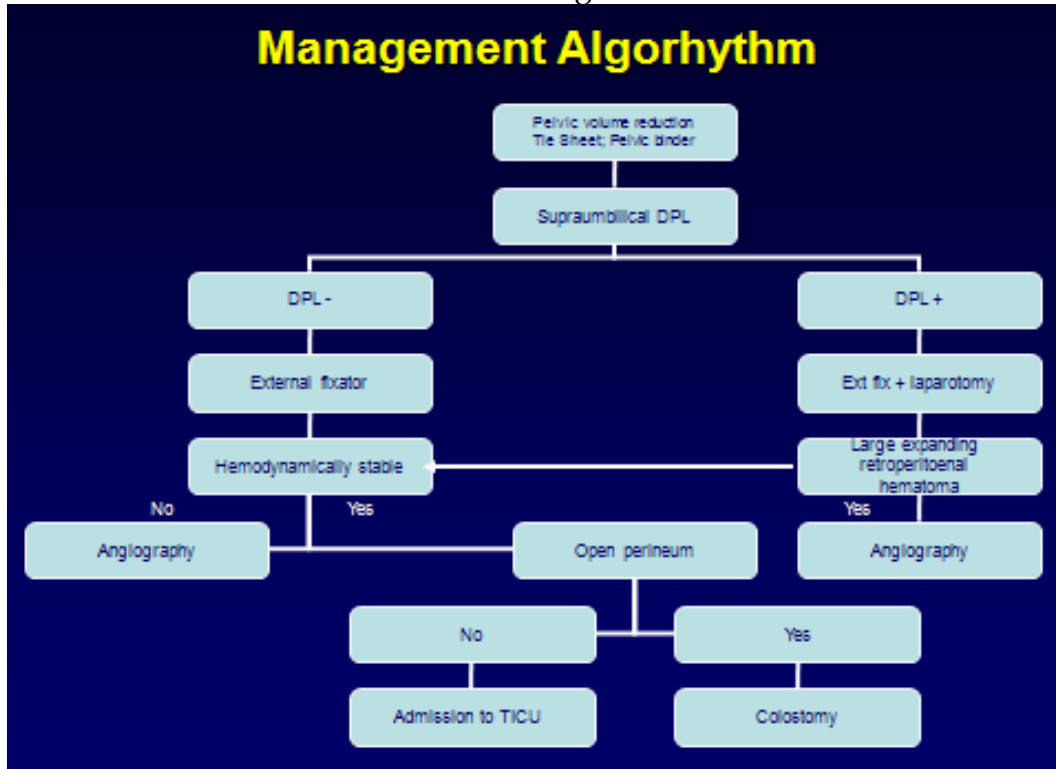
5. ABDOMINAL INJURY
E. Pelvis Injury

GUIDELINES:

1. Follow the ABC's.
2. If the patient is unstable and the pelvic x-ray is suggestive of a LC II or III, APC II or III, or a VS injury, apply a pelvic binder, activate the MTP and start transfusing the patient. Next, rule out an intra-abdominal source of bleeding using a FAST or supra-umbilical DPL. FAST is not sensitive enough to exclude intra-peritoneal bleeding in patients with pelvic fractures² (Level I recommendation). Supra-umbilical DPL is the best test to exclude intra-abdominal bleeding in hemodynamically unstable patients (Level II Evidence)^{3,4}.
3. Examine and document distal neurovascular status of limbs.
4. Examine for urethral blood or scrotal hematoma.
 - a. If present, obtain urethrogram prior to Foley.
 - b. If gross hematuria present, obtain CT cystogram.Examine for perineal, vaginal or rectal lacerations.
5. If the patient is stable, obtain a CT scan (Level II Evidence)
 - a. If anterior ring injury and pubic diastasis >2cm, consider performing retrograde urethrogram before passing Foley catheter.
 - b. If pubic diastasis > 2 cm obtain CT cystogram
6. Consider angiography in:
 - a. Patients with pelvic fractures and hemodynamic instability in whom other sources of bleeding have been ruled out (Level I Evidence).
 - b. Patients with blush in the pelvis on CT regardless of hemodynamic stability (Level I Evidence)
 - c. Presence of a pelvic hematoma > 500 cm³
 - d. Patients with pelvic fractures who continue to require blood transfusion after AE should undergo repeat angiography (Level II Evidence)
 - e. Patients > 60, female, with open book, butterfly or vertical shear fracture should undergo angiography independent of hemodynamic status
 - f. AE of both internal iliac arteries is safe and is not associated with sexual dysfunction in males (Level III Evidence).
7. If there is significant injury of rectum, anus, or perianal skin, perform a diverting colostomy, washout the rectal stump and washout debride and pack the wound.
8. If there is an intra-abdominal injury requiring laparotomy, with concomitant orthopedic pelvic Ex-Fix, control the intra-abdominal bleeding quickly (splenectomy, nephrectomy, liver packing), perform retroperitoneal packing and proceed with the damage control closure. If the patient remains unstable proceed with angiography and AE.

5. ABDOMINAL INJURY
E. Pelvis Injury

Treatment Algorithm



References

1. Young JWR, Burgess AR. Radiologic Management of Pelvic Ring Fractures in Systematic Radiographic Diagnosis. Baltimore: Urban and Schwarzenberg; 1987.
2. Friese RS et al: Abdominal ultrasound is an unreliable modality for the detection of hemoperitoneum in patients with pelvic fracture. J Trauma. 2007;63:97-102
3. Hubbard SG et al: Diagnostic errors with peritoneal lavage in patients with pelvic fractures. Arch Surg 1979; 114: 884
4. Culliname Dc et al: Eastern Association for the Surgery of Trauma Practice Management Guidelines for Hemorrhage in Pelvic Fracture – Update and Systematic Review J Trauma 2011; 71: 1850-1868
5. Davis JW et al: Western Trauma Association Critical Decisions in Trauma: Management of Pelvic Fracture with Hemodynamic Instability. J Trauma 2008; 65(5); 1012-1014

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**Westchester
Medical Center**

Westchester Medical Center Health Network

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 fracture bone despite extensive soft tissue laceration or damage |
| III B. | Grade III fracture with extensive soft tissue loss and 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 to saving the patients limb. Once the patient is stabilized, the fracture will be evaluated and a Neuro Vascular 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 that include the joints proximal and distal to the fracture site. For grade I and II Gustilo open fractures, the patient should receive cefazolin 2 grams IV immediately in the trauma resuscitation area (Level 1). For contaminated and grade III wounds, gentamicin 3.5 mg/kg will be added to cefazolin IV (Level 1). Duration of antibiotics for Grade I and II will be 24 hours after the wound is closed. For Grade III fractures or contaminated wounds, we recommend Ceftriaxone 2g every 24hrs. The duration of Antibiotic therapy with Grade III open fractures will be 24-72hrs after soft tissue closure (Level 2). Open fracture wounds contaminated by soil, fresh water, and seawater will require adjustments to antibiotic therapy (Appendix A). Rotations with Health Care associated risk factors for MRSA infections (Appendix B) may require a switch from Cephalosporin use to vancomycin. Adult renal dosing adjustments can be found in Appendix C. Medication and immobilization of the extremity should be followed by debridement and washout on the OR. For Grade III C injuries, with a pulseless distal extremity

6. EXTREMITY INJURY
A. Open Fracture

or an ABI less. 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 and is not needed if the patient has had a history of tetanus immunization previously and is under the age of 50 years old.

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

| | Absence of potential soil or water contamination | Presence of potential soil contamination (in absence of water contamination) | Presence of water contamination |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gustilo-Anderson fracture type I or II* | | | |
| Preferred regimen | Cefazolin 2g IV every 8 hours ^{†Δ} | Ceftriaxone 2g IV every 24 hours [◊] <u>PLUS</u> metronidazole 500mg IV/PO every 8 hours | No modification needed for fracture type I or II |
| Alternative regimen for patients with beta-lactam hypersensitivity | Vancomycin: 15-20mg/ kg every 12 hours for most patients with normal renal function Subsequent dose and interval adjustments based on trough-guided serum concentration monitoring | Clindamycin 900mg IV every 8 hours | No modification needed for fracture type I or II |
| Gustilo-Anderson fracture type III* | | | |
| Preferred regimen | Ceftriaxone 2g IV every 24 hours [◊] | Ceftriaxone 2g IV every 24 hours [◊] <u>PLUS</u> metronidazole 500mg IV/po every 8 hours | Fresh water contamination: Piperacillin-tazobactam 4.5g IV every 6 hours [◊] Sea water contamination: Piperacillin-tazobactam (as <u>above</u>) ^{◊,¶} PLUS doxycycline 100mg IV/po orally every 12 hours |
| Alternative regimen for patients with beta-lactam hypersensitivity | Clindamycin 900mg IV every 8 hours | Vancomycin every 12 hours PLUS levofloxacin 750mg IV/po 24 hours | Fresh water or sea contamination: Vancomycin every 12 hours PLUS levofloxacin 750 iv/po mg 24 hours |

IV: intravenous;

¶For patients >120kg, cefazolin dosing consists of 3g IV every 8hrs.

Δ For patients at risk of methicillin-resistant *Staphylococcus aureus* (MRSA), gram-positive coverage should consist of vancomycin in place of cefazolin.

◊ For patients at risk for MRSA, vancomycin should be added to regimen.

If further guidance is needed: please call Antimicrobial Stewardship via tiger text or infectious diseases consult

Duration: the duration of antibiotic therapy depends on the classification of the fracture

- For Gustilo-Anderson fracture type I or II open fractures, antibiotics may be discontinued 24hrs after wound closure.
- For Gustilo-Anderson fracture type III open fractures, antibiotics may be discontinued after 72hrs or within a day after soft tissue injuries have been closed

Prolonged administration of antibiotics does not reduce the risk of infection and can lead to the development of resistant organisms

6. EXTREMITY INJURY
A. Open Fracture

| | | | | |
|-------------------------------------------------------------------------------------------|--------------|------------------------|---------------|---------------------------------------------------------------------------------------------------------------------------------|
| 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. Add 0.75gm 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: |
| <ul style="list-style-type: none"> • Recent hospitalization • Residence in a long term care facility • Recent surgery • Hemodialysis |
| Additional risk factors for MRSA infection include: |
| <ul style="list-style-type: none"> • HIV infection • Injection drug use • Prior antibiotic use |
| Factors associated with MRSA outbreaks include: |
| <ul style="list-style-type: none"> • Incarceration • Military service • Sharing sport equipment • Sharing needles, razors, or other sharp objects |

**6. EXTREMITY INJURY
A. Open Fracture**

Orthopedic Surgery Response Criteria < 30minutes:

- Open long bone fractures
- Unstable pelvic fracture
- Any Amputations excluding digits

References

1. Gustilo RB and Anderson JT. Prevention of infection in the treatment of 1025 open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg Am. 58:453-458, 1976.
2. Gustilo RB et al. Problems in the management of grade III (severe) open fractures: a new classification of grade III open fractures. J Trauma. 24:742-746, 1984.
3. Luchette FA et al. EAST Practice Management Guidelines Workgroup: practice management guidelines for prophylactic antibiotic use in open fractures. Eastern Association for the Surgery of Trauma, 2000.
4. Hoff WS et al. East practice management guidelines workgroup: Update to practice management guidelines for prophylactic antibiotic use in open fractures. J Trauma 70(3): 751-754, 2011.

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6. EXTREMITY INJURY
B. Mangled Extremity

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 of the scoring systems are based on data from lower extremity injuries only. Johansen et al¹ 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 age of the patient (NISSSA) score to predict the need for amputation². All scoring systems, however, have not been validated in larger prospective studies.

Mangled Extremity Severity Score

Score

| | | No = 0 Yes = 1 | |
|---------------|----------------------------------------------------------------|-------------------|--|
| | Limb Ischemia For > 6hrs | | |
| Limb Ischemia | Reduce Pulse but normal perforation | +1 | |
| | Pulseless, paresthesia’s slow capillary refill | +2 | |
| | Lool paralysis; Numb/ insensate | +3 | |
| Patient Age | < 30 yrs. | 0 | |
| | 30 - 50 yrs. | +1 | |
| | > 50 & up | +2 | |
| Shock | SBP > 90mm/ Hg | 0 | |
| | Transient Hypotension | +1 | |
| | Persistent Hypotension | +2 | |
| Mechanism | Low Energy Stab, GSW, Simple Fx. | +1 | |
| | Medium Energy Dislocated/ Multi Fractures | +2 | |
| | High Energy High Speed MVA, Rifle Shot | +3 | |
| | Very High Energy High speed trauma with gross contamination | +4 | |

Total

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

6. EXTREMITY INJURY
B. Mangled Extremity

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 ABC's 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 which allows 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.

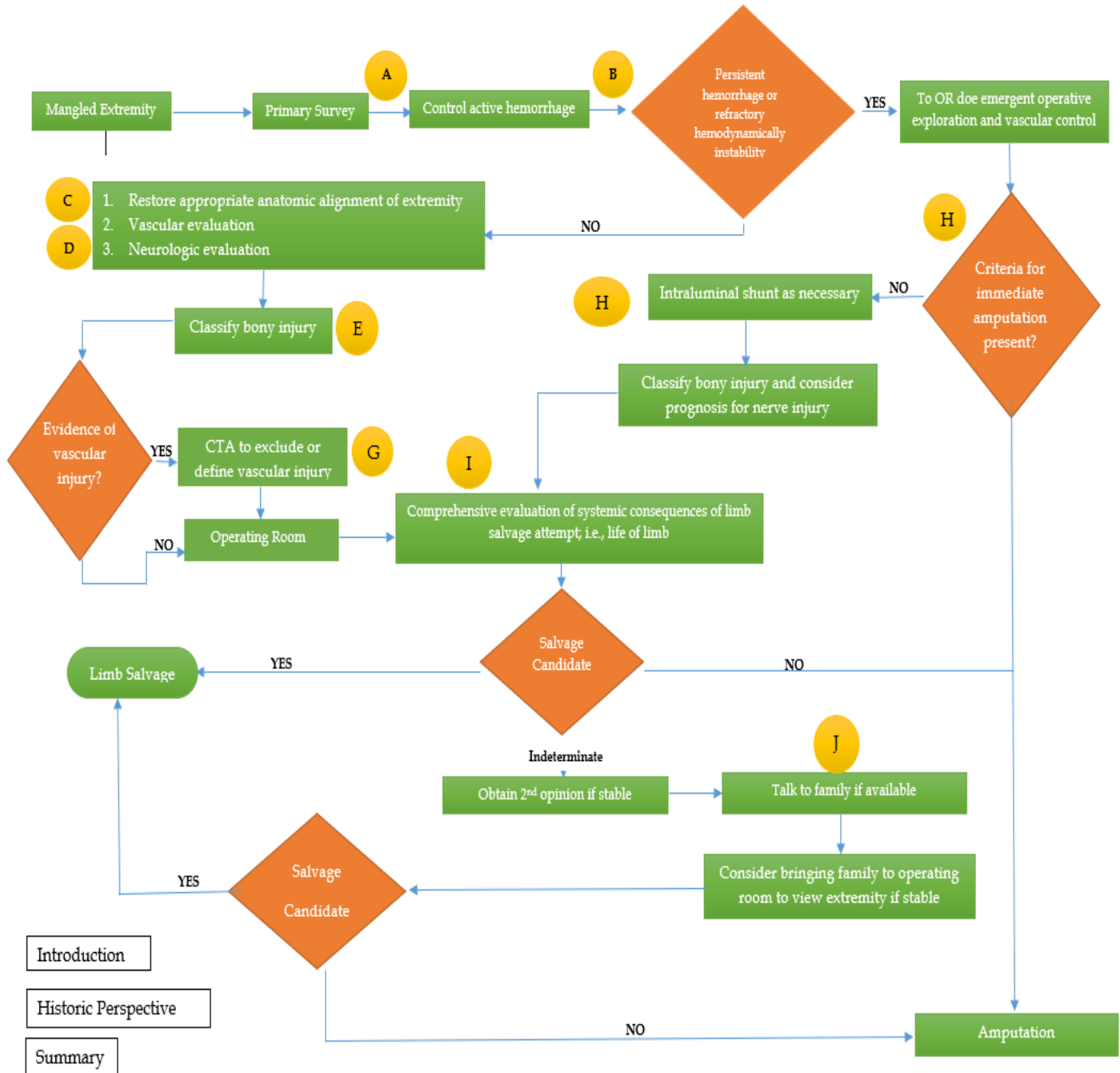
If no active bleeding, evaluate for vascular injury or compromise:

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 or Brachial-Brachial index. An ABI or BBI less than 0.9 requires further 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, or hemorrhage. 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 2 Attending Surgeons from different services.

6. EXTREMITY INJURY
B. Mangled Extremity



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

6. EXTREMITY INJURY
B. Mangled Extremity

1. Johansen K et al. Objective criteria accurately predict amputation following lower extremity trauma. *J Trauma*. 30:568 -572; discussion 572-573, 1990
2. McNamara MG et al. Severe open fractures of the lower extremity: A retrospective evaluation of the Mangled Extremity Severity Score (MESS). *J Orthop Trauma*. 8:81- 87, 1994
3. Russell WL et al. Limb salvage versus traumatic amputation. A decision based on a seven-part predictive index. *Ann Surg*. 213:473-81, 1991
4. Suedkamp NP et al. The incidence of osteitis in open fractures: an analysis of 948 open fractures (a review of the Hannover experience). *J Orthop Trauma*. 7:473-82, 1993.
5. Bosse MJ et al. A prospective evaluation of the clinical utility of the lower-extremity injury-severity scores. *J Bone Joint Surg Am*. 83-A:3-14, 2001

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6. EXTREMITY INJURY
C. Penetrating Extremity Injury

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 ABC's.
2. Perform rapid physical exam, noting nature of distal pulses and neurologic findings (see algorithm).
3. If the patient arrives with 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 deficits 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.

6. EXTREMITY INJURY
C. Penetrating Extremity Injury

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. 6Ps- Pulselessness, Pallor, Pain, Paralysis, Paresthesia’s, and Poikilothermia
 - e. Palpable thrill or audible bruit
 - f. Rapidly developing compartment syndrome.
 - g. Arterial Pressure Index ABI < 0.90 or pulse deficit = 95% sensitivity/ 97% specificity arterial injuries

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 mandates an emergent operation, depending on location. 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 is 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 backflow¹.

6. EXTREMITY INJURY
C. Penetrating Extremity Injury

10. If neurologic deficit is present:
 - a. Document the level of deficit.
 - b. Obtain orthopedic or neurosurgical consult.
11. Penetrating injuries without vascular injury on diagnostic studies and without neurologic injury can have the wound locally treated and the patient may be discharged.
12. Administer one gram of cefazolin IV for SWs. GSWs do not require antibiotics. Debride foreign material. Administer tetanus IM as needed if the patient does not have a history of prior immunization or is above the age of 50yo.
13. Debride wound edges and close or treat with dressings depending on clinical conditions.
14. 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.

6. EXTREMITY INJURY
C. Penetrating Extremity Injury

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 DVT²⁻⁴.

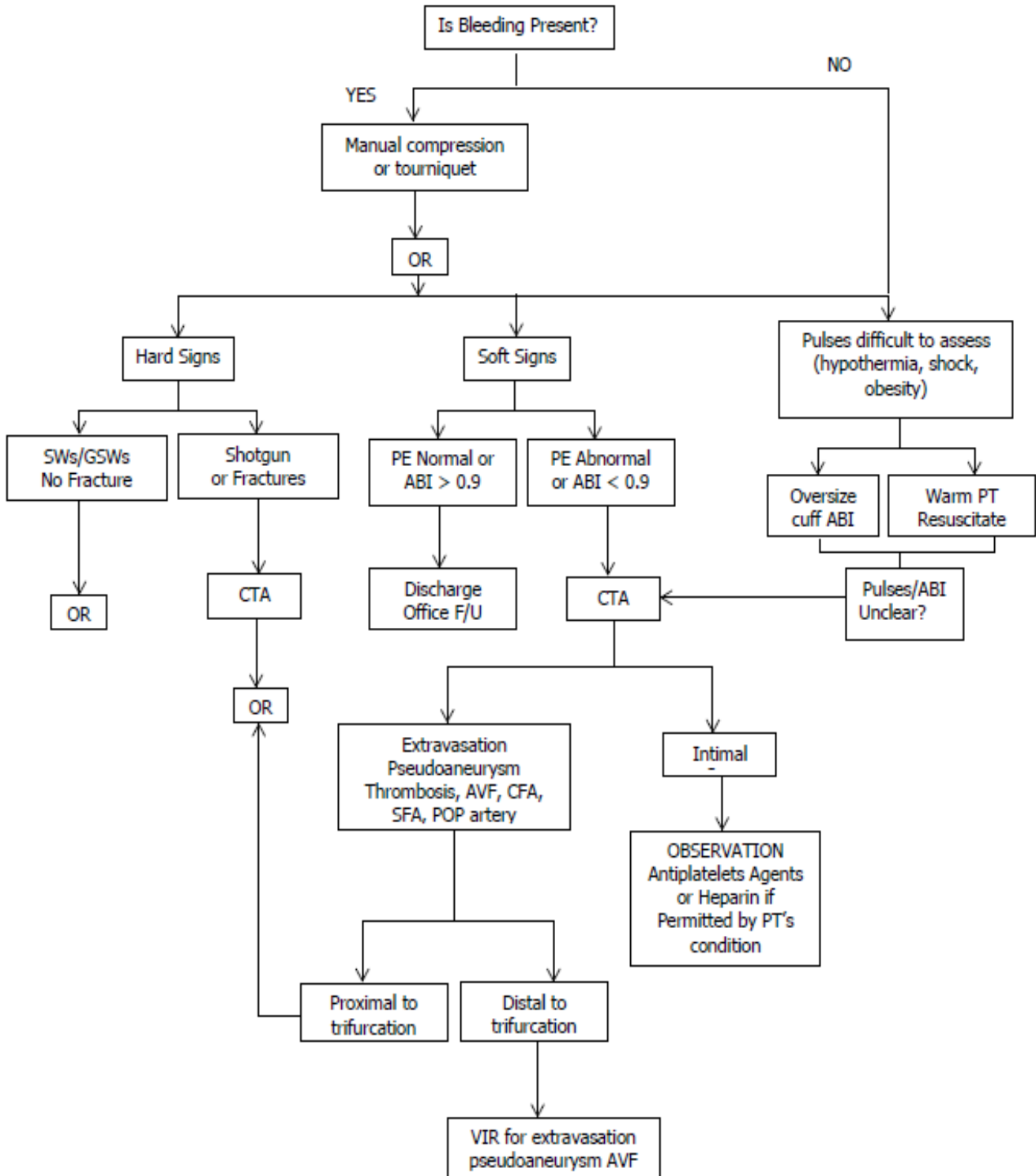
6. EXTREMITY INJURY
C. Penetrating Extremity Injury

Sequence and Priorities for the Treatment of Vascular Injuries

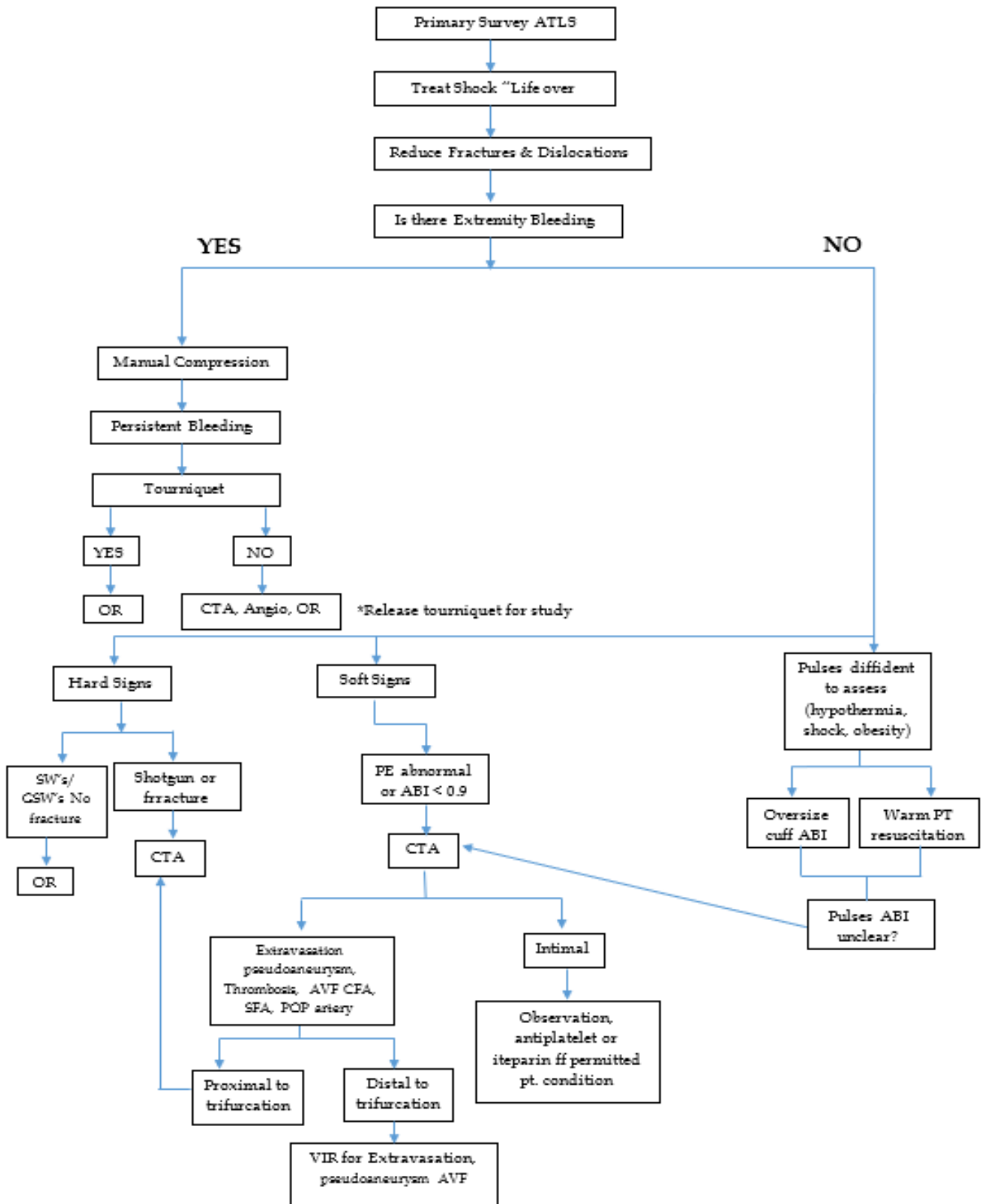
6. Temporary control of bleeding
 - ✓ Digital pressure
 - ✓ Tourniquet
 - ✓ Balloon catheter in transition zones
7. Obtain appropriate “Extensile” exposure
8. Obtain definitive control
 - ✓ Proximal control is key
 - ✓ Do not violate anatomic barriers that help contain the bleeding
 - ✓ Always begin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

6. EXTREMITY INJURY
C. Penetrating Extremity Injury

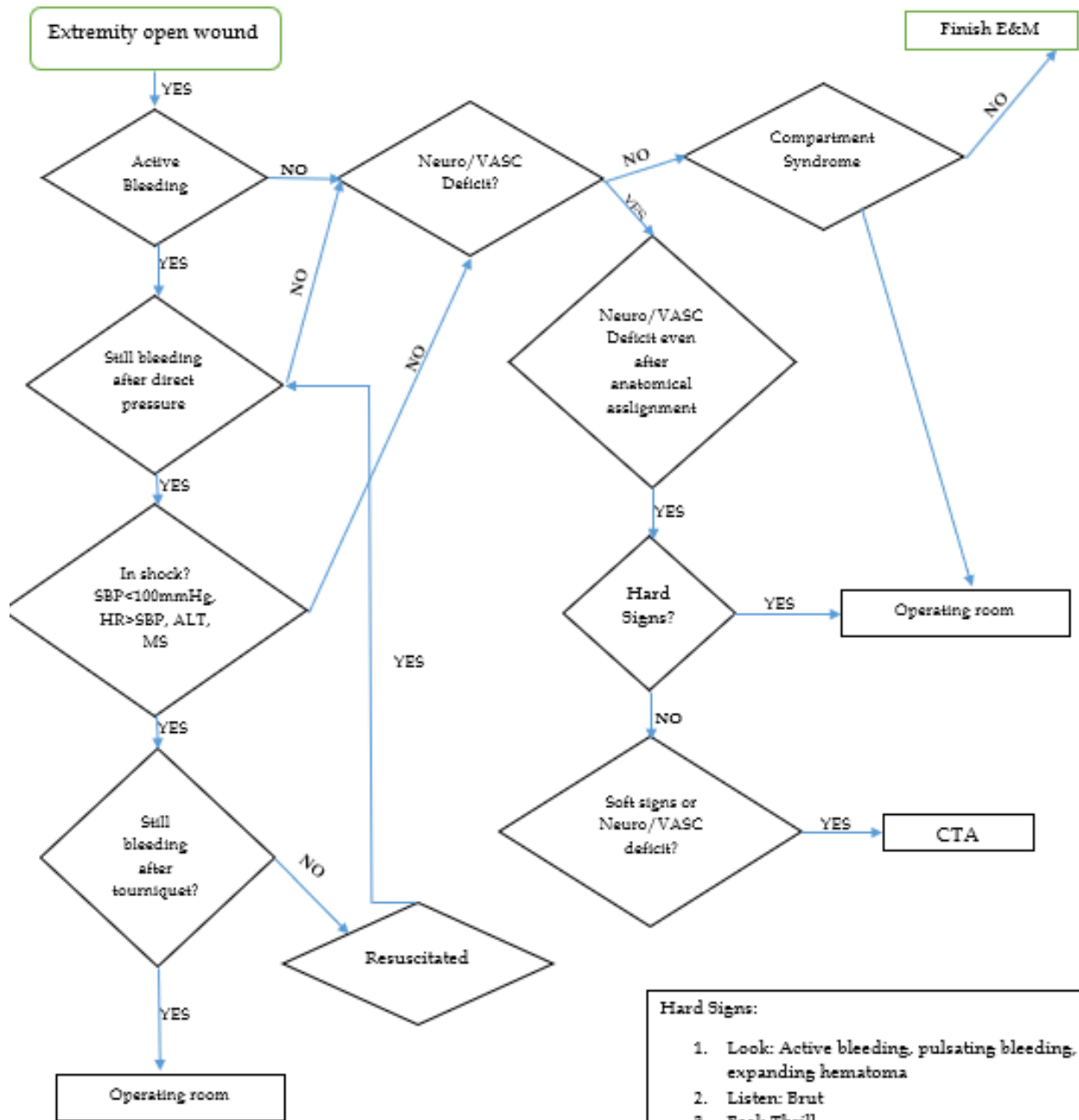
PENETRATING EXTREMITY INJURIES



6. EXTREMITY INJURY
C. Penetrating Extremity Injury



6. EXTREMITY INJURY
C. Penetrating Extremity Injury



- 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

6. EXTREMITY INJURY
C. Penetrating Extremity Injury

References

1. D Feliciano et all: Evaluation and Management of Peripheral Vascular Injury. Part 1. Western Trauma Association/Critical Decisions in Trauma. J Trauma 2011; 70:151-156.
2. Evaluation and management of penetrating lower extremity arterial trauma: An Eastern Association for the Surgery of Trauma practice management guideline. J Trauma 2012;73: S315 -S320
3. P Pappas et all: Outcome of complex venous reconstructions in patients with trauma. JVS 1997; 25: 398-405.
4. M Kurtoglu et all: Serious Lower Extremity Venous Injury Management with Ligation: Prospective Overview of 63 Patients. Am Surgeon 2007; 73: 1039-1043

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**Westchester
Medical Center**

Westchester Medical Center Health Network

TRAUMA PRACTICE MANAGEMENT MANUAL

CHAPTER 7

SPECIAL POPULATIONS / MISC.

7. Special Populations
A. Genitourinary Trauma

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 |

**7. Special Populations
A. Genitourinary Trauma**

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 nephrectomy² (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. Nonpulsatile, 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-devascularized 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). 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 at bed-rest. An interval CT scan at 72 hours should be done to reassess the injury for the presence of an urinoma. If an 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 stable³ (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).

7. Special Populations
A. Genitourinary Trauma

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 as 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 from 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 at 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 with 4-0 Vicryl
5. Drain the site with a JP
6. Isolated the injury if possible with either peritoneum or omentum

7. Special Populations
A. Genitourinary Trauma

Stable patients

Injury to the lower third of the ureter can be treated easily 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, and autotransplantation is always feasible⁶.

Unstable patients

If the patient is unstable and has suffered a high-grade ureteral injury, you should either ligate 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

7. Special Populations
A. Genitourinary Trauma

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 decompression⁷. 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 the suspicion of urethral injury.

The posterior urethra is injured in males and females in association with pelvic fracture. In contrast, the male anterior urethra may be injured in penetrating injuries or in straddle-type injury 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.

7. Special Populations
A. Genitourinary Trauma

Scrotal injuries

All penetrating scrotal injuries must be explored surgically, and may be accompanied by 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.

References

1. Baverstock R et al. severe blunt renal trauma: A 7 year retrospective review from a provincial trauma center. *Can J Urol* 8(5): 1372-6, 2001
2. Gonzalez RP et al. Surgical management of renal trauma: is vascular control necessary? *J Trauma* 47(6):1039-42, 1999.
3. Altman AL et al. Selective nonoperative management of blunt grade 5 renal injury. *J Urol* 164(1):27-30, 2000.
4. Velmahos GC et al. Selective management of renal gunshot wounds. *Br J Surg.* 85(8):1121-4, 1998.
5. Wessells H et al. Criteria for nonoperative treatment of significant penetrating renal lacerations. *Journal of Urology.* 157(1):24-7, 1997.
6. Lynch TH et al. EAU Guidelines on Urological Trauma *European Urology* 47: 1-15, 2005
7. Parry NG et al. traumatic rupture of the urinary bladder: Is the suprapubic tube necessary? *J Trauma* 54:431-436, 2003.
8. Koraitim MM et al. Risk factors and mechanism of urethral injury in pelvic fractures. *Br J Urol* 77:876, 1996.

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7. SPECIAL POPULATIONS
B. DVT Prophylaxis

OBJECTIVE: To define the different approaches to DVT prophylaxis in trauma patients.

Guidelines: The NIH estimates that approximately 20% of trauma patients may develop DVT¹. All non-ambulatory trauma patients should be considered at risk of DVT; therefore, they should undergo DVT prophylaxis. Absolute contraindications to immediate anticoagulation include intracranial and intra-spinal bleeding as well as ongoing coagulopathy and/or bleeding. Patients with absolute contraindication to immediate pharmacological DVT prophylaxis must undergo placement of sequential compression devices (SCDs) unless there are specific contraindications to their use, such as external fixator, compartment syndrome, crush injury, major vascular injuries compromising the blood supply to the extremities.

The following guidelines are extracted from the latest ACCP consensus paper²:

1. All trauma patients should receive thromboprophylaxis, if possible (Grade 1A).
2. In the absence of a major contraindication, LMWH prophylaxis should be started as soon as it is considered safe to do so (Grade 1A).
3. Mechanical prophylaxis should be used if LMWH prophylaxis is delayed or if it is currently contraindicated due to active bleeding or a high risk for hemorrhage (Grade 1B).
4. DUS screening is recommended only in patients who are at high risk for VTE (e.g., the presence of a spinal cord injury [SCI], lower extremity or pelvic fracture, major head injury, or an indwelling femoral venous line), and who have received suboptimal prophylaxis or no prophylaxis (Grade 1C).
5. IVCs (IVC Filters) should not be used as primary prophylaxis in trauma patients (Grade 1C).
6. DVT prophylaxis should be continued until hospital discharge, including the period of inpatient rehabilitation (Grade 1C+).
7. Patients with major impaired mobility should be treated after hospital discharge with LMWH or a VKA (target INR, 2.5; INR range, 2.0 to 3.0) (Grade 2C).

DVT prophylaxis in patients with traumatic brain injury

It is known that TBI patients are at increased risk of DVT. This is the result of hypercoagulability caused by a variety of mechanisms including the release of tissue factor. The appropriate timing of chemical thromboprophylaxis in these patients has been debated for a long time. DVT chemical thromboprophylaxis can be safely initiated 48 hours after evidence of no further progression of intracerebral hemorrhage^{3,4}. The decision to use unfractionated heparin or low molecular weight heparin will be made in conjunction with Neurosurgery.

DVT prophylaxis in patients with spinal cord injury

The incidence of DVT and PE is 3 times higher than the general population in patients with spinal cord injury with a reported incidence that ranges from 49% to 72%. The most recent ACCP recommendations are to provide a combined approach of mechanical and chemical DVT

7. SPECIAL POPULATIONS
B. DVT Prophylaxis

prophylaxis started within 72 hours of injury and of withholding chemical DVT prophylaxis for surgical interventions with reinstatement of it within 24 hours of the procedure.

The routine use of prophylactic IVC filters remains controversial. There is a growing body of evidence suggesting that IVC filters increase the incidence of recurrent DVT over time. Furthermore, it has been shown that IVC filters quadruple the incidence of DVT during the rehabilitation⁵.

DVT prophylaxis in patients with spine fractures with or without spinal cord injury

The following guidelines will be implemented:

- Patients with spine fracture and epidural hematoma (EDH) will be placed on SQH 5,000 units Q8Hrs until cleared by the Spine Service.
- Patients with spine fracture without EDH will receive Lovenox 24 hours after injury.
- Patients can be treated with Lovenox 48 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.
- Please Note: Lovenox should be withheld 12 hours before a planned procedure.

REFERENCES

1. Consensus Conference, National Institutes of Health: Prevention of venous thrombosis and pulmonary embolism. JAMA 1986; 256:744.
2. Guyatt GH et al. Antithrombotic Therapy and Prevention of Thrombosis. 9th Ed: ACCP Evidence-Based Clinical Practice Guidelines. Chest 141 (2): 7S-47S, 2012
3. Phelan HA et al. Chemical venous thromboembolic prophylaxis is safe and effective for patients with traumatic brain injury when started 24 hours after the absence of hemorrhage progression on head CT. J Trauma 72: 426-430, 2012
4. Kim J et al. Preliminary report on the safety of heparin for deep venous thrombosis prophylaxis after severe head trauma J Trauma 53: 38-42, 2002
5. Gorman PH et al. Prophylactic IVC filter placement may increase the relative risk of DVT after acute spinal cord injury. J Trauma 66: 707-712, 2019

7. SPECIAL POPULATIONS
B. DVT Prophylaxis

Risk Factors for DVT

| Underlying Condition | |
|---------------------------------------------|---|
| Morbid obesity | 4 |
| Malignancy | 2 |
| H/o hypercoagulable state | 4 |
| H/o DVT | 4 |
| In-Hospital Factors | |
| Femoral venous line > 24 hrs | 2 |
| ≥ 4 U PRBCs in 24 hrs | 2 |
| Repair or ligation of major vascular injury | 3 |
| Injury-related factors | |
| AIS > 2 chest | 2 |
| AIS > abdomen | 2 |
| AIS > 2 head or GCS < 8 | 3 |
| Complex LEs Fracture | 4 |
| Pelvic Fracture | 4 |
| SCI | 4 |
| Age | |
| 40-60 | 2 |
| 60-75 | 3 |
| > 75 | 4 |

DVT Prophylaxis

Approved Date: 04/30/2017
 Revised Date: 02/01/2021
 To be Reviewed: 02/01/2024

7. SPECIAL POPULATION
C. Massive Transfusion Protocol (MTP)

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 of 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 judgement
 - 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).

7. SPECIAL POPULATION
C. Massive Transfusion Protocol (MTP)

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.

**7. SPECIAL POPULATION
C. Massive Transfusion Protocol (MTP)**

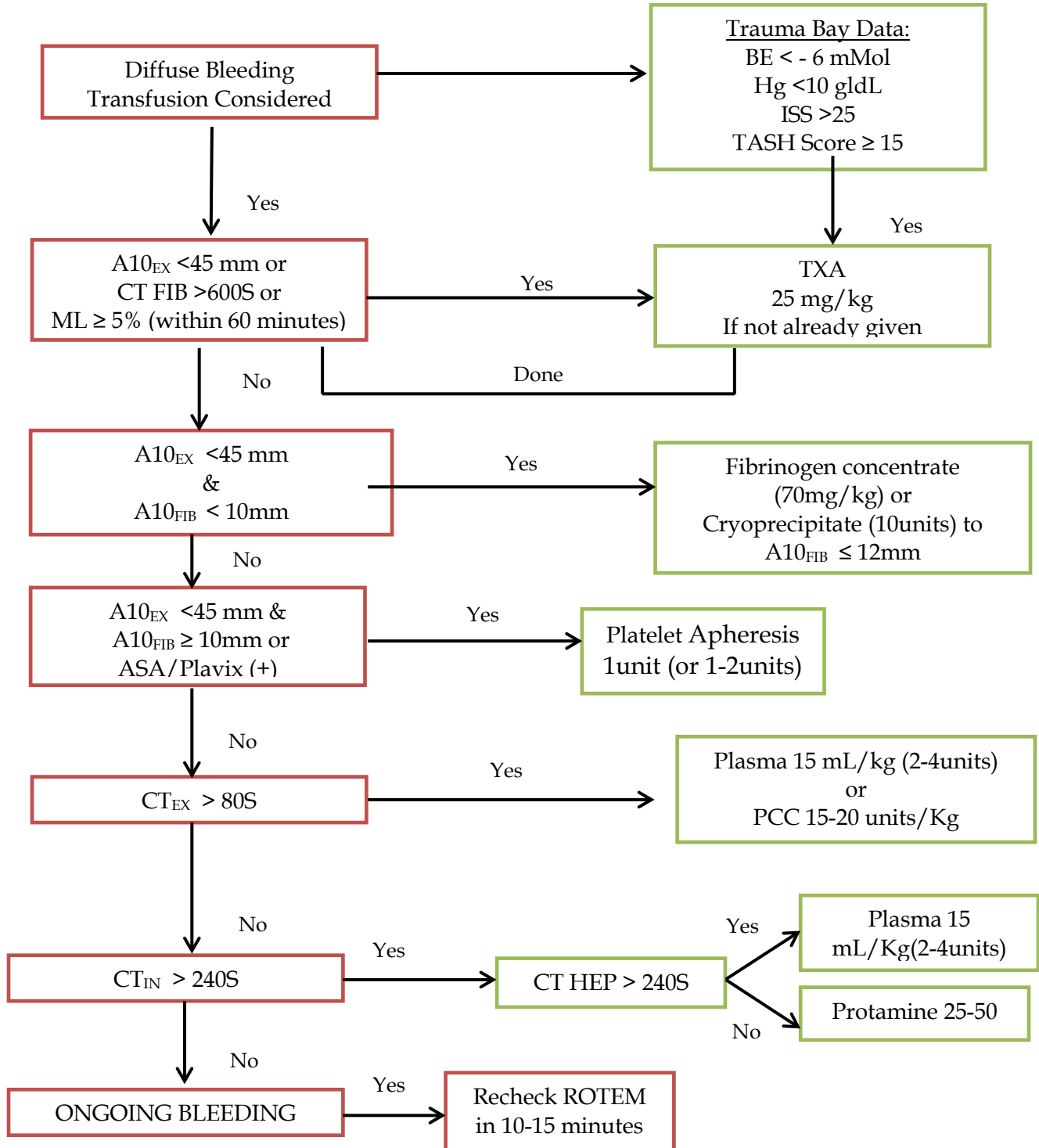
For ADULT MTP

| 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 3 rd pack if MTP is expected to be continued |
| Pack 4 | 6 | 6 | 1 | | |
| Pack 5 | 6 | 6 | 1 | | |

THROMBOELASTOMETRY RESULTS: If used and abnormal, continue MTP packs Prothrombin Complex Concentrate (Kcentra) or recombinant Factor VIIa (NovoSeven) may be considered, if bleeding continues.

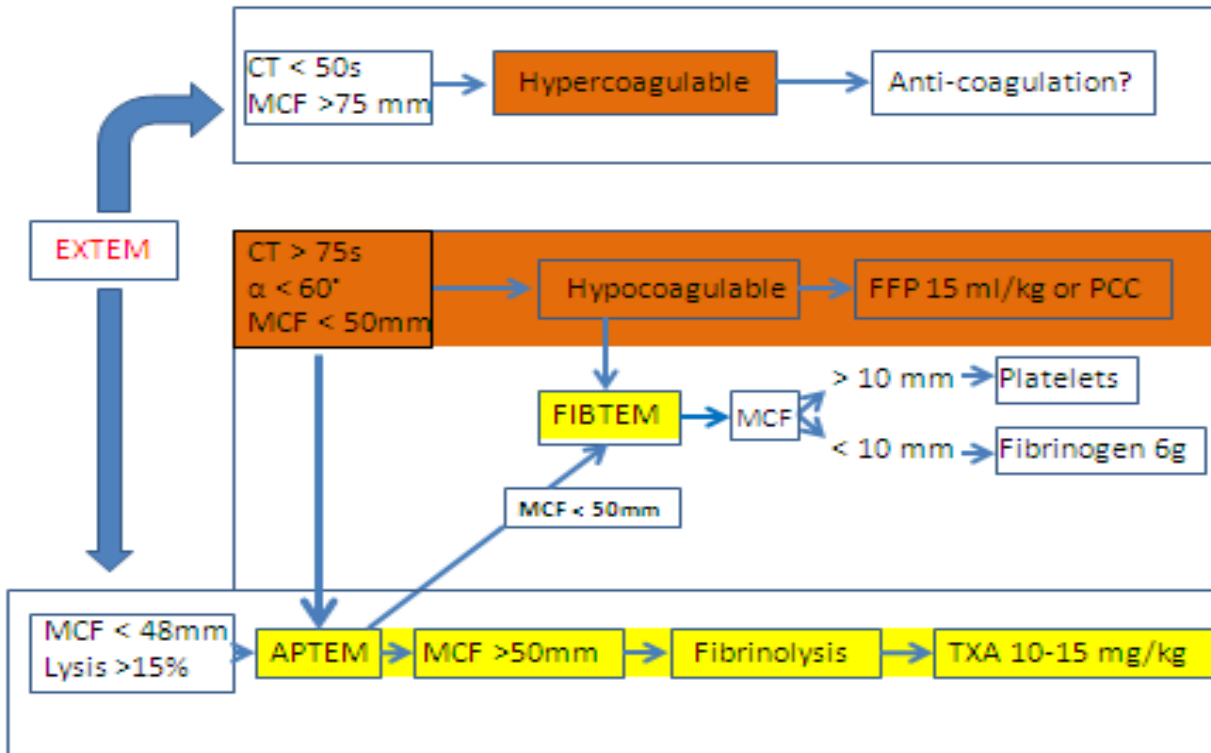
7. SPECIAL POPULATION
C. Massive Transfusion Protocol (MTP)

TRAUMA - ROTEM-GUIDED TRANSFUSION MANAGEMENT



7. SPECIAL POPULATION
C. Massive Transfusion Protocol (MTP)

ROTEM Guided Transfusion Management



7. SPECIAL POPULATIONS
D. Communication In Multisystem Injured Patient

OBJECTIVES: 1. 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 at 12 noon in the TICU Tuesday through Friday to summarize daily care plans as well as discharge dispositions

Approved Date: 02/01/2020
To be Reviewed: 02//01/2023

7. SPECIAL POPULATION
E. Emergency Blood Release for Level 1 Activations

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

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.)

7. SPECIAL POPULATION
E. Emergency Blood Release for Level 1 Activations

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.

Approved Date: 8/2021
To Be Reviewed: 8/2024

7. Special Populations
F. Non-Surgical Admissions

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 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 under any circumstance.
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 (including orthopedic injuries to more than one extremity) 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:

**7. Special Populations
F. Non-Surgical Admissions**

- a. injuries
 - b. injury severity score of less than 15
 - c. generation of trauma activation and/or trauma consultation
 - d. Consultation of appropriate surgical services including timeliness
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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