Saint Francis Hospital
Trauma Manual

Trinity Health Of New England

Department of Acute Care Surgery and Surgical Critical Care Last Updated: 10/9/2021

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Introduction

Activation Criteria

FULL ACTIVATION CRITERIA:

- Unable to adequately ventilate, assisted ventilation, or intubated
- SBP< 90 in adult, or age specific hypotension in a child:

Age	**SBP** (mm Hg)
<1y	<60
1-10 y	<70 + 2x age
>10y	<90

- **SBP < 110 for geriatrics***
- GCS ≤ 10
- Penetrating injuries to the head, neck, torso, or extremities proximal to the elbow/knee
- Traumatic paralysis or complete loss of sensation to one or more extremity
- Transfers requiring blood transfusion
- Amputated, Crushed, de-gloved, or mangled extremity (excluding digits)
- Major burns >25% TBSA, electrical burns, or facial burns with concern for airway involvement
- 2 or more proximal long bone fractures
- At the discretion of MD, RN, or EMS

CORE ACTIVATION CRITERIA:

- **Falls:** adult > 20 ft, Child >10 ft or 3 x height, geriatric* > standing height
- MVC with:
  - Ejection from vehicle
  - Intrusion > 12" in occupant compartment
  - Death in same passenger compartment
- Motorcycle crash > 20 MPH
- Pedestrian struck > 20 MPH
- Burns > 10% TBSA
- Blunt abdominal injury with firm/distended abdomen or seatbelt sign
- Penetrating extremity trauma distal to knee/elbow
- At the discretion of MD, RN, or EMS

TRAUMA CONSULTS:

- Any patient with an identified traumatic injury that did not meet activation criteria
- A full or core activation may also be called at the discretion of the ED for patients who are found to have traumatic injuries during their initial ED workup

TRAUMA TRANSFERS:

- All calls from transferring facilities for traumatic injury will be routed to the Trauma attending on call via the transfer line.
- The trauma attending will advise the transfer line as to the appropriate level of activation.
- The transfer line will then notify the ED

NOTE: hangings and drownings are NOT activation criteria

***Geriatric defined as ≥65 yrs old**

Senior Resident Learning Objectives and Responsibilities

The PGY4/5 residents should become skilled in the resuscitation, evaluation, and treatment of all injured patients. They should be able to lead and coordinate the trauma team during all phases of patient care from arrival to discharge.

Clinical Skills:

- Evaluate and treat critically injured patients based on ATLS principles
- Manage the multi-system trauma patient with particular emphasis on prioritization of injuries and treatments
- Coordinate the functions of various members of the trauma teams to ensure efficient and comprehensive patient care
- Manage pre-existing disease states including the use of appropriate consultations.

Surgical Skills to Acquire:

- Supervise performance of invasive procedures by junior residents and advanced practice providers.
- Resuscitative Thoracotomy when indicated
- Trauma related operations including laparotomy, thoracotomy, peripheral vascular repair, and fasciotomy
- Damage control laparotomy with various maneuvers for exposure and control of bleeding.
- Cricothyroidotomy (ideally supervised; unsupervised if need be)

The resident will learn, understand, and demonstrate knowledge of:

- Physiologic response to injury
- The fundamental principles of diagnosis and treatment of injuries typically managed by consulting services (i.e. orthopedic, neurosurgical, and urologic injuries).
- The structure and importance of the trauma system, including the quality improvement processes thereof.

The resident will be able to analyze papers in the scientific literature and show that they can apply them as appropriate. They will be an effective teacher of all junior team members and of the advanced practice providers. They should review and analyze outcomes on a daily basis, and learn from mistakes and respond appropriately to criticism.

Additional PGY4/5 Responsibilities:

1. Conduct daily rounds on the ACS service.
2. Responsibly allocates manpower for the day with regards to floor work, trauma clinic, consults, trauma activations, and operative cases.
3. Submit weekly M&M cases by Friday of each week (for the following Wednesday).
4. Responds to ED trauma room for all activations while in hospital and on call.
5. Assigns educational topics to junior residents and students as they see fit.
6. Attends/participates in all trauma conferences and rounds.

Mid-Level Resident Learning Objectives and Responsibilities

The PGY 2/3 resident should learn detailed principles of evaluation and management of injured patients. They should master the skills of caring for the mildly to moderately injured patient. They should begin to understand and participate in the quality initiatives of the trauma system as a whole.

Clinical Skills:

- Evaluate patients in the trauma bay according to ATLS principles
- Perform, under observation, the initial resuscitation of mild to moderately injured trauma patients.
- Diagnose and treat immediately life-threatening injuries (unstable airway, tension pneumothorax)
- Demonstrate that they are skilled in the follow-up care of injured patients; including, but not limited to: review of radiographic studies, coordination of services for care of the patient, discussion with patient families, and discharge planning.

Surgical Skills to Acquire:

- Placement of central venous lines and chest tubes with minimal guidance from senior residents or faculty.
- Wound care and laceration closure
- Cricothyroidotomy (supervised)

The resident will learn, understand, and demonstrate knowledge of:

- The pathophysiology of trauma – including the types of shock
- Assess the Glasgow coma score and its significance with regards to management and prognosis
- The structure and organization of the trauma response team.

The resident will show evidence of reading both basic texts and current scientific literature as it applies to the care of trauma patients. They will be an effective teacher of all junior team

members and of the advanced practice providers. They should review and analyze outcomes on a daily basis, and learn from mistakes and respond appropriately to criticism.

Additional PGY2/3 responsibilities:

- Act as the contact person for new consults (both general surgery and trauma), and be able to triage the care of those patients based on acuity.
- Be responsible for the care of the patients located in the emergency department until they reach their admission destination (ICU vs. surgical floor).
- Act as a resource for the junior resident and advanced practice providers for patient care issues on the floor.
- Present weekly trauma M&M cases under the guidance of the trauma program manager, trauma faculty, and senior residents.
- Present new/overnight cases, in detail, during morning report after they are on call overnight.
- Attend/participate in trauma conferences and rounds as they are clinically free to do so.
- Scrub into trauma and general surgery OR cases as they are clinically free to do so.

Intern Learning Objectives and Responsibilities

The PGY1 residents on the trauma service should learn the basic principles of caring for injured patients both in the ED and on the hospital floors. They should appreciate the importance of a systematic approach to the trauma evaluation, and will be ATLS certified prior to the start of their rotation. They will also understand the need for repeated examinations, follow up of diagnostic studies, and careful planning of outpatient services for the patients as they transition out of the hospital.

Clinical Skills:

- Recognize immediately life-threatening conditions and understand the principles of treatment.
- Accurately interpret and meaningfully apply information from diagnostic studies such as laboratory and imaging studies.
- Evaluate acute problems in floor patients and develop plans to further evaluate and treat these problems.
- Treat common medical problems in surgical patients.
- Learn to prioritize responsibilities and manage multiple patients concurrently.
- Coordinate plans for rehabilitation, discharge, and follow-up of injured patients.

Surgical Skills to Acquire:

- Central venous placement (supervised)
- Tube thoracostomy (supervised)
- Wound closure

The resident will learn, understand, and demonstrate knowledge of:

- ATLS guidelines for trauma evaluation and resuscitation with emphasis on the ABCDE approach and the Primary/Secondary survey strategy.
- Basic principles of postoperative care of trauma patients.
- Basic concepts of rehabilitation of trauma patients.
- The concepts of trauma systems and the function of a level I trauma center

The resident will show evidence of reading both basic texts and current scientific literature as it applies to the care of trauma patients. They will be an effective teacher of medical students. They should review and analyze outcomes on a daily basis, and learn from mistakes and respond appropriately to criticism.

Additional PGY1 Responsibilities:

- Attending and coordinating multi-disciplinary meetings of ancillary services to plan for the safe discharge and follow-up care of the injured patient.
- Respond to all trauma activations and assist with the evaluation and treatment of the patient as dictated by the trauma team leader.
- Evaluate and discuss the clinically status of the floor patients in detail during morning report, PM sign out, and on service rounds. They will also develop and present a care plan accordingly.
- Work in conjunction with the senior residents and advanced practice providers to accomplish any tasks for the floor patients in an efficient and appropriate manner.

Advanced Practice Provider Learning Objectives and Responsibilities

The role of the advanced practice provider (APP) on the trauma service is to provide exceptional continuity for the standards of care set forth in this manual with regards to care for the injured patient. They will master the care of the injured patient on the surgical floor, including their appropriate and safe transition out of the hospital to home/rehab and their follow-up care. They will also master the initial evaluation and resuscitation of the mildly to moderately injured trauma patient.

Clinical Skills:

- Recognize immediately life threatening injury and treat it as appropriate.

- Evaluate acute problems in floor patients, formulate a plan for further evaluation and treatment, including facilitating transfer to a higher level of care if needed.
- Coordinate multi-disciplinary plans for the injured patient, including those of ancillary services such as case management, physical therapy, and follow up care.
- Demonstrate the ability to triage and efficiently evaluate multiple patients in the emergency department or on the surgical floors.
- Coordinate the needs of a patient during massive transfusion efforts with regards to a balanced resuscitation, correction of endpoints of resuscitation, and adjunct treatments such as TXA.

Surgical Skills:

- Assistance with bedside procedures
- Independent performance of bedside procedures (dependent on experience)
- First assistant in the operating room for procedures of mild and moderate complexity/acuity.

Additional APP responsibilities

- Participate in the trauma QI process including peer review and research
- Act as a resource of junior and mid-level residents with regards to both clinical care and systems navigation of trauma patients

Tertiary Survey

The purpose of the tertiary survey is to re-examine the patient in a complete and thorough manner approximately 24 hours after the traumatic injury. All patients admitted to the trauma service, or admitted to other services with the trauma team in consultation, should undergo tertiary survey.

There is a high rate of delayed presentation / delay in the diagnosis of injuries in the trauma patient, especially in the multiply injured patient. 3.9 - 4.3% of all injuries are detected on tertiary survey, and 1.5 - 2.6% are missed on tertiary survey but detected prior to discharge.[1] Most commonly, injuries that are detected on the tertiary survey which are not detected on initial presentation are injuries to the extremities or injuries in the patient with altered mental status.

[1] Keijzers GB, Giannakopoulos GF, Del Mar C, Bakker FC, Geeraedts LM Jr. *Scand J Trauma Resusc Emerg Med*. 2012 Nov 29;20:77. doi: 10.1186/1757-7241-20-77. Review.

Guidelines for the performance of the tertiary survey are as follows:

- The tertiary survey will be a complete re-assessment of the patient as if the secondary survey is being repeated.
- The survey will ideally be done when the patient is awake and capable of participating in the exam. If this isn't possible due to altered mental status, yet another survey of the patient must be performed when they can finally participate in the examination.
- The survey will also include another detailed review of any lab work and radiology studies performed during the primary and secondary surveys.
- Any suspected injury based on physical examination must be interrogated by appropriate means (i.e. radiographic exams, splinting, bedside procedures, operative intervention as needed).
- The survey can be used as the daily progress note, but it must not be completed in haste by the team member performing the exam. It generally requires more than one team member to perform the examination especially if the patient is immobile from injury or otherwise.
- Particular attention should be made to patients transferred from an outside hospital, as they have a higher incidence of missed injury.[2]

[2] Hensgens RL, El Moumni M, IJpma FFA, Harbers JS, Duis KT, Wendt KW, Govaert GAM. *Eur J Trauma* Emerg Surg. 2019 Aug 9. doi: 10.1007/s00068-019-01195-1.

Weekly Schedule

Monday

- **0700 Morning Report**
- **0800 Service rounds**
- **1600 Evening Sign Out**

Tuesday

- **0700 Morning Report**
- **0745 Trauma M&M**
- **0830 Service Rounds**
- **1600 Evening Sign Out**

Wednesday

- **0700 Weekly M&M (except 4th Wednesday of every month)**
- **0800 Morning Report**
- **0900 Service Rounds**
- **1600 Evening Sign Out**

Thursday

****** 1st Thursday each month: Trauma Multidisciplinary Committee from 0700 - 0800******

- **0630 Resident Teaching (Trauma simulation 4th Thursday in Trauma bay)**
- **0715 Morning Report**
- **0800 Service Rounds**
- **1300 Research Meeting**
- **1600 Evening Sign Out**

Friday

- **0700 Morning report**
- **0745 Residents to Report to Conference**
- **1600 Evening Sign Out**

IV Access in the Trauma Bay

IV access in the trauma bay should not be trivialized. 100% of trauma patients undergo placement of a peripheral IV catheter, with many also receiving central venous catheters. IV access related complications are well described and largely preventable. The following recommendations should be observed in order to minimize line-related complications and decrease risk of thrombophlebitis, CLABSI, and other infectious or thrombotic complications.

- All lines placed in the field or ED are considered unsterile and should be replaced as soon as patient stability allows. Central lines placed with full barrier precautions are an exception.
- In an unstable patient, wide bore access should be obtained both "above the diaphragm" and "below the diaphragm." A central venous catheter should be inserted into the femoral vein. Large bore IVs (14 or 16 gauge) should be placed in the arm with consideration for placement of a subclavian central venous catheter.
    - Femoral access should be utilized with caution in the setting of severe pelvic fractures or potential for IVC injury (i.e. GSW to abdomen).
    - Patients with suspected cardiogenic shock should have a subclavian catheter or internal jugular catheter placed for monitoring of central venous pressure.
- **ALL CENTRAL LINES *SHOULD* BE PLACED UNDER "FULL BARRIER PRECAUTIONS."**
    - Defined as sterile gown, gloves, cap, mask, and full draping. This includes those people assisting with the procedure. Chlorhexidine prep should be used on the site prior to the procedure.
    - Exception can be made for a patient in extremis (i.e. resuscitative thoracotomy, arrest, etc.). This line should be removed as patient stability allows.

If intravenous access is unobtainable, intraosseous access is a preferred method for establishing access. This is true especially in children and should be considered prior to attempts at central venous line placement. The three most commonly used infusion sites for intraosseous infusion are the sternum, humerus, and tibia. In adults, flow rates of the sternum are 1.6 times better than the humerus and 3.1 times greater than the tibia.[3] Administration of blood products, ACLS medications, and adjuncts such as TXA can all be given via intraosseous access.[4]

If a resuscitative thoracotomy is performed and access is inadequate, a central catheter placed directly into the heart should be considered by the attending surgeon. This can be performed in a variety of ways with no clear consensus about best technique in the trauma literature.

[3] J Trauma Acute Care Surg. 2015 Feb;78(2):295-9. doi: 10.1097/TA.0000000000000516.
[4] J Trauma Acute Care Surg. 2018 Feb;84(2):379-385. doi: 10.1097/TA.0000000000001741.

Initial Laboratory Studies in the Trauma Patient

Generally, blood samples are obtained by the nurses and techs in the trauma room. They obtain the sample while simultaneously obtaining IV access. The most important tests include the type and screen and blood gas (for measuring endpoints of resuscitation).

All Trauma victims

*VBG (iSTAT) – ABG if in extremis and unable to obtain bloodwork

*Type and screen – can scooped up from the stretcher or from inside the chest if need be

EtOH level

UA/Urine toxicology screen as indicated

Urine or serum pregnancy (female age >10 or <60)

CBC

Coags

CMP

Pregnant Trauma victim (in addition to above)

Fibrinogen – consumption of fibrinogen is an indication of DIC; triggered by placental abruption.

Kleihauer-Betke – used to measure the amount of fetal hemoglobin transferred from a fetus to a mother's bloodstream.

ACLS in the Trauma patient

Are you performing CPR in the trauma bay?

YES?

Then STOP! They have no blood in their heart to circulate! Do one of the following instead:

1) **Perform an EDT / place a REBOA, and massively transfuse, or;**

2) **Declare them dead**

Vasopressor use in trauma patients has largely been shown to increase mortality. For the vast majority of trauma patients, they need blood product resuscitation and they need it now. Here is a list of studies which demonstrate this:

Plurad DS, Talving P, Lam L, et al: Early vasopressor use in critical injury is associated with mortality independent from volume status. *J Trauma* 2011; 71:565–570; discussion 570–572

Sperry JL, Minei JP, Frankel HL, et al: Early use of vasopressors after injury: Caution before constriction. *J Trauma* 2008; 64:9–14

Makoto A, Abe T, Saitoh, D, et al: Use of Vasopressor Increases the Risk of Mortality in Traumatic Hemorrhagic Shock: A Nationwide Cohort Study in Japan. *Critical Care Medicine*; 46(12):e1145-e1151.

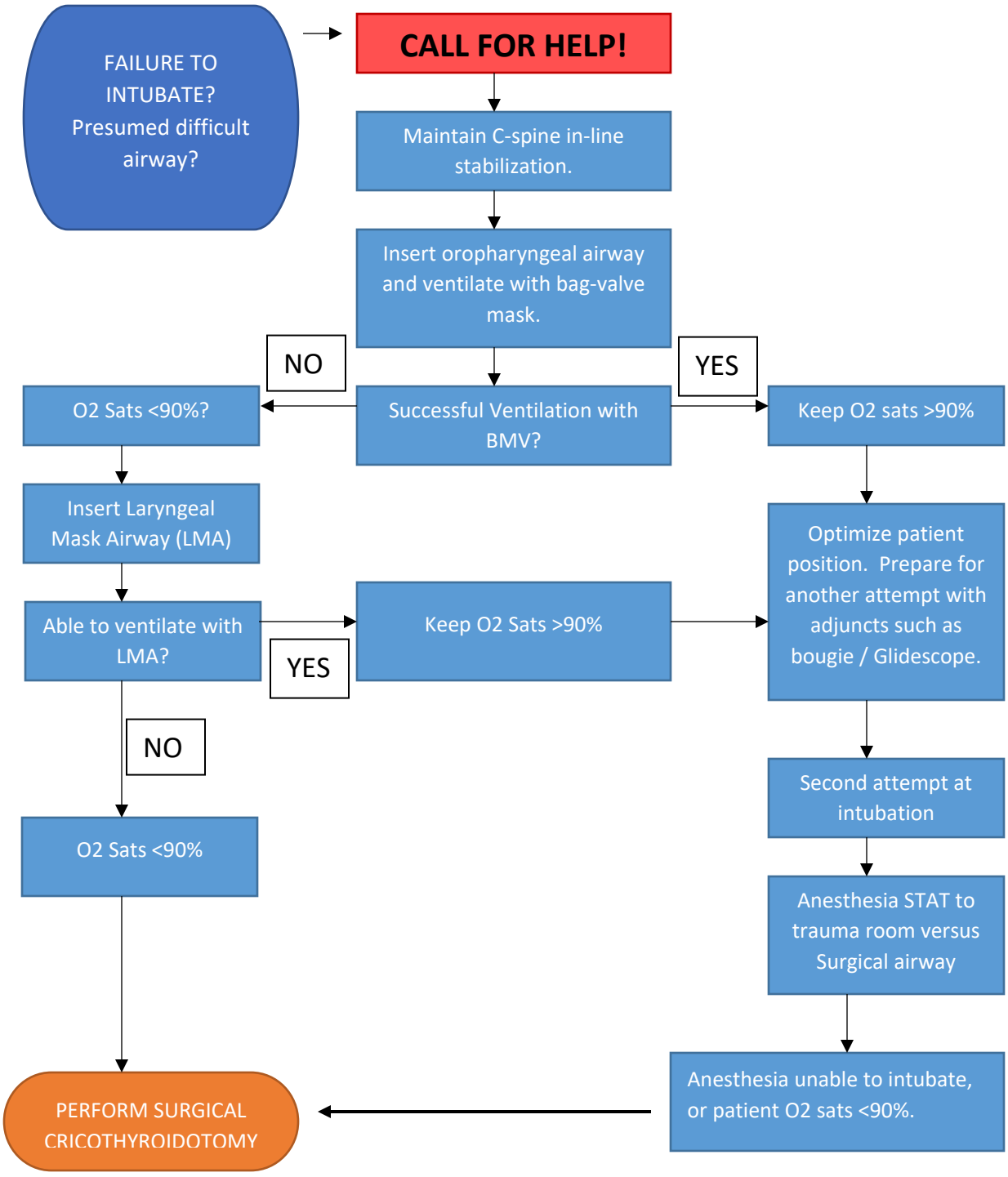
Rapid Sequence Intubation

1. If patient will require intubation; upgrade to full trauma if not already triaged as such.
2. Assemble staff, i.e. ED attending, trauma surgery team, and respiratory therapist
3. Continuous monitoring of BP, ECG, and SaO2.
4. Consider appropriateness of patient for RSI, DSI, Awake, Surgical or Code Airway – At discretion of ED Attending and Trauma Attending

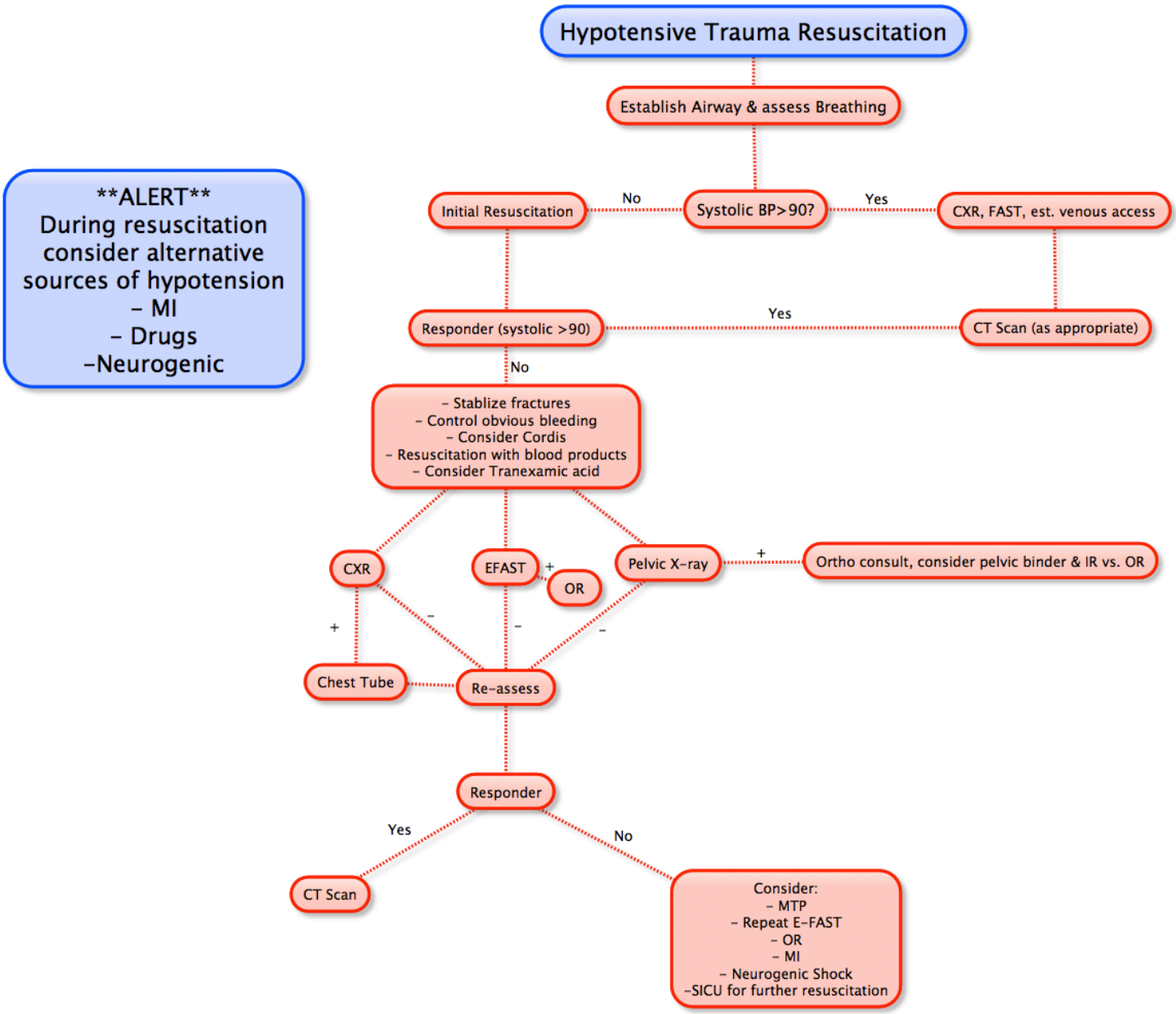
   IF RSI appropriate:
   1. Prepare the Patient: pre-oxygenation; position – reverse trendelenburg stretcher if possible
   2. Assess Difficulty of Patient (Examine airway, check anatomy, LEMONS)
   3. Consider Anesthesiology Consultation if significant difficulty anticipated
   4. Prepare equipment with specific backup plans (suction, ETT with syringe, color capnography, laryngoscope, BVM, oral/nasal airways, video-laryngoscope, Bougie)
   5. Prepare the Team – Identify the roles and plan out loud
   6. Consider Pre-medications as indicated with caution:
      i. Fentanyl give at least 3 minutes ahead in the setting of suspected elevated intracranial pressure or CAD, be ready to ventilate, avoid in normo- and hypotensive
      ii. Atropine at bedside (1mg IV adults; 0.02mg/kg pediatric)
   7. Inducing agent at the discretion of the attending (i.e. Etomidate 0.3mg/kg IV or Ketamine 1-2 mg/kg)
   8. Check for ease of bagging
   9. Paralytic agent at the discretion of the attending (i.e. Succinylcholine 1.5mg/kg IV or Rocuronium 1.2mg/kg IV)*
   10. Wait until full paralysis 60 seconds, check eyelid/jaw.
   11. Manual Inline cervical immobilization of potential C-spine injury with collar open.
   12. Pass the ETT
   13. Confirm ETT position with end tidal CO_2, chest rise, bilateral breath sounds, misting of ETT, and CXR
   14. Consider long term sedation with propofol (5-50mcg/kg/min) or midazolam (0.05-0.2mg/kg/hr) depending on hemodynamics.

*Avoid succinylcholine if >24 hours post burn, >7 days post crush, hyperkalemia, penetrating eye injuries, CVA, rhabdomyolysis, neuromuscular disease, or family history of malignant hyperthermia.

Management of the Difficult Airway



Resuscitation of the Hypotensive Trauma Patient



Practice Guidelines for the Treatment of Hemorrhagic Shock from Traumatic Injury

I INTRODUCTION

Mortality rates for traumatic injury have been decreasing for the past 30 years with the implementation of damage control strategies. They continue to be elevated during the first hour following trauma center arrival among patients with uncontrolled hemorrhage.[5] This continued high mortality rate is attributable to ongoing hemorrhagic shock as a result of the self-perpetuating triad of coagulopathy, acidosis, and hypothermia.[6] Measures to stop this process have long been a part of trauma resuscitation, including hypothermia management, surgical control of ongoing bleeding, and treatment of coagulopathy with blood products.

"Massive transfusion (MT)" is universally accepted as a transfusion of >9 units of PRBCs in a 24 hour period.[7] For the past 20 years, there has been a trend towards increased use of blood products during trauma resuscitation and MT. This has been driven largely by military experience and has carried into the civilian setting – 3% of civilian trauma requires similar damage control principles.[9]

The current proven strategies for MT include a high plasma : platelet : PRBC ratio. This transfusion strategy has been shown to improve mortality.[8,9] Exact ratios are debatable, but a 1:1:1 ratio is currently the accepted standard of care with evidence that it reduces death due to exsanguination within 24 hours.[10] Additionally, there is evidence that a "plasma first" approach also reduces mortality by 8-10%.[11] This benefit is most clear in pre-hospital transport times of greater than 20 minutes.[12]

In addition to modern MT practices, maintaining normothermia and preventing acidosis are the key components to an effective trauma resuscitation. The following guideline will address all aspects of the resuscitation of a trauma patient with suspected hemorrhage – including the

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[5] Demetriades D, Murray J, Charalambides K, Alo K, Velmahos G, Rhee P, Chan L. Trauma Fatalities: Time and Location of Hospital Deaths. *J Am Coll Sur* 2004; 198:20-26.

[6] MacLeod JB, Lynn M, McKenney MG, Cohn SM, Murtha M. Early Coagulopathy Predicts Mortality in Trauma. *J Trauma.* 2003; 55:39-44.

[7] alone DL,. Hess JR, Fingerhut A. Massive transfusion practices around the globe and a suggestion for a common massive transfusion protocol. *J Trauma* 2006; S91-S96.

[8] Holcomb JB, Wade CE, Michalek JE, Chisholm GB, Zarzabal LA, Schreiber MA, Gonzalez EA, Pomper GJ, Perkins JG, Spinella PC, Williams KL, Park MS. Increased plasma and platelet to red blood cell ratios improves outcome in 466 massively transfused civilian trauma patients. *Ann of Surg* 2008; 248:447-458.

[9] Zink KA, Sambasivan CN, Holcomb JB, Chisholm G, Schreiber MA. A High ratio of plasma and platelets to packed red blood cells in the first 6 hours of massive transfusion improves outcomes in a large multicenter study. *Am J Surg* 2009; 197:565-570.

[10] Holcomb JB, Tilley BC, Baraniuk S, et al. Transfusion of Plasma, Platelets, and Red Blood Cells in a 1:1:1 vs a 1:1:2 Ratio and Mortality in Patients With Severe Trauma: The PROPPR Randomized Clinical Trial. *JAMA.* 2015;313(5):471–482. doi:10.1001/jama.2015.12

[11] Sperry JL, Guyette FX, et al. Prehospital Plasma during Air Medical Transport in Trauma Patients at Risk for Hemorrhagic Shock. N Engl J Med 2018; 379:315-326.

[12] Pusateri AE, Moore EE, Moore HB, et al. Association of Prehospital Plasma Transfusion With Survival in Trauma Patients With Hemorrhagic Shock When Transport Times Are Longer Than 20 Minutes: A Post Hoc Analysis of the PAMPer and COMBAT Clinical Trials. *JAMA Surg.* Published online December 18, 2019. doi:10.1001/jamasurg.2019.5085

recognition of hemorrhagic shock, intravenous access, early triggers for activating the massive transfusion protocol (MTP), adjuncts to the MTP, the transition of care from one hospital venue to another, and cessation of MTP.

II EARLY RECOGNITION OF HEMORRHAGIC SHOCK

Predicting the need for MT is difficult. Mortality improves with early recognition and activation of MTP, but complications also increase of patients receive un-necessary blood products. Various prediction tools exist in order to predict the need for MT. Positive prediction values hover around 50 percent, but more importantly the negative predictive values are generally in the 90-95 percent range. Because of its pre-hospital utility, we will focus on the Shock Index (SI) as an early trigger for MTP activation. Additionally, adjunct bloodwork on presentation and clinical circumstances may assist in the decision to activate MTP.

***Shock Index = Heart Rate / Systolic Blood Pressure**

Action plans for early recognition of need for MT:

A) Age, mechanism of injury, GCS, and blood pressure from the field will be included in the trauma page whenever possible.
B) SI >1 with penetrating mechanism of injury is indication for pre-hospital activation of MTP.
C) SI >1 and age >55, regardless of mechanism, is indication for pre-hospital activation of MTP regardless of mechanism.
D) Initial blood pressure will be obtained manually by an emergency department tech or nurse.
E) Initial SI on arrival will be documented by the care team in the medical record.
F) SI > 0.9 should raise suspicion for hemorrhage, especially with a pulse pressure <45.
G) Venous blood gas will be obtained as a point of care test as an adjunct to the primary survey. This will provide an initial base deficit. Base deficit will be recorded on the trauma continuity form so that it can be corrected as a measureable endpoint of resuscitation.
H) Base deficit of 5 or more (also expressed as a base excess of -5 or less) should raise suspicion for hemorrhage.

III INITIAL RESUSCITATION OF THE TRAUMA PATIENT IN HEMORRHAGIC SHOCK

****Please also reference the St. Francis Hospital Massive Transfusion Protocol****

Suspected hemorrhage in a trauma patient should prompt the use of universal blood product infusion rather than crystalloid or colloid solutions. Additionally, trauma centers with thawed plasma immediately available have seen reductions in blood product utilization.[13] The use of a "plasma first" approach has reduced mortality by 10% in the pre-hospital settings, and seems to have the largest benefit in those patients with transport times of greater than 20 minutes.[7,8]

[13] American College of Surgeons (2014). ACS TQIP Massive Transfusion in Trauma Guidelines.

Early activation of MTP has been shown to improve outcomes.[14] Tranexamic Acid (TXA) is an antifibrinolytic agent that has been shown to decrease the mortality of bleeding patients if given with the first 3 hours after their injury. The relative risk was 0.79 compared to placebo.

Action plans for the initial resuscitation of the trauma patient in hemorrhagic shock:

A) Large bore IV access should be obtained.
    a. 16g or larger in the upper extremity should be attempted by ED nursing
    b. Smaller gauge IVs can be upsized to a RIC catheter
B) Central access with a cordis can be placed in the femoral vein. **Consider access in the arm or subclavian vein as well, especially for penetrating abdominal/pelvic trauma.**
C) All blood products and fluids should be given via the rapid insfuser at a rate that can sustain permissive hypotension (80-100 systolic).
D) The trauma bay refrigerator should be stocked with 2U FFP and 4U PRBC
E) 2 units of FFP should be initially given. Activation of MTP should be considered at this point.
F) Any need for further resuscitation beyond the 2U of FFP ***mandates*** activation of MTP.
G) Ongoing component therapy will continue as described in the MTP protocol.
H) Any blood components should be recorded on the trauma continuity form.
I) All patients who undergo MTP activation should receive 1g TXA infused over 10 minutes and an additional 1g of TXA over the course of 8 hours after the bolus dose.

IV USE OF PRESSORS IN HEMORRHAGIC SHOCK

Vasopressor use in trauma patients has largely been shown to increase mortality.[15,16,17] For the vast majority of trauma patients, vasopressors should be avoided until surgical bleeding is controlled and they are proven to be adequately resuscitated with blood products.

A 2019 study showed that low-dose arginine vasopressin supplementation in patients with hemorrhagic shock may decrease overall transfusion needs.[18] While promising, there is not yet enough evidence to support this change in practice.

V HYPOTHERMIA

[14] Nunez TC. Voskresensky IV. Dossett LA. Shinall R. Dutton WD. Cotton BA. Early prediction of massive transfusion in trauma: simple as ABC (assessment of blood consumption)? *J Trauma* 2009; 66:346-352.

[15] Plurad DS, Talving P, Lam L, et al: Early vasopressor use in critical injury is associated with mortality independent from volume status. *J Trauma* 2011; 71:565–570; discussion 570–572

[16] Sperry JL, Minei JP, Frankel HL, et al: Early use of vasopressors after injury: Caution before constriction. *J Trauma* 2008; 64:9–14

[17] Makoto A, Abe T, Saitoh, D, et al: Use of Vasopressor Increases the Risk of Mortality in Traumatic Hemorrhagic Shock: A Nationwide Cohort Study in Japan. *Critical Care Medicine*; 46(12):e1145-e1151.

[18] Sims CA, Holena D, Kim P, et al. Effect of Low-Dose Supplementation of Arginine Vasopressin on Need for Blood Product Transfusions in Patients With Trauma and Hemorrhagic Shock: A Randomized Clinical Trial. *JAMA Surg.* 2019;154(11):994–1003. doi:10.1001/jamasurg.2019.2884

Hypothermia is a pathophysiologic consequence of severe injury and subsequent resuscitation. It is estimated that as many as 66% of trauma patients arrive in the emergency department with hypothermia.[19] Temperature loss is most severe in the emergency department setting.[20] Body temperatures less than 33°C produce a coagulopathy that is functionally equivalent to factor deficiency states seen when coagulation factor concentrations are less than 50%. The most significant effect of hypothermia in trauma is coagulopathic bleeding due to prolonged clotting cascade enzyme reactions, dysfunctional platelets, and fibrinolysis.[21]

Action Plans for Identification and Prevention of Hypothermia:

A) Remove blood-soaked or wet clothes and dressings from contact with the patient.
B) Ambient trauma bay temperature should be 80 F.
C) Decrease air flow over the patient by keeping the room doors shut.
D) All trauma patients will have a temperature recorded in the trauma bay. This will be recorded on the trauma continuity form for when the patient moves from the emergency department.
E) Warm blankets will be applied to the patient when possible.
F) Aluminum space blankets over the patient provide greater heat exchange by creating a 43 C microenvironment around the patient, effectively stopping heat loss.
G) Head covering is of utmost importance – 50% of heat loss is from the neck up.[22]
H) All blood products and fluid resuscitation should be administered through the rapid insfuser at a temperature of 42C.[23]
I) Intraoperative temperatures will be intermittently monitored and recorded.
J) During laparotomy, use dry towels or plastic bags to cover the exposed bowel. Moist towels increase evaporative heat loss by 250%.[11]

VI TRANSITION FROM ED TO OR / IR / SICU

The movement of an unstable trauma patient should not be taken lightly. Severe hemodynamic instability generally necessitates transfer to the operative theater rather than to CT or to interventional radiology. There are many “boxes to check” in the care of the hemorrhaging patient, and it is important to perform a systematic review of the patient’s prior resuscitative efforts when they reach a new location.

Action plans for patient transfer, transport, and preservation of continuity of care:

[19]Luna G.K., Maier R.V., Pavlin E.G., et al. Incidence and effect of hypothermia in seriously injured patients. *J Trauma* 1987;27:1014-1018.
[20] Gregory J.S., Flancbaum L., Townsend M.C., et al. Incidence and timing of hypothermia in trauma patients undergoing operations. *J Trauma* 1991;31:795-800.
[21]Gentilello L.M., Jurkovich G.J. Hypothermia. In: Ivatury RR, Cayten CG, eds. The Textbook of Penetrating Trauma. Baltimore: Williams & Wilkens; 1996;995-1005.
[22]Johansson PI, Stensballe, Hemostatic resuscitation for massive bleeding: the paradigm of plasma and platelets--a review of the current literature. Transfusion. 2010;50(3):701.
[23] American Association of Blood Banks. Technical Manual. Standards for Blood Banks and Transfusion Services. 18th Ed. Bethesda, MD: American Association of Blood Banks; 1998.

A) The trauma continuity form will remain bedside with the patient until the patient is stable in the ICU setting. **Please see attachment to this guideline.**
    a. This form will include valuable information regarding resuscitation efforts including IV access, patient temperature, TXA status, blood products administered, and endpoints of resuscitation (i.e. last base deficit).
    b. The form will be maintained by bedside nursing in the ED and ICU. It will be maintained by the anesthesia team in the OR.
B) The trauma surgery attending should remain with the patient during all transportation and transitions between care teams. They will provide clinical oversight and act as ultimate continuity of care. The chief surgical resident can perform this role should the attending be otherwise encumbered and backup attending has yet to arrive.
C) The trauma surgery attending will remain at the patient's bedside in any "austere" area of the hospital such as CT or Interventional Radiology. The chief surgical resident can perform this role should the attending be otherwise encumbered and backup attending has yet to arrive.
D) Once surgical bleeding is controlled (either via operative control or embolization), the resuscitation should continue in the ICU, where the trauma surgery attending will continue the direct oversight of the resuscitation with the help of the SICU APP/resident team.
    a. Arrival of the patient to the ICU should be anticipated with the necessary equipment to continue rapidly infusing products.
    b. Attention should be paid to correcting factors that exacerbate coagulopathy such as hypothermia, acidosis, and hypocalcemia.
    c. Frequent reassessments should be made to determine if the patient requires a return to the operating room, interventional radiology, or cessation of MTP either due to a) clinical improvement or b) medical futility.

VII ICU RESUSCITATION ALGORITHM AND CESSATION OF MTP

Action plans for the continuation of MTP in the ICU

A) Upon arrival in the ICU, baseline lab measures should be obtained and repeated as needed (or at least hourly until the MTP is halted)
    a. INR, aPTT, Fibrinogen, hemoglobin/hematocrit, platelet count, ionized calcium, blood gas with base deficit
    b. TEG if available with POC review of the tracing
B) Use of empiric, fixed ratios of blood per MTP should be followed until surgical bleeding has been controlled AND until the POCT and laboratory data are available.
C) Once bleeding is controlled and aforementioned data are available, ongoing resuscitation should be goal directed:
    a. No POCT TEG available
        i. PRBC for Hb < 10
        ii. Plasma for PT > 18

iii. Plasma for aPTT > 35
iv. Platelets for < 150
v. Cryoprecipitate for fibrinogen < 180

b. POCT TEG available
i. Plasma for r-value > 9 minutes
ii. Plasma and/or cryoprecipitate for k-time >4 minutes
iii. Cryoprecipitate for alpha-angle <60 degrees
iv. Platelets for mA <55mm
v. TXA or Amicar for LY30 >7.5%

D) MTP should be discontinued at the discretion of the trauma surgeon (in consultation with the anesthesiologist if still in the OR). This should be after control of bleed, correction of goal directed laboratory data, and with the following clinical criteria:
a. Hemodynamics are stable or improving
b. Stable or increasing urine output
c. Decreasing requirement for vasopressors (ideally none)

MTP should be discontinued when there is recognition that further resuscitation is futile.

Resuscitative Thoracotomy

1. **Pulselessness in the trauma bay is considered to be from hemorrhage until proven otherwise. ACLS protocols will not work in a patient that has no blood to circulate.**

2. **RT can be considered in a patient that is found to be in arrest.**

3. **Goals of the RT are as follows:**

    a. **Relieve tension pneumothorax and identify/evacuate massive hemothorax**
    b. **Relieve cardiac tamponade**
    c. **Cross-clamp the aorta to preserve perfusion of coronary and carotid circulation**
    d. **Identify any devastating thoracic injury that can be temporarily controlled**
    e. **Initiate open cardiac massage**

How to perform RT:

1. **RT is always performed on the left.**

2. **Simultaneous right chest tube is required to rule out right hemi-thorax injury**

3. **Central IV access is of utmost importance and should be performed simultaneously by another experienced provider – Remember patient needs MTP!**

4. **Left anterolateral thoracotomy is performed from sternum to the bed – $4^{th}/5^{th}$ intercostal space.**

5. **Retractor placed with crank toward axilla (to allow for potential conversion to bilateral anterolateral thoracotomy i.e. "clamshell" thoracotomy)**

6. **Open pericardial sac longitudinally in a location anterior to phrenic nerve; deliver the heart**

7. **Mobilize the inferior pulmonary ligament.**

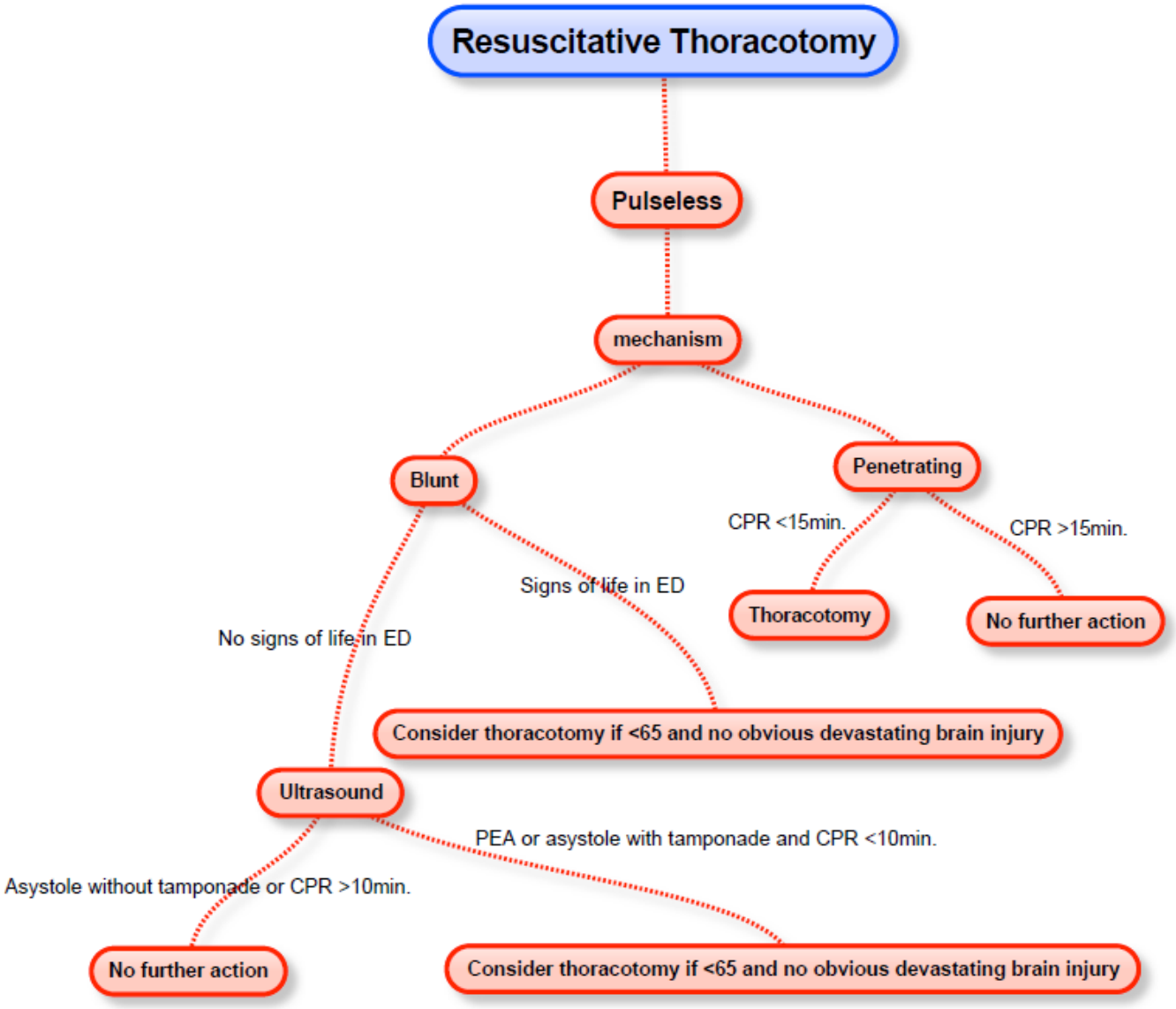
8. **Provider on patient's right should retract the lung medially to expose the patient's spine and Aorta directly anterior to the spine.**

9. **Sharply dissect a plane of tissue anterior and posterior to Aorta, place Aortic crossclamp**

10. Assess for thoracic injury and perform open cardiac massage with MTP ongoing.

11. If right chest tube has evidence of hemothorax, convert to bilateral thoracotomy for control of potentially lethal hemorrhage on the right.

12. Decision to perform RT will always be at the discretion of the provider, but the following algorithm is derived from evidence looking at meaningful neurologic recovery in the settings of arrest following both blunt and penetrating trauma.



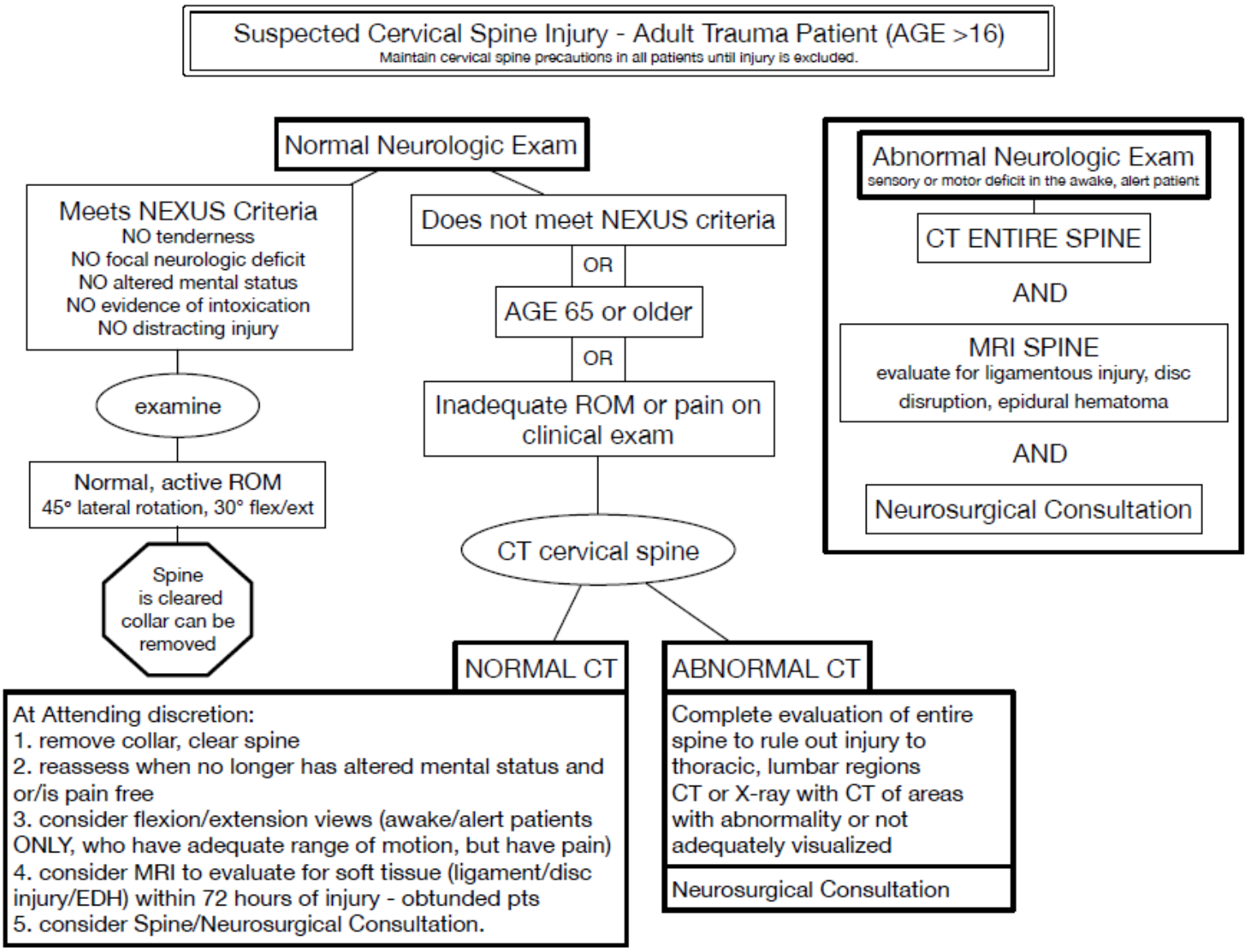
1. Defining the limits of resuscitative ED thoracotomy: a contemporary WTA perspective. Moore et al. J Trauma 2011 Feb;70(2):334-9

Imaging Studies in Blunt Trauma

☐ **Trauma Head CT**	**CT head non-contrast** – Suspicion of head injury AND anyone of the following are present: ☐ Taking any anticoagulation or antiplatelet agents ☐ GCS < 15 on arrival ☐ Suspected open or depressed skull fx ☐ Any sign of basilar skull fx (hemotympanum, raccoon eyes, Battle's sign, oto- or rhinorrhea) ☐ Dangerous mechanism i.e. ped struck, ejected, Fall > 3 feet: or 5 stairs ☐ Age ≥ 65 Consider if: ☐ Retrograde amnesia > 30 minutes ☐ ≥ 2 episodes of vomiting or 2 episodes of seizure with no history of seizure
☐ **Trauma Face CT**	**CT Max/Face** ☐ Exam is suggestive of midface or mandibular fracture
☐ **CT Angio - Neck**	**CT Angio or Neck** – Order if any one of the following are present: ☐ Neurologic abnormality not explained by diagnosed injury or previous imaging ☐ Arterial epistaxis ☐ Seat belt sign on neck ☐ GCS ≤ 8 unexplained by brain imaging ☐ Fracture through foramen transversarium ☐ Petrous bone fracture ☐ C-spine fracture (C1-C3) or subluxation at any level ☐ LeFort II or III fractures ☐ Expanded Denver Criteria **Please see blunt cerebrovascular injury protocol (page XX)**

☐ **Trauma Chest CT** Note: please order 3D recons if Rib fractures	**CT chest w/IV contrast** – Suspect aortic injury if sufficient mechanism and: ☐ CXR findings: widened mediastinum, irregular or non-visible aortic knob, apical pleural cap, deviated trachea/mainstem ☐ Sternal fracture ☐ First rib fracture ☐ MVC 30 Mph + Chest wall tenderness to palpation(TTP) ☐ Chest wall tenderness suggestion of significant rib fractures ☐ Hypotensive episode ☐ Torso crush injury ☐ CXR ≥ 3 rib fractures ☐ Concern for thoracic spine fracture (tenderness on exam)
☐ **Trauma Abd/Pelvis CT**	**CT abd/pelvis w/IV contrast** – Image if any of the following are present: ☐ Abnormal abdominal, pelvic or lumbar spine exam ☐ Positive FAST – but HD stable and no peritonitis ☐ Intubated patient ☐ GCS < 11 ☐ Impaired or unreliable exam with sufficient mechanism ☐ Concern for lumbar spine fracture ☐ Hemodynamic responsive & stable after IV Fluid
☐ **CT C-Spine**	☐ **CT cervical spine** ☐ Age ≥ 65, if mechanism and even if no pain or tenderness ☐ on exam ☐ Dangerous mechanism (fall > 3 feet/5 stairs, axial loading, i.e. MVC >60 mph, roll over, ejection, bicycle crash, ped struck.) ☐ Midline TTP or pain w/ROM ☐ Any neurologic symptoms (motor/sensory/paresthesia) ☐ Any distracting injury

C-Spine Clearance

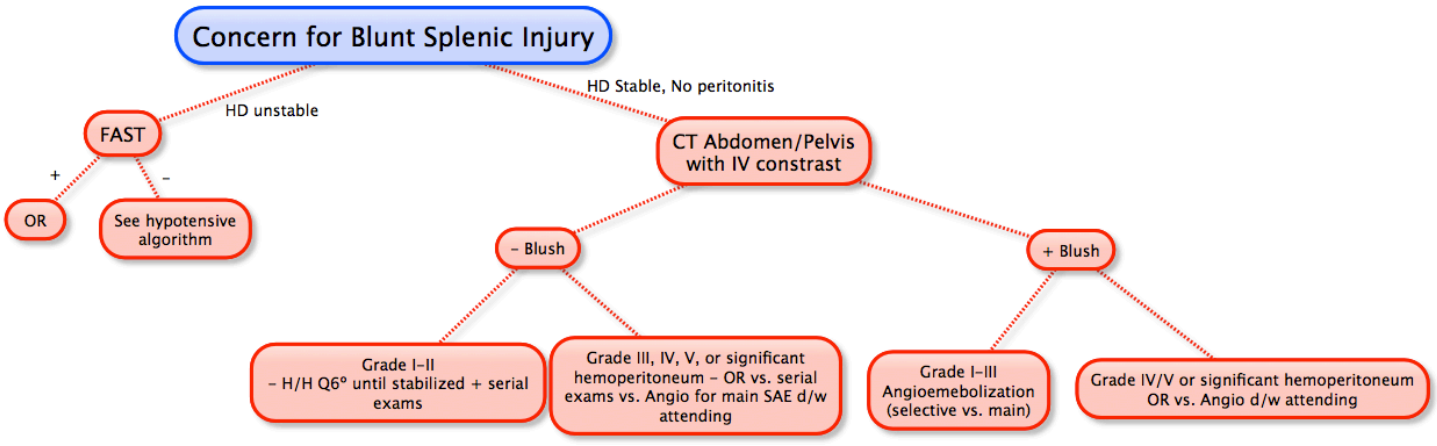


Splenic Trauma

Spleen injury scale (1994 revision)

Grade*	Injury type	Description of injury	ICD-9	AIS-90
I	Hematoma	Subcapsular, <10% surface area	865-01	2
			865.11	
	Laceration	Capsular tear, <1cm	865.02	2
		parenchymal depth	865.12	2
II	Hematoma	Subcapsular, 10%-50% surface area	865.01	
		intraparenchymal, <5 cm in diameter	865.11	
				2
	Laceration	Capsular tear, 1-3cm parenchymal depth that does not involve a trabecular vessel	865.02 865.12	
				3
III	Hematoma	Subcapsular, >50% surface area or expanding; ruptured subcapsular or parecymal hematoma; intraparenchymal hematoma ≥ 5 cm or expanding		
	Laceration	>3 cm parenchymal depth or involving trabecular vessels	865.03	3
			865.13	
IV	Laceration	Laceration involving segmental or hilar vessels producing major devascularization (>25% of spleen)		4
V	Laceration	Completely shattered spleen	865.04	5
	Vascular	Hilar vascular injury with devascularizes spleen	865.14	5

*Advance one grade for multiple injuries up to grade III.
From Moore et al. [4]; with permission



- To consider NOM patient must be HD stable, no peritonitis, and no other indication for urgent laparotomy plus admit to monitored bed with serial exams.
- Failure NOM if becomes HD unstable, develop peritonitis, require >2-4U PRBC in 24hr.
- Consider other factors such as age, concomitant injuries, and baseline medical status in all decisions for non-operative management.

CDC recommendations for vaccines for asplenia:

At time of discharge:

- PCV 13 (Prevnar 13)
- Meningococcal ACYW (Menactra, Menveo, MedQuafi)
- Meningococcal B (Bexsero or Trumenba)
- Hib (ACThib OR Hiberix)

8 weeks later:

- PPSV23 (Pneumovax 23)
- Meningococcal ACYW (Menactra, Menveo, Medquafi)
- Meningococcal B (Bexsero or Trumenba)

Long term:

- PPSV 23 (Pneumovax 23) every 5 years
- Meningococcal ACYW (Menactra, Menveo, MedQuafi) every 5 years
- Seasonal flu annually

The Trinity formulary for Meningococcal ACYW is Menactra. Menactra cannot be given at the same time as PCV 13, as it interferes with the immunologic response to PCV13. Thus, in addition to the schedule above, the patient would have to return 4 weeks from discharge to receive Menactra. If the patient does not follow up, they then have received no vaccination against meningococcal ACYW. Here in Hartford, many of our patients do not have primary care doctors or access to reliable transportation. Multiple follow up visits can be difficult or impossible.

Menveo **CAN** be administered at the same time PCV13. In a population at very high risk but low compliance with follow up, **Menveo** should be available through the Trinity formulary.

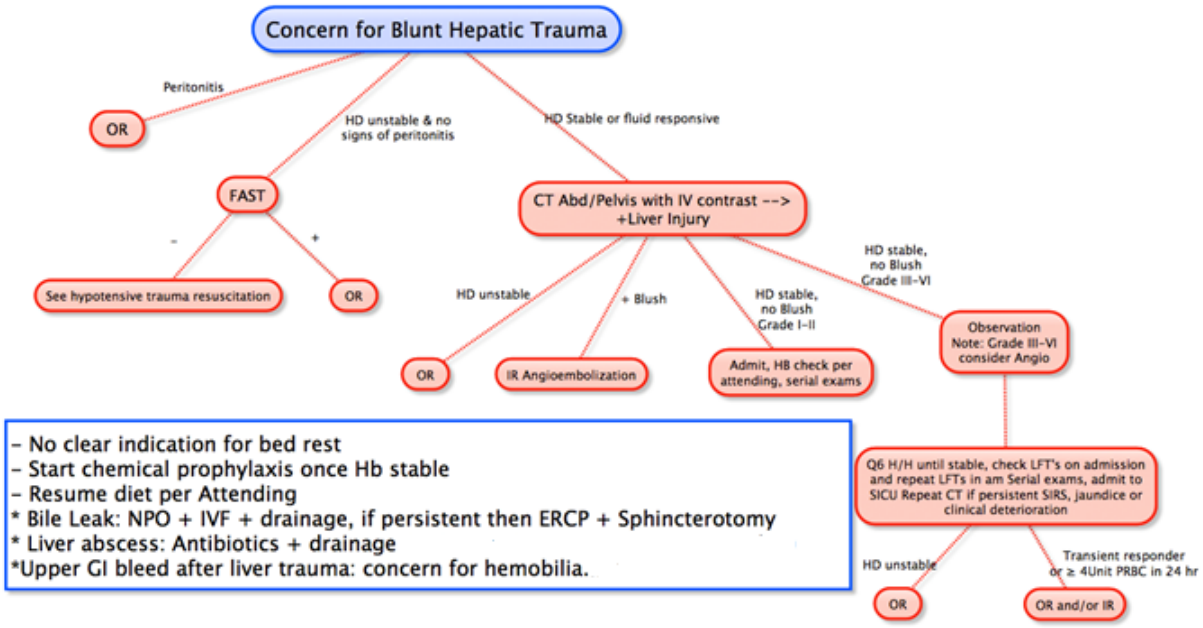
Hepatic Trauma

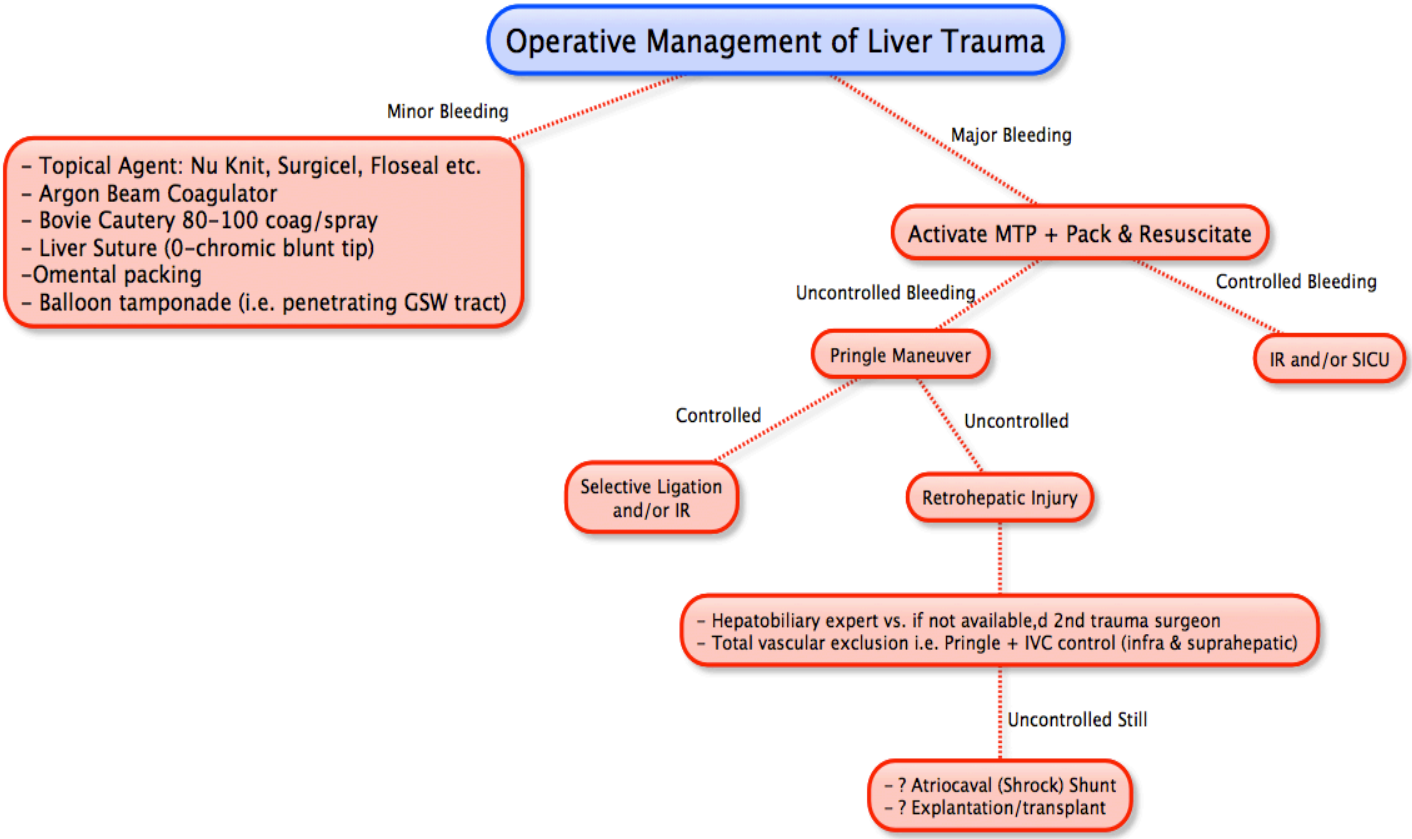
Table 8

Liver injury scale (1994 revision)

Grade*	Type of Injury	Description of injury	ICD-9	AIS-90
I	Hematoma	Subcapsular, <10% surface area	864.01 864.11	2
	Laceration	Capsular tear, <1cm parenchymal depth	864.02 864.12	2
II	Hematoma	Subcapsular, 10% to 50% surface area intraparenchymal <10 cm in diameter	864.01 864.11	2
	Laceration	Capsular tear 1-3 parenchymal depth, <10 cm in length	864.03 864.13	2
III	Hematoma	Subcapsular, >50% surface area of ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma > 10 cm or expanding		3
	Laceration	>3 cm parenchymal depth	864.04 864.14	3
IV	Laceration	Parenchymal disruption involving 25% to 75% hepatic lobe or 1-3 Couinaud's segments	864.04 864.14	4
V	Laceration	Parenchymal disruption involving >75% of hepatic lobe or >3 Couinaud's segments within a single lobe		5
	Vascular	Juxtahepatic venous injuries; ie, retrohepatic vena cava/central major hepatic veins		5
VI	Vascular	Hepatic avulsion		6

*Advance one grade for multiple injuries up to grade III
From Moore et al. [4]; with permission



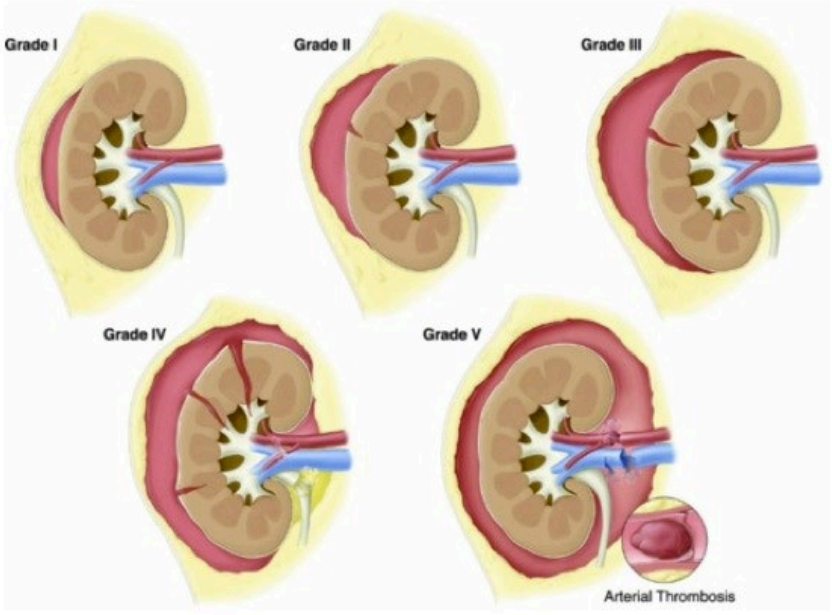

Operative Management of Liver Trauma
Minor Bleeding
- Topical Agent: Nu Knit, Surgicel, Floseal etc.
- Argon Beam Coagulator
- Bovie Cautery 80-100 coag/spray
- Liver Suture (0-chromic blunt tip)
-Omental packing
- Balloon tamponade (i.e. penetrating GSW tract)
Major Bleeding
Activate MTP + Pack & Resuscitate
Uncontrolled Bleeding
Controlled Bleeding
Pringle Maneuver
IR and/or SICU
Controlled
Uncontrolled
Selective Ligation and/or IR
Retrohepatic Injury
- Hepatobiliary expert vs. if not available,d 2nd trauma surgeon
- Total vascular exclusion i.e. Pringle + IVC control (infra & suprahepatic)
Uncontrolled Still
- ? Atriocaval (Shrock) Shunt
- ? Explantation/transplant

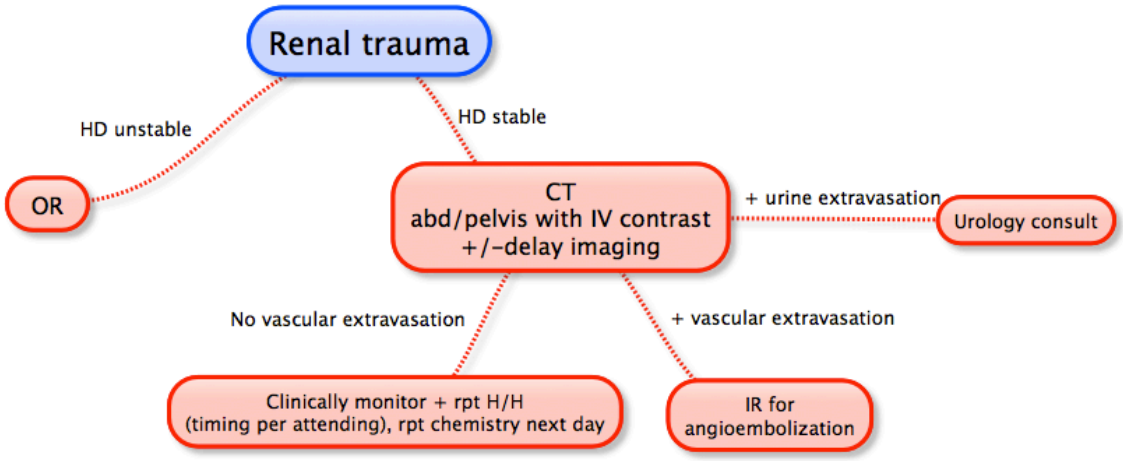
Renal Trauma

Kidney injury scale

Grade*	Type of injury	Description of injury	ICD-9	AIS-90
I	Contusion	Microscopic or gross hematuria, urologic studies normal	866.01	2
	Hematoma	Subcapsular, nonexpanding without parenchymal laceration	866.11	2
II	Hematoma	Nonexpanding perirenal hematma confirmed to renal retroperitoneum	866.01 866.11	2
	Laceration	<1.0 cm parenchymal depth of renal cortex without urinary extravagation	866.02 866.12	2
III	Laceration	<1.0 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravagation	866.02	3
IV	Laceration	Parenchymal laceration extending through renal cortex, medulla, and collecting system	866.12	4
	Vascular	Main renal artery or vein injury with contained hemorrhage		4
V	Laceration	Completely shattered kidney	866.03	5
	Vascular	Avulsion of renal hilum which devascularizes kidney	866.13	5

*Advance one grade for bilateral injuries up to grade III
From Moore et al. [7]; with permission





Blunt renal artery injury: assess complete vs. incomplete; < or > 4hrs., ? 2nd functional kidney and d/w attending

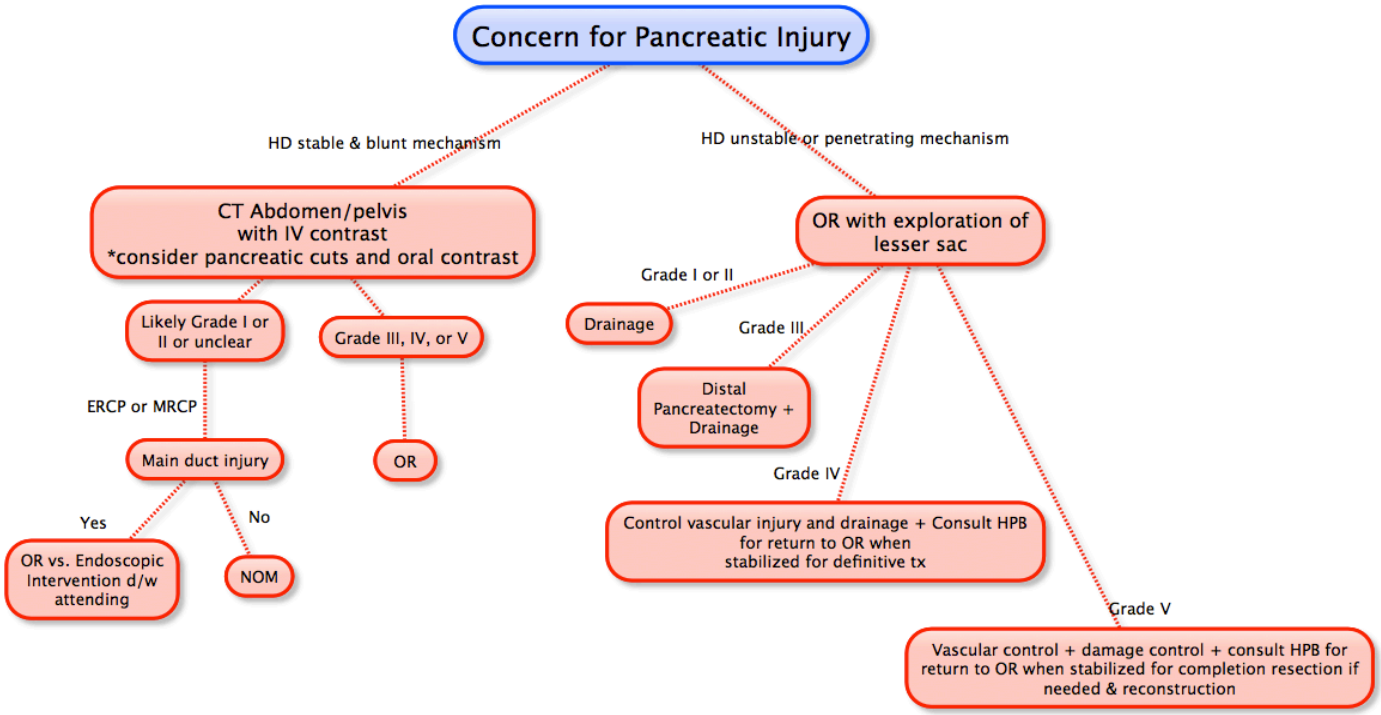
Pancreatic Injury

Table 10

Pancreas Injury Scale

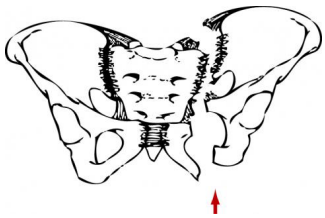
Grade*	Type of Injury	Description of Injury	ICD-9	AIS-90
I	Hematoma	Minor contusion without duct injury	863.81-863.84	2
	Laceration	Superficial laceration without duct injury		2
II	Hematoma	Major contusion without duct injury or tissue loss	863.81-863.84	2
	Laceration	Major laceration without duct injury or tissue loss		3
III	Laceration	Distal transection or parenchymal injury with duct injury	863.92/863.94	3
IV	Laceration	Proximal? transection or parenchymal injury involving ampulla	863.91	4
V	Laceration	Massive disruption of pancreatic head	863.91	5

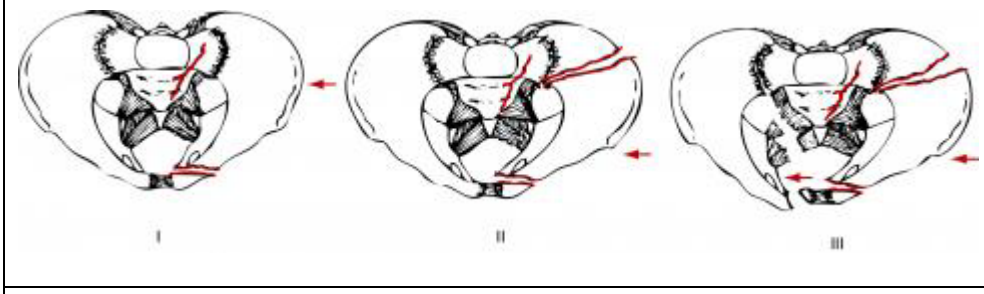
*Advance one grade for multiple injuries up to grade III. *863.51,863.91 - head; 863.99,862.92-body;863.83,863.93-tail. ¤Proximal pancreas is to the patients' right of the superior mesenteric vein. From Moore et al. [6]: with permission.



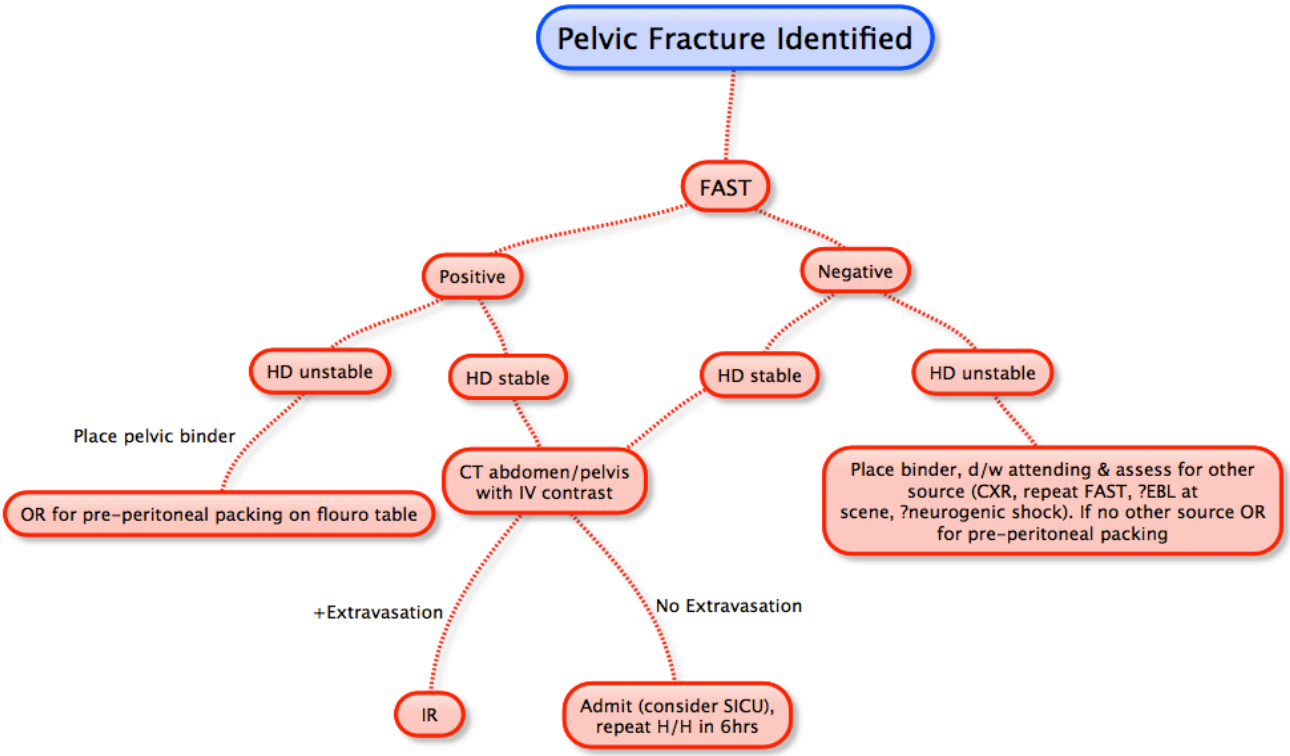
Note: Consider transcholecystic cholangiogram with IV morphine to cause ampullary contraction or administration of Secretin (0.2mcg/kg IV over 1min.) to elucidate duct injury

Pelvic Fratures

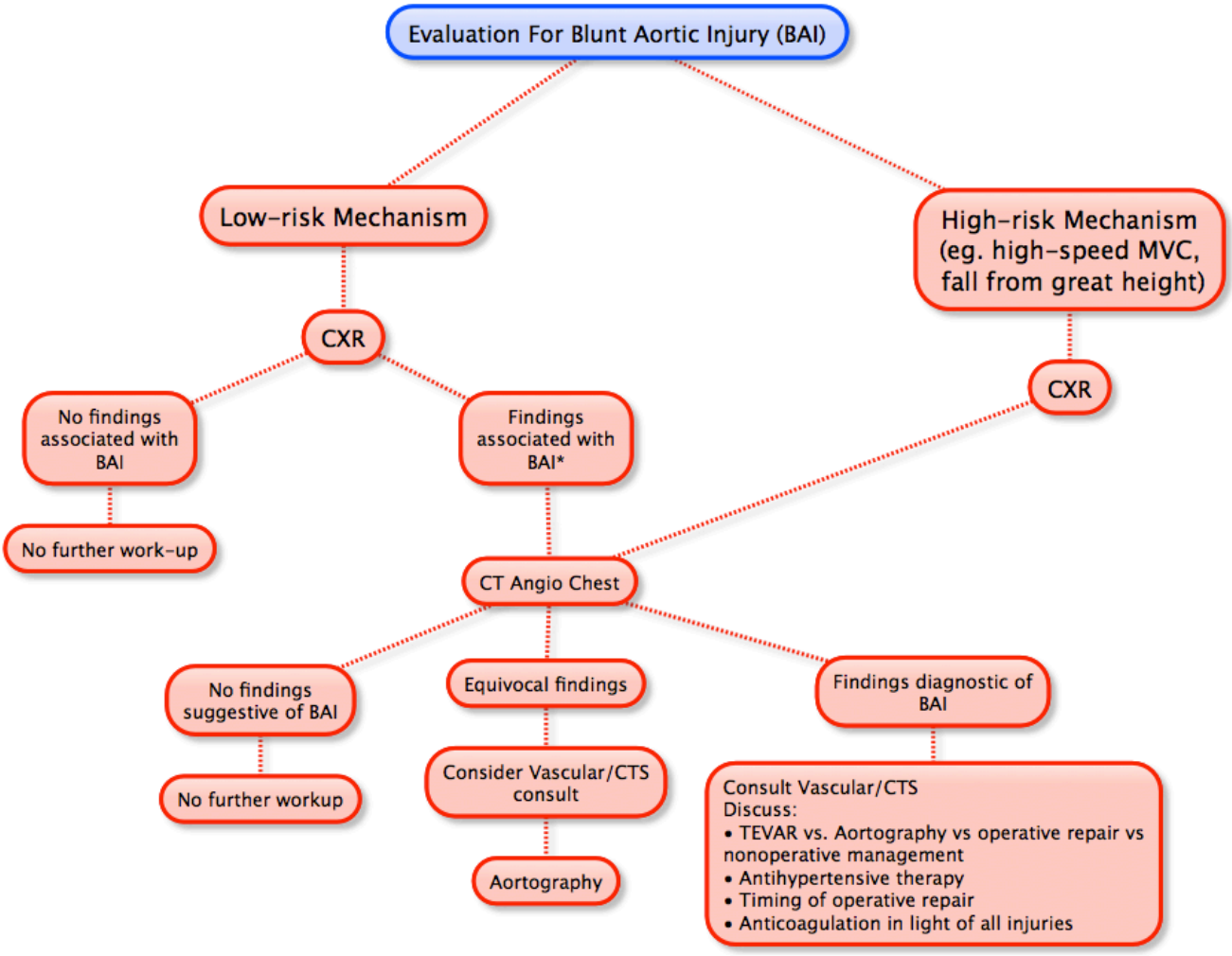
	
Vertical Shear	**Anterior Posterior Compression Type I-III**



Lateral Compression Type I-III



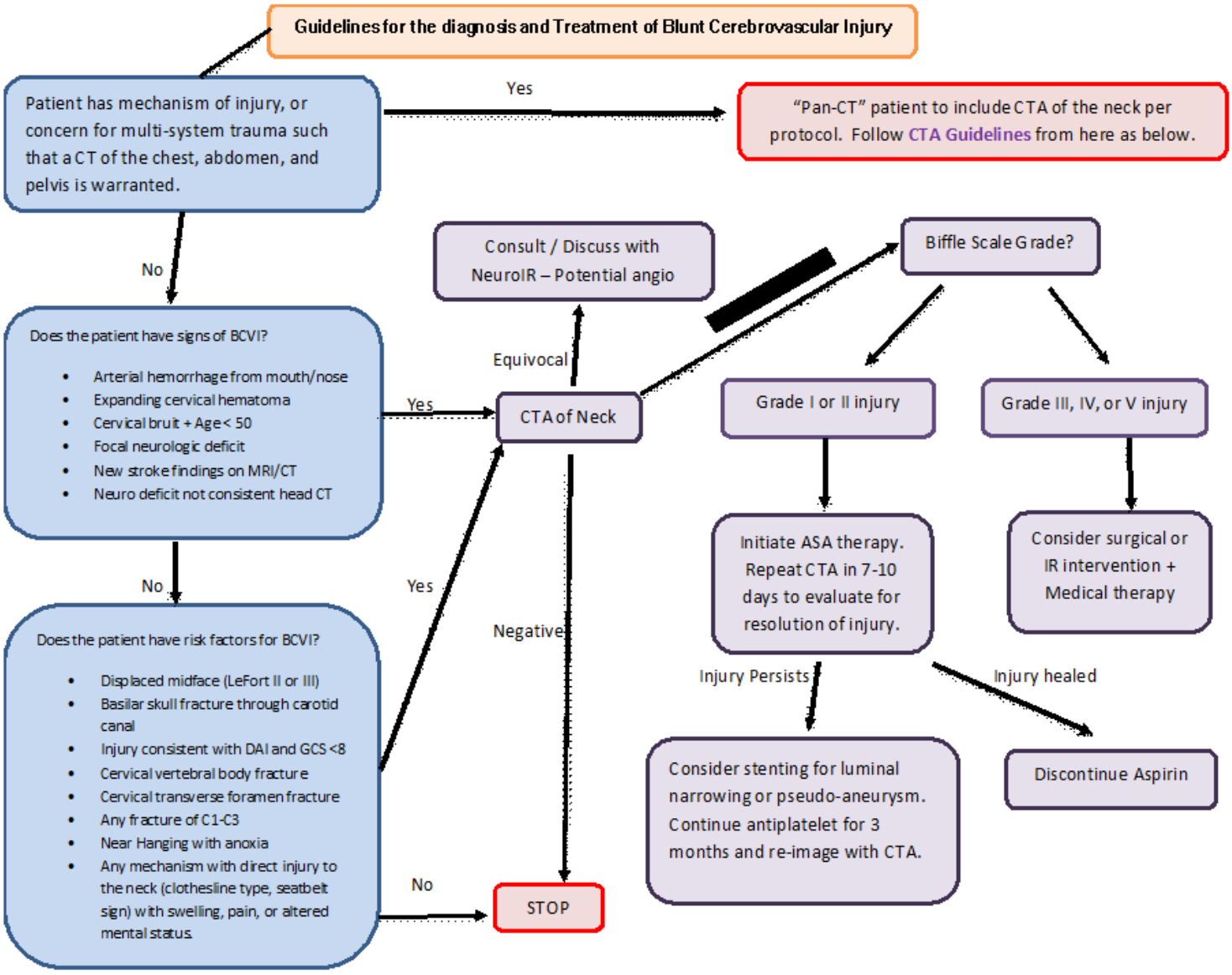
Blunt Aortic Injury



CXR Findings Associated With BAI
- Widened mediastinum (≥8cm)
- >0.38 mediastinal/chest ratio
- Indistinct aortic knob
- Depressed left main stem bronchus
- Opacification of aortopulmonary window
- Apical capping
- Widened paratracheal stripe
- Concominant clavicle, scapula & 1st rib fractures

*Consider upright CXR to evaluate isolated widened mediastinum

Blunt Cerebrovascular Injury



Chest Wall Injury Protocols

Medical Management of Rib Fractures

Rib Fractures with spontaneous breathing
Incentive spirometry performed in ED

All

ADMIT LOCATION		RESPIRATORY CARE	PAIN MANAGEMENT
Floor	**IS>1500cc* Consider Admit for pain and respiratory care.** **If IS falls by 25% transfer to SICA**	• IS Q 1 hour while awake • Chest physiotherapy routine BID • Special Respiratory Instructions: PEP/ Aerobika therapy initial done by RT then q 4 hours by RN • Albuterol Updrafts q 6 hours • CXR day #2 and prn	• Acetaminophen 650mg q 6 hours • Ibuprofen 400-800mg q 8 hours ○ If age >70, start PPI • Neurontin 100-300mg q 8 hours • Oxycodone 5-10mg q 3 hours prn
SICA	**IS 1000-1500cc* or age >55** **If IS falls by 25% transfer to SICU**	• BiPaP as needed	• Pain Regimen as above • Insert OnQ catheter or Consider Epidural
SICU	**IS <1000cc* or age >65**	• BiPaP Standing q4 hours and overnight • Consider CPAP • Consider metanebs when available	• As above. If refractory pain, consider intubation or surgical intervention if within 72 hours of injury.

follow up in Chest Wall Injury Clinic within 1 – 2 weeks with a CXR to be done the morning prior to the visit.

***Hard number not as sensitive as % predicted**

***Chest Wall Injury Pain Medication Guidelines* (A1)**

Chest Wall Injury Pain Medication

- Neurontin 100 mg TID scheduled & titrate as needed **(adjust for renal fx)
- Tylenol 650 mg q hours scheduled
- Ibuprofen 600-800 mg q 8 hours scheduled **(adjust for renal fx)
  - Start PPI if age > 70
- Oxycodone IR 5-10 mg q3 hours prn
- Consider OnQ pump placement if inadequate pain control with oral meds
- No nicotine patches or gum

Pain Medications at Discharge

- Prescribe (1) week narcotics if still requiring
- Prescribe (2-3) weeks gabapentin, ibuprofen, and tylenol
- Continue with Incentive Spirometer
- Schedule outpatient clinic f/u 1-2 weeks with CXR on day of clinic visit

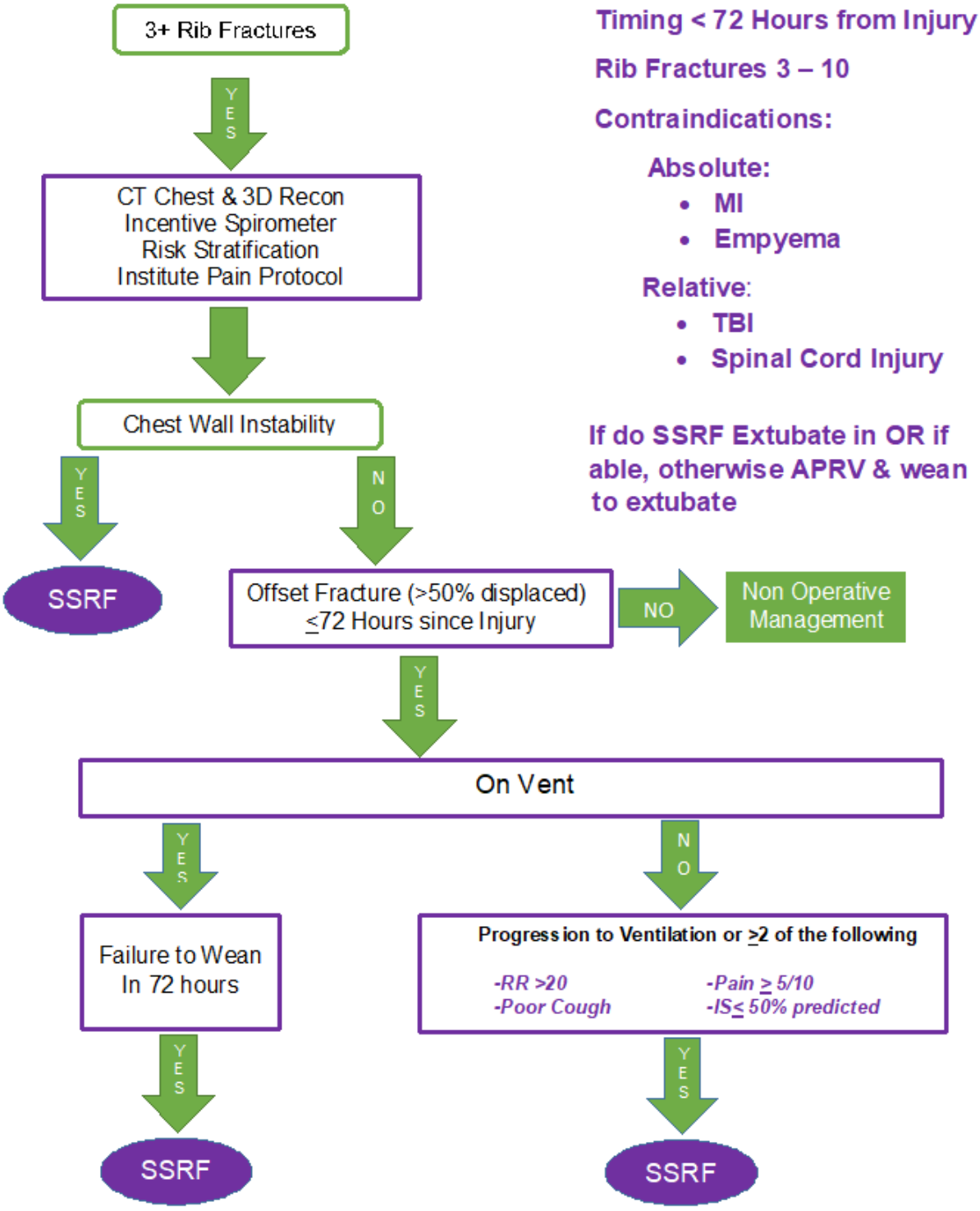
***Chest Wall Injury Respiratory Guidelines* (A2)**

- *Order Chest Physiotherapy routine BID (RT)*
- *Order Special Respiratory Instructions: PEP/Aerobika Therapy initial treatment done by Respiratory Therapy then q4 hours by RN*
- *Incentive Spirometer q1 hour (6-10 times/hour)*
- *Updrafts q6 hours scheduled*

Order PFT's within 24 hours, once pain controlled (**pending availability)
Consider Metanebs for patients unable to do IS (**pending availability)

Trinity Health Of New England | Saint Francis Hospital and Medical Center

Clinical Decision Guidelines for Candidates for SSRF



Timing < 72 Hours from Injury

Rib Fractures 3 – 10

Contraindications:

Absolute:

- **MI**
- **Empyema**

Relative:

- **TBI**
- **Spinal Cord Injury**

If do SSRF Extubate in OR if able, otherwise APRV & wean to extubate

Chest Wall Injury Post Op SSRF Guidelines

IMMEDIATE POST OP

- *Pain medications per Guidelines (A1)*
- *CXR (portable in PACU)*

DAILY

- *Daily AP/Lateral CXR in am prior to 0700 rounds; if PTX on CXR chest tube to suction*
- *Continue with Respiratory Therapy as per Guidelines (A2)*
- *Continue with Oral Pain Medications as per Guidelines (A1)*
- *Monitor Chest Tube output; when <200 cc can remove Chest Tube*

POST OP DAY #1

- *Chest tube to waterseal if no air leak of chest tube or no pneumothorax seen on CXR*
- *Diuresis in am with IV Lasix 10-20 mg if electrolytes and renal function within normal limits*

POST OP DAY #2

- *Incisional dressing to be removed; to need to reapply dressing unless drainage noted*
- *Diuresis in am with IV Lasix 10-20 mg if electrolytes and renal function within normal limits*

POST OP DAY #3 - DISCHARGE

- *Consider Lasix if renal function within normal limits and no evidence of hypovolemia*
- *Monitor Chest Tube output; when <200 cc can remove Chest Tube*
- *Remove OnQ prior to discharge. If empty simply remove. If medication remains in device, clamp for 4 hours prior to removal and ensure good pain control.*

ON DISCHARGE

- *CXR to be obtained within 12 hours of discharge.*
- *Follow-up in office in 1 week if with pleural effusion or 2 weeks otherwise; both with CXR prior*

Documentation Daily Note for Chest Wall Injury Patients

Pain Score: ____/10

Narcotics: ___mg q __h

Tylenol: _____mg q__h

NSAID: _____mg q__h

Gabapentin: ____mg q ___h

Epidural: [ ] Yes / [ ] No

OnQ: [ ] Yes / [ ] No

Rib Block within 24h: [ ] Yes / [ ] No (Date:___)

RASS/GCS: _____

Incentive Spirometry: _____ml

Respiratory Rate: ____

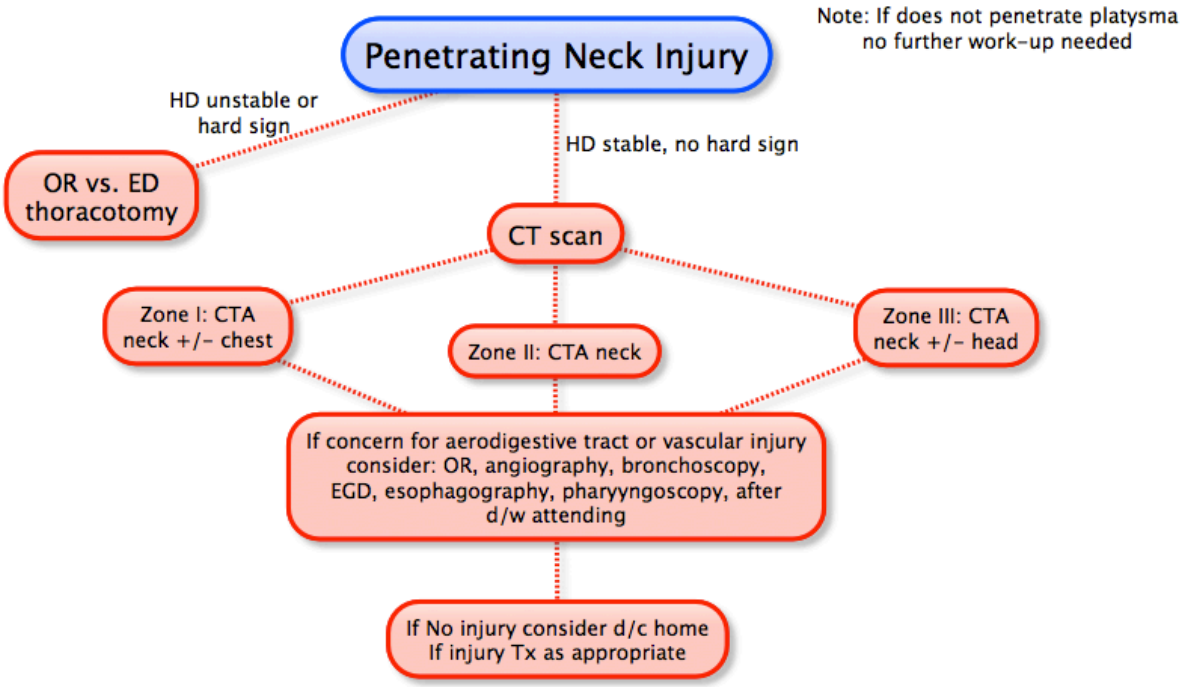
Cough Quality: [ ] Poor / [ ] Adequate

O2 Requirement: _____LPM via _____

Penetrating Neck Injury

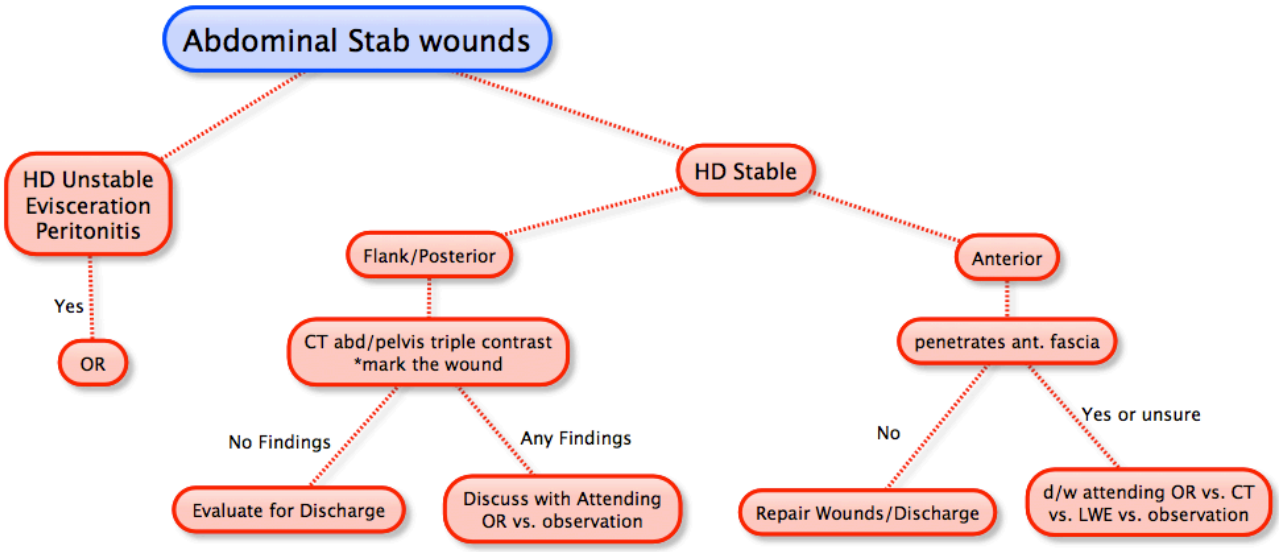
"Hard Signs of Penetrating Neck Injury"

- **Severe or pulsatile bleeding**
- **Expanding hematoma**
- **Airway obstruction**
- **Bruit on auscultation**
- **Neurologic deficit**
- **Hematemesis**
- **Massive subcutaneous emphysema**
- **Air bubbling through wound**



1. Penetrating Zone II Neck Trauma: EAST guideline: J Trauma 2008
2. Western Trauma Association Critical Decisions in Trauma: Penetrating neck trauma: WTA 2013 Algorithm. Sperry et al. J Trauma Acute Care Surg 2013

Abdominal Stab Wounds



- Do not probe wounds
- Do not explore wound involving the rib cage
-observation: monitored bed, serial abd exams, CBC Q8hr, vitals Q4hr. & PO trial before discharge

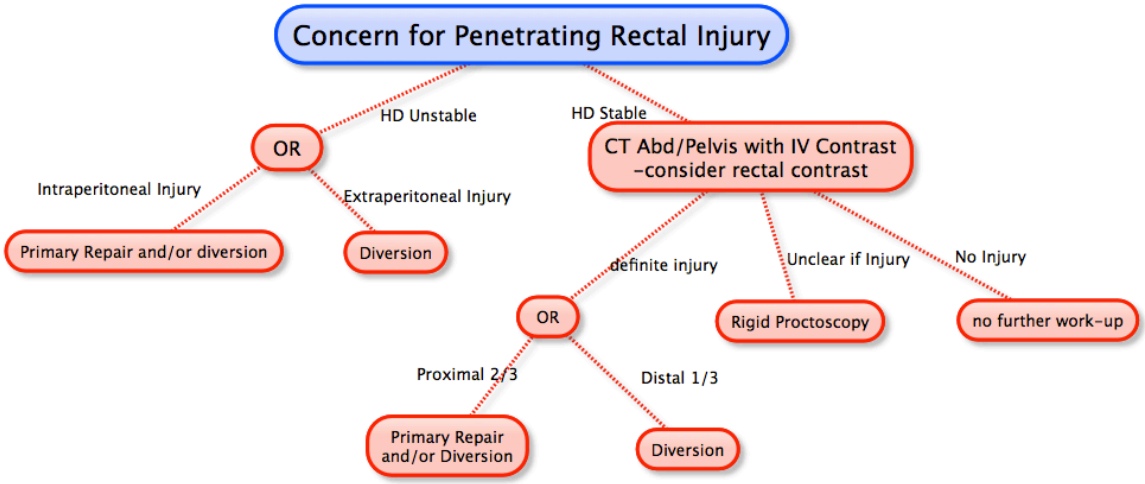
Rectal Injury

Table 16

Rectum injury scale

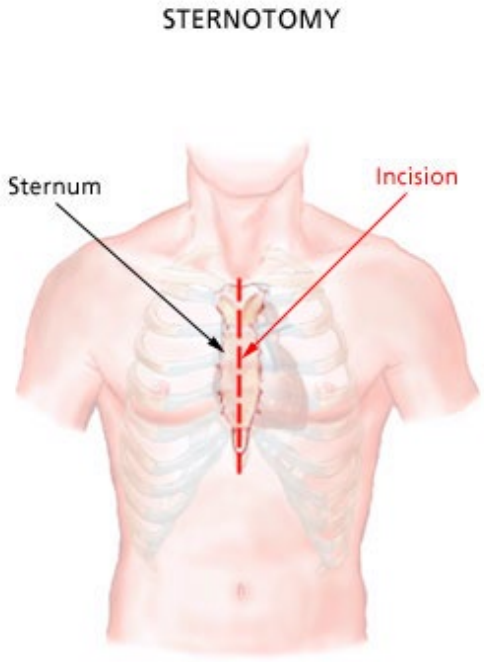
Grade*	Type of injury	Description of injury	ICD-9	AIS-90
I	Hematoma	Contusion or hematoma without devascularization	863.45	2
	Laceration	Partial-thickness laceration	863.45	2
II	Laceration	Laceration < 50% of circumference	863.55	3
III	Laceration	Laceration ≥ 50% of circumference	863.55	4
IV	Laceration	Full-thickness laceration with extension into the perineum	863.55	5
V	Vascular	Devascularized segment	863.55	5

*Advance one grade for multiple injuries up to grade III.
From Moore et al. [6]; with permission



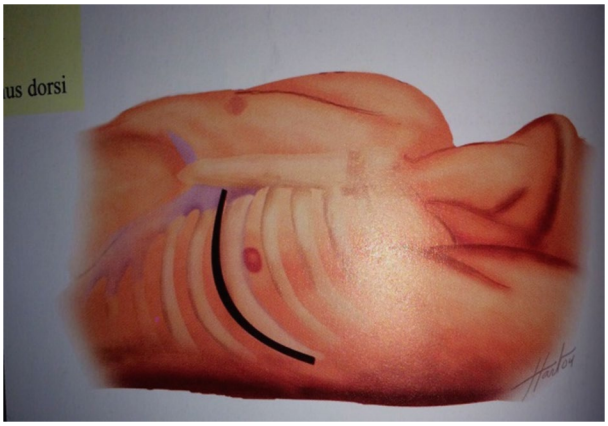
Presacral drainage only if clinical signs of infection, not prophylactically

Exposure of Great Vessels



- **Incision**: Above manubrium to below xiphoid
- **Access**: Thoracic Aorta and arch, Innominate Artery & Vein, proximal right subclavian (left subclavian best approached through left 3rd ICS thoracotomy)
- **Closure**: 2-3 cutting sternal wires through manubrium, multiple intercostal sternal wires for sternal body and layers overlying
- Can extend to clavicular incision to obtain control of subclavian or vertebral vessels

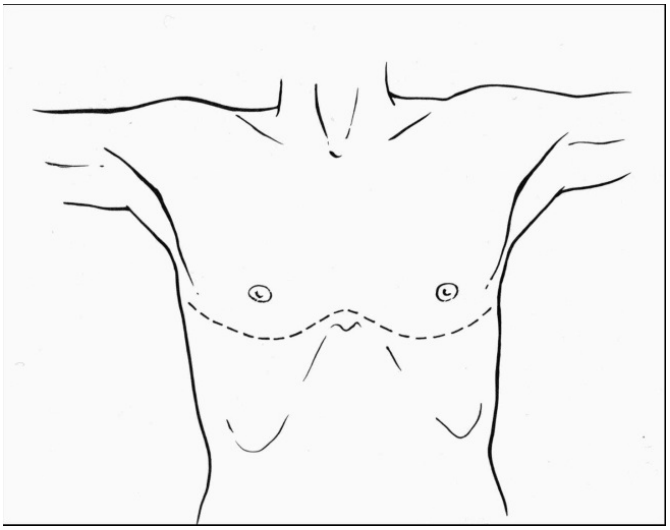
Resuscitative Thoracotomy



- **Incision**: Left 5th Intercostal space (inframammary fold) anterolateral thoracotomy (from sternum lateral to anterior axillary line then angle up toward axilla following the curve of the rib)

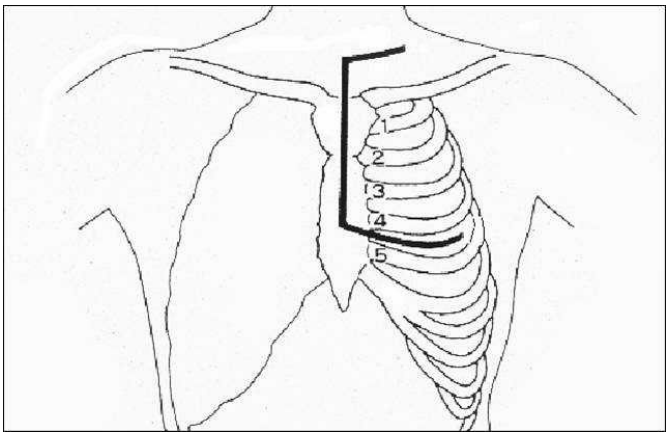
- **Indication**: Traumatic arrest, penetrating trauma with refractory hypotension (sbp <70)
- **Possible Maneuvers**: Open pericardium to relieve tamponade if present, open cardiac massage, cross-clamp aorta, pulmonary hilar twist versus clamp for lung hemorrhage, internal defibrillation

Clamshell Thoracotomy



- **Incision**: Left 5th ICS bilaterally and crossing sternum (alternative is Left 5th ICS then extending upward across sternum to right 4th ICS thoracotomy)
- **Indications**: To improve access to the heart (especially right side) when already have performed left anterolateral thoracotomy.
- **Access**: entire thorax (although superior mediastinal structures still may be somewhat difficult to reach) Note: place Finochietto retractor against sternal portions and elevate
- **Closure**: Place bilateral chest tubes and mediastinal tube. Close sternum with sternal wires and thoracotomy in layers. Remember to address IMA's.

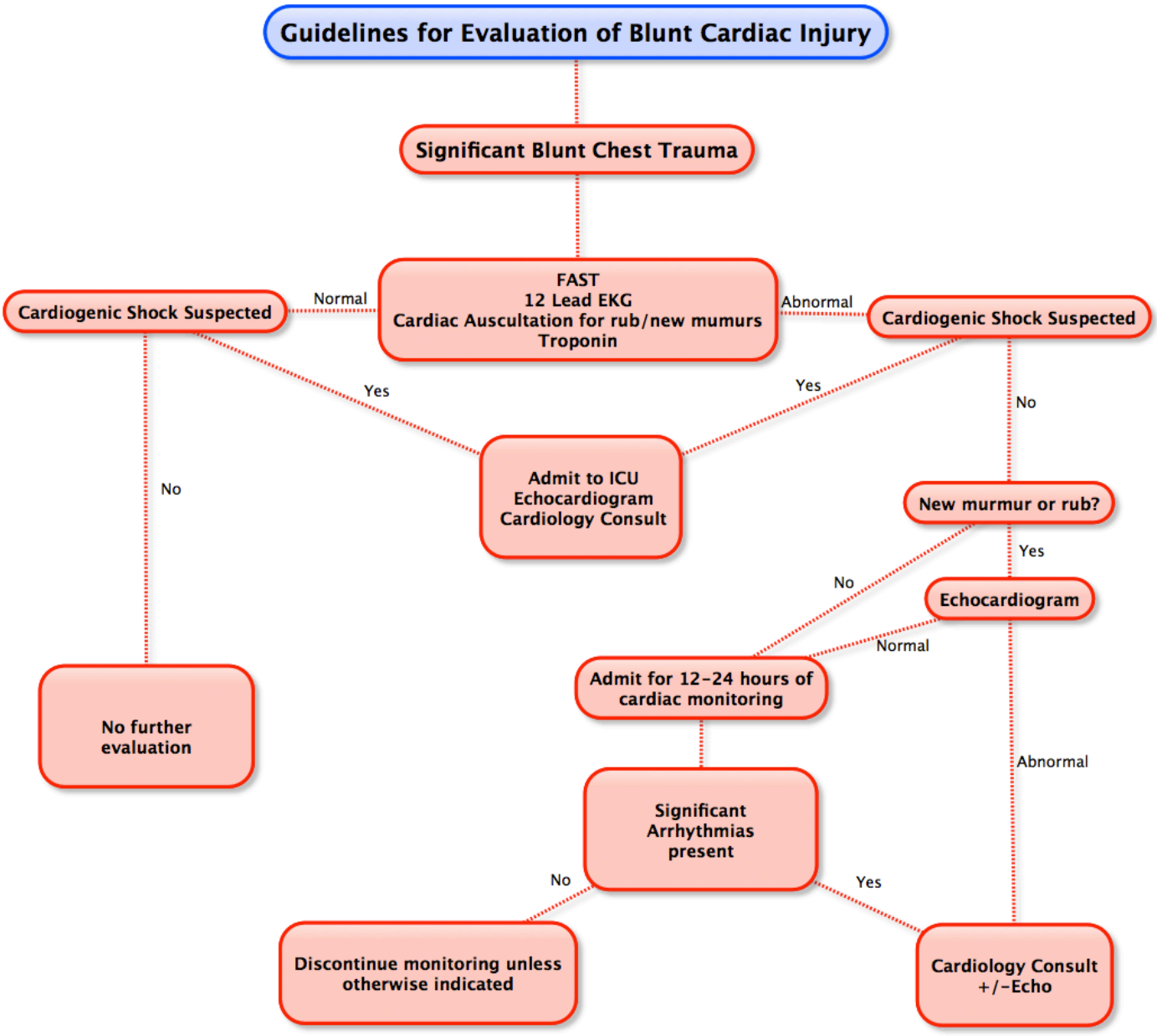
Trapdoor (Anterolateral thoracotomy + partial sternotomy + clavicular incision)



- **Incision**: Left 4th or 5th ICS thoracotomy + partial sternotomy to level of left thoracotomy + supraclavicular incision (clavicular resection can be done if lifesaving)
- **Indications**: Injury to left thoracic outlet
- **Closure**: left chest tube and mediastinal tube as indicated, sternal repair with wires and consider hardware fixation, thoracotomy and supraclavicular repair in layers

Note: very morbid, should consider endovascular alternatives if possible

Blunt Cardiac Injury



Traumatic Brain Injury

See Guidelines for the Management of the Patient with Traumatic Brain Injury Policy

Brain Death

PURPOSE

To establish a uniform practice of the determination of brain death in adult patients and to provide clear documentation of such determination in the medical record

POLICY

In compliance with the Uniform Determination of Death Act of 1981, and the General Statutes of Connecticut concerning anatomical donation (Chapter 368; sec. 19a-279h), it is the policy of Saint Francis Hospital and Medical Center that brain death occurs at the time that the individual patient has sustained irreversible loss of cortical and brain stem activity in the adult (as defined by age > 18 years). It is also the policy of Saint Francis Hospital and Medical Center that a patient may be pronounced dead if two physicians determine, in accordance with the procedure outlined below, that the patient has suffered a total and irreversible cessation of all brain function. Neither the physicians who attend the donor at death nor the physicians, who determine the time of death, may participate in the procedures for removing or transplanting organs and/or tissues. This policy is in accordance with the Saint Francis Hospital and Medical Center "Policy and Procedures for Withholding & Withdrawing Life-Sustaining Measures", which has been in effect since June 25, 1997 (Attachment #1).

In accordance with the Saint Francis Hospital and Medical Center "Organ/Tissue/Eye Donation Policy", all patients who meet criteria for the diagnosis of brain death will be referred to the local Organ Procurement Organization (OPO) for potential organ donation.

SCOPE

Dependent/MD initiated. All Adult Critical Care Units Page 2

PROCEDURE

The basic requirement for the declaration of brain death is the irreversible loss of cortical and brain stem activity in the adult. This requires an absence of **brain stem reflexes** and **cortical activity**, as well as a demonstration that this state is **irreversible.** Two clinical exams must be performed by qualified physicians. The two exams may be consecutive and without a predetermined mandatory interval between them. A qualified attending physician may be a trauma surgeon, an intensivist, a neurosurgeon, or neurologist. One of the two exams must be performed by an intensivist, neurologist or neurosurgeon**. Resident physicians are not qualified to perform the exams without the direct supervision of a qualified attending physician**. The results of both exams must be documented in the medical record by the attending physician performing the exam. The details of the procedure for the declaration of brain death are outlined below.

GENERAL STATEMENTS:

1. Exclude possibility of brain function recovery. Rule out sedative drug overdose, hypothermia, neuromuscular blockade, and shock as possible etiologies of apparently absent brain function.

2. The clinical brain death exam should not be undertaken unless the patient has a core body temperature of 950 F (350C) or greater, and a systolic blood pressure of at least 90mmHg.

3. For patients with metabolic or hypoxic brain injury, a period of observation of at least 24 hours without clinical neurologic change is necessary prior to the first brain death exam.

4. In those circumstances that do not permit reliable examination of the eye(s), eye movement(s), or pupillary reaction due to direct trauma to the eye(s) or drug effect (i.e., Atropine), consideration should be given to obtaining a confirmatory study as defined below. A confirmatory study may also be necessary in circumstances that do not permit reliable examination of motor function, such as in spinal cord injury, Guillain-Barre Syndrome or myasthenia gravis, etc.

5. After determination of coma of specific cause and absence of hypothermia, CNS depressant drugs, neuromuscular blockade and hypotension implementation of the Brain Death Examination Protocol should occur.

BRAIN DEATH EXAMINATION PROTOCOL:

To be performed only by qualified attending physician as defined in policy statements above.

1. Establish cerebral unresponsiveness by applying painful stimuli (i.e. sternal rub, supra-orbital pressure and nail-bed pressure) and watch for motor response in all extremities. Lack of motor response indicates cerebral unresponsiveness. Spinal level movements do not preclude the diagnosis of brain death.

2. Establish absence of brainstem reflexes:

- Pupils should be unreactive to bright light. Size of pupils may range from 4mm to 9mm, but should be fixed.
- Absent corneal reflex to touch with a cotton-tipped swab.
- Absent gag reflex upon stimulus of posterior pharynx with tongue blade or Yankauer suction device. Page 3
- Absent cough response with deep tracheal suctioning.
- Absent oculocephalic reflex (Doll's Eyes): there should be no movement of the eyes with turning of the head from side to side. Position of eyes will remain fixed when this reflex is absent. Do not perform until cervical spine injury has been ruled out.
- Absent oculovestibular reflex (Cold calorics): confirm patency of external auditory canal by otoscopic exam. There should be no movement of the eyes one minute after irrigation in each ear with 50ml of cold water. The test should be performed in each ear, at least five minutes apart. Position of the eyes will remain fixed when this reflex is absent.

3. The Apnea Test Procedure must be performed at the conclusion of the second positive clinical brain death examination (unless the patient fails to meet the necessary eligibility requirements)

4. Confirmatory testing may be necessary in certain situations. Situations which may necessitate a confirmatory test for the diagnosis of brain death may include, but are not limited to:

- Severe facial trauma
- Pre-existing pupillary abnormalities
- Toxic or therapeutic levels of any sedative drugs, amino glycosides, tricyclic antidepressants, anticholinergics, antiepileptic drugs, chemotherapeutic agents or neuromuscular blocking agents.
- Spinal cord injury or disease resulting in paralysis or motor weakness.
- Mydriatic agents.

- Sleep apnea or severe pulmonary disease resulting in chronic CO2 retention.
- Ineligibity for apnea test.

Acceptable confirmatory tests include: 1) A single EEG which showing no electrical activity during at least 30 minutes of recording, 2) a cerebral angiogram or 3) a radionuclide cerebral perfusion scan.

5. Documentation:

For each brain death examination, the physician should document in the medical record:

- The etiology and irreversibility of the condition
- The absence of motor response to painful stimulus
- The absence of each brain stem responses
- Justification for confirmatory test and the result of the confirmatory test.

6. Apnea Test on ECMO
   The patient should be placed on continuous positive airway pressure (CPAP) while the sweep gas flow rate is set to a meximum of 1.0 liter/minute. If the PaC02 does not rise above 60 mmHg or change by 20 mmHg, the sweep flow can be incrementally lowered to as low as 0.1 liter/minute while still maintaining adequate oxygenation in most circumstances.

Burns

REMEMBER THAT BURN PATIENTS ARE TRAUMA PATIENTS FIRST AND FOREMOST!

Special Airway Considerations
Inhalation injury can be a rapidly progressing emergency.

Care of the burn

- Establish appropriate pain control
- Clean the burn with Hibiclens (Except above and around the eyes)
- Debride loose tissue and broken blisters
- Rinse the burn with saline or water
- Pat the burn dry
- Apply a coat of the appropriate antibacterial & consider non-stick dressing

Topical Agents

- Silvadene cream daily to most areas
- Sulfamylon BID cream to ears
- Bacitracin ointment TID to face
- Dress with non-stick dressing

IF TRANSFERING THE PATIENT, ONLY USE CLEAN DRY DRESSING….DO NOT COVER WITH SILVADENE OR OTHER TOPICAL AGENT

Chemical Injuries

- **Alkali / Acid Burns**
    - Remove clothing
    - Brush off dry powder
    - Do not neutralize (b/c exothermic reactions)
    - Flush with water
    - Check pH of skin surface (Nitrazine paper) to a goal of pH 7
    - Alkali injuries can require extensive irrigation (2-3x that of acid burns)
    - Proceed to care of the burn (above)

Extent and Depth of Burn

Survival from a major thermal injury requires early and aggressive fluid therapy to prevent predictable complications. Hypovolemic shock and hypovolemic renal failure are expected in inadequately treated burn injuries. An early estimation of the extent of burn is critical in order to promptly calculate and initiate fluid resuscitation. After completing the primary survey and correcting the immediate life threatening conditions (ABCDE), calculating the extent and depth of burn is a critical portion of the secondary survey. This evaluation of extent and depth of burn allows us to predict fluid resuscitation

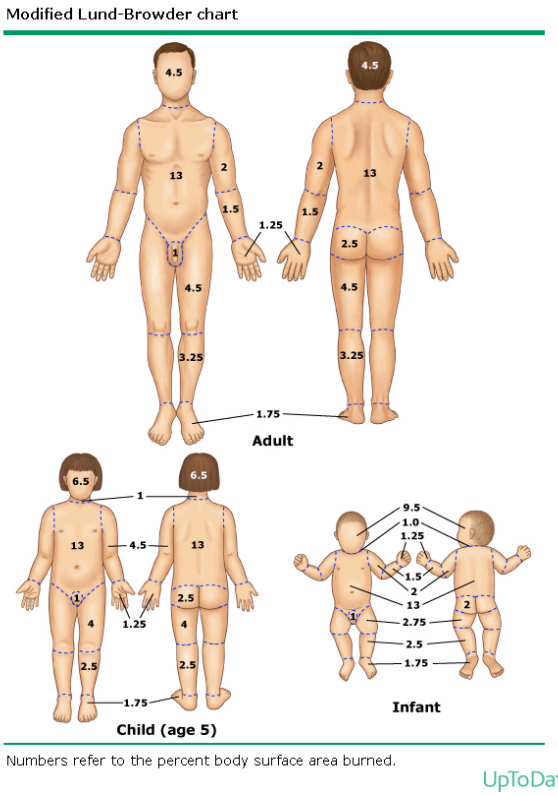
needs and need for surgery. There are three different mechanisms to estimate the Total Burn Surface Area (TBSA) of a burn.

Extent of Burn

Rule of nines
The body is divided into zones considered to have an area of 9% (head, upper extremities, leg, thigh), or multiples of 9% (18% anterior trunk, 18% posterior trunk). The groin is considered to have 1%. The rule of nines is adequate for field use to calculate fluid requirements for fluid resuscitation so that clinicians can initiate fluid resuscitation with confidence and without delay, but lacks the sensitivity to anatomical proportionality between infants, children and adults

Rule of palms
The "rule of palms" is a method used to estimate the surface area of irregular or "spotty" burns. The palm and fingers of the hand (the palmar surface) are considered to represent 1% of your body's surface area. Use the patient's hand as a measure and estimate how many of the patient's hands it would take to cover each burn area. Total up all the areas burned to obtain a reasonable estimate for calculating requirements for fluid resuscitation.

Lund-Browder Diagrams
The "rule of nines" is an adequate measure for the first field estimation of total body surface area burn and combined with the "rule of palms" is reasonable for field clinicians to use to begin early and appropriate fluid resuscitation, but accurate computations of TBSA needs to be calculated early to ensure timely infusion of required volumes. Lund-Browder diagrams allow for closer approximation by allowing for different proportions between, infant, child and adult proportions. You may combine the Lund-Browder diagrams for confluent burn injured areas and use the "rule of palms" for spotty areas.



Depth of Burn

First degree burn is not included in calculating fluid resuscitation and burn management

Second degree burn also called dermal or partial thickness
Superficial- wet, red, painful and tender. Deep- mottled pink/white color, moderately sensitive, may not blanch under pressure, and display delayed capillary filling

Third degree burn, also called full thickness.
Full thickness burns may initially share characteristics with mid dermal burns, but do not blanch under pressure. Within a day they become dry, leathery, maybe translucent white with visible vessels, have decreased sensation, and often are not tender to touch. While these burns are most accurately considered insensate, they do not have light touch sensation or sharp dull discrimination, protective sensation is usually intact. Since the underlying corpuscles in subcutaneous fat and muscle are usually present, firm pressure can be usually felt.

Fluid Resuscitation
The Parkland formula is a reasonable place to start with determining the needs for fluid resuscitation of a burn patient. Generally, they should be resuscitated to a urine output of 0.5-1cc/kg/hr. Only use 2nd and 3rd degree burns as part of your %TBSA calculation

4 mL x Weight in Kilograms x %TBSA total for 24 hours. Give ½ in first 8 followed by second ½ over next 16 hours.

Example: 70kg man with 50% TBSA

4mL x 70 x 50 = 14,000; Give 7L in the next 8 hours and the other 7L in the following 16 hours.

Carbon monoxide poisoning

Check carboxyhemoglobin level if suspect possible carbon monoxide poisoning. i.e. enclosed space inhalation

Carbon monoxide is a poison that primarily acts to limit the ability of Hgb to deliver oxygen to cells. By having an affinity for Hgb 200x greater than oxygen, CO binds to Hgb thereby displacing oxygen. The degree of CO Hgb binding determines symptoms: 0-10% none; 10-30% headache; 30-40% severe headache, weakness, dizziness; 40-60% increased heart rate, increased respiratory rate, seizures, hemodynamic collapse; >60% coma, death.

There are very few indications for hyperbaric oxygen therapy for carbon monoxide poisoning. The $t_{1/2}$ for COHgb is 40 minutes on 100% and 20 minutes for 100% at 3atm (hyperbaric). This 20 minute advantage is obviated by the time it takes to transport patients to a hyperbaric chamber. The marginal benefit is miniscule compared to the risks associated with transporting a critically ill patient away from an acute care area. In the rare patient with carboxyhemoglobin of <25% with symptoms or >25% without symptoms, who does not need other life-saving therapies, hyperbaric therapy can be considered.

➢ Burn Center Referral Criteria

American Burn Association Referral Criteria

Burn injuries that should be referred to a burn center include the following:

1. **Partial-thickness burns** of greater than 10% of the total body surface area (TBSA)

2. **Significant burns** involve the face, hands, feet, genitalia, perineum, or major joints (e.g., circumferential, not small splatter)

3. Third degree burns in any age group

4. Electrical burns, including lightning injury

5. Chemical burns

6. Inhalation injury

7. Burn injury in patients with preexisting medical disorders that could complicate management, prolong recovery, or affect mobility

8. Any patients with burns and concomitant trauma (such as fractures) in which the burn injury poses the greatest risk of morbidity or mortality. In such cases, if the trauma poses the greater immediate risk, the patient's condition may be stabilized initially in a trauma center before transfer to burn center. Physician judgment will be necessary in such situations and should be in concert with the regional medical control plan and triage protocols.

9. Burned children in hospitals without qualified personnel or equipment for the care of children

10. Burn injury in patients who will require special social, emotional, or rehabilitative interventions
www.ameriburn.org