TRAUMA SURGERY PLAYBOOK

GUIDES AND ALGORITHMS

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About this manual

Trauma surgery often lacks the allure and prestige associated with other surgical disciplines. While it may be glamorized in movies, in reality, it is frequently avoided by many surgeons due to its unpredictability, discomfort, and messiness. Some surgeons even dismiss it as trivial, thinking that injury repair is straightforward. However, this perception changes abruptly when a surgeon finds themselves on call, facing a critically injured patient with anxious family members ready to hold the hospital and staff accountable. In such high-stakes situations, the attending doctors must act swiftly, devise a plan, and execute it flawlessly.

Contrary to a mono-organ approach, trauma surgery demands a comprehensive and adaptable mindset. Life seldom presents simple, straightforward problems; instead, it often throws complex and unexpected challenges. This manual aims to bring order to the chaos of trauma care, offering structured treatment strategies for managing multiple injuries and unstable patients.

Departing from traditional academic writing, this manual is designed to be a rapid and practical reference for trauma cases, avoiding the pitfalls of being overly theoretical or tedious. It addresses common trauma issues through guidelines, algorithms, and diagrams frequently used at Hospital Tuanku Ja'afar Seremban.

While this manual is tailored to HTJS's specific context, including its unique resources, systems, and skills, it may not be directly applicable elsewhere. Nonetheless, the underlying concepts and ideas might still be valuable to other centers, but caution is advised against uncritical adoption outside HTJS.

The algorithms and pathways presented are based on the best available evidence and are adapted to fit the local context. Reference materials are provided at the end of the manual to keep the main content clear and accessible.

This manual does not claim to be the definitive way to manage trauma. Trauma surgery is characterized by numerous approaches, each with its own merits and drawbacks.

This manual is intended for the exclusive use of those working at HTJS. It is freely distributed, with no copyright or commercial interests.

The Author
2024

Essentials of Primary Survey

Airway

Airway must be cleared and secured, it it is not, the airway must be made secure by means of endotracheal intubation (or in rare cases a surgical airway)

A patient with a GCS of < 8 is regarded as unable to maintain own airway and thus mandates a controlled airway

A hard neck collar should be applied until the C-spine can be cleared either on clinical and/ or radiological examination

→

To note:

Patients ability to speak
Stridor
Gross level of consciousness
Secretions/food particles in oral cavity

Resp rate if not intubated yet

Breathing

Ensure good ventilation, if the patient cannot maintain adequate respiration, means of artificial ventilation must be provided

Clinical signs of a tension pneumothorax should prompt insertion of a chest drain at this juncture without waiting for radiological confirmation, simple pneumothoraces should await CXR results

→

Monitor:

O2 Sats
Resp rate
Chest drains function, effluent and amount (if inserted)

Circulation

Maintain good circulation
Insert two large bore venous cannula into uninjured limbs (or any convenient area available)

Draw bloods for FBC, group, type and match and other baselines required

Start fluid resuscitation, balanced salt solutions while waiting for blood and products, limit crystalloids once blood and products are available

→

Monitor:

BP, HR, O2 Sats,
12 leads ECG
Blood gases

Perform: FAST scan

Secure ALL visible bleeding

Disability

Evaluate GCS in detail
Evaluate pupils
Note any focal neurologic deficits

Exposure

Log roll patient (neutral spine), this takes 5 people to perform safely
Examine back and spine.
PR exam, inspect perineum, note position of prostate and presence of blood on gloves

Adjuncts and requests

- CXR supine
- Pelvic X-ray, supine
- Nasogastric tube, decompress and drain
- Indwelling Foley's urinary catheter, note nature and volume
- Apply splints and binders as necessary

- go through list even if it seems unnecessary
- follow the by order of priority. i.e A before B and so on.
- Note down all information listed above

SPEAKING THE SAME LANGUAGE

Trauma care at times can be hurried and chaotic. Resuscitation and operations occur at high speed and it happens for a good reason, to avoid death. The speed at which these processes run may lead to confusion and disorganization of the teams involved in the care of the patient. If allowed to run wild, this will ultimately be detrimental to the survival of the patient.

There are a few aspects to be highlighted here, mainly ;

A.Communication among medical staff

B.Communication with the patient and/or next of kin

C.Documentations and medicolegal considerations

A.Communication among medical staff

Consider the situation in the resuscitation room (Red Zone), things are abuzz, and resuscitation is ongoing in a patient who is unstable and bleeding. Staff are running to and fro doing seemingly unproductive and repetitive stuff. In a center well experienced in dealing with a fair volume of trauma cases, things may look chaotic, but it is controlled chaos. In other places, it may be total chaos. The difference is practice. The more practice one gets, the better the team becomes. But it is only true when the fact is realized. If past mistakes are not identified and rectified, the experiences may not be beneficial for future cases. To avoid such a haphazard learning process, most EDs, including ours, have designated team members for resuscitation. Ensure that you know what role you play in resuscitation and what needs to be done beforehand.

If you are a member of the surgical team, chances are that you will have a lot to do to arrange a patient for urgent transfer to OT for surgery. Phone calls and notifications need to be made. Details need to be checked and double-checked. Regardless of whomever you need to speak to, to get what you want, there are a few useful points to remember as a guide to effective communication:

1.Have a system
2.Speak with clarity and audibly
3.Do not multi-task staff
4.Avoid conflicting instructions
5.Keep the whole team informed of the direction or change in the direction of management.

The above points apply to all stages in the care of the injured patient from the ED through to the point of discharge.

System

A simple system to not miss out on details in communicating with colleagues is outlined below:

I	**Identify**	Begin with identifying yourself, especially when conversing through the phone to the party on the other side. Do this clearly with the appropriate designations "I am Dr XY, the Surgeon/MO on call for today", for example. This will instantly create a point of reference for the receiving side. You may also need to identify the other party as well, "may I know who I am speaking to?". Once this is done, in some cases the patient too, may need to be identified, "Mr ABC, is our patient in ED....."
S	**Situation**	Briefly but succinctly outline the current situation at hand, "We have an unstable patient in ED, who is bleeding intraabdominally.....", for instance. Be concise.
B	**Background**	A short narration of what has happened up to that point in time. "He was brought in by ambulance, motor vehicle accident two hours ago, hypotensive upon arrival. We have started resuscitation with crystalloids and blood. Currently BP has picked up slightly, and .....etc etc".
A	**Assessment**	State your thoughts on the matter. "Although, we managed to bring up his BP somewhat, seeing that the FAST scan shows a lot of fluid in his abdomen, I don't think we can support his vitals very long...."
R	**Request**	Assert your request. "Can we have a theatre soon?. We need to operate on him....".

The system outlined can be used to communicate about other cases too, to various staff members in a variety of situations. Running through this scheme avoids a haphazard process and helps avoid omissions of important information.

Loud and clear

A study published in the *Injury J*ournal a while ago found that only 56% of spoken words during the process of resuscitation in ED were audible and about 50% were understandable. So speak up and speak with clarity. Repeat yourself to ensure other team members understand what is being said. It is not fun to send a circulating nurse running to the storage area in search of an instrument only to bring back the wrong one (but one that almost sounds the same). Try and use words that are commonly

used and understood, we all know "haemostats" are the same as curved artery clamps, but our nurses refer to them as "arteries". Specify the request, such as size and numbers if necessary. Do not shout and never utter profanities at the staff even if the situation is stressful. Remember, stressful situations are temporary, the staff will still be working with you for quite some time. Treat them appropriately. If tempers are lost, remember to rectify them later.

Multi-tasking

Avoid sending a staff on a wild goose chase. It's not kind to the staff and not kind to the patient as well, as valuable time is lost running around doing too many things. Worse still, the staff member does one thing and the rest are not done but not delegated to other staff members. If staff numbers are minimal, prioritize your orders. Re-examine the importance of having a particular equipment over the other for example, or can it be done without both? Staff members tasked with collecting, checking, and administering blood transfusions are best left to do that and only that. The last thing needed is a catastrophic wrong transfusion.

In trauma surgery, there is a thing called "flailing". Flailing is a repetitive, ineffective action during an operation. When it happens, quickly re-evaluate your options to:

1.Retreat
2.Reconsider what you were doing
3.Retry doing what it was that you were doing
4.Find another alternative solution to the problem

Once you have decided, get the staff moving to get equipment or instruments or whatever else that will be required to execute the plan. This avoids multi-tasking to the point of ineffectiveness. Always remember, the nurse is human not a headless chicken.

Avoid conflicting orders

Under duress, in emergencies, most people are not efficient thinking machines, our sympathetic drive takes over and a "fight-flight" reaction ensues. More so seen in Nurses, House Officers, and junior Medical Officers, this tends to dull their senses and they end up feeling like a ping pong ball. There ought to be just one captain of the ship and he or she shall issue orders. But even captains can be reduced to non-thinking machines in conditions of high stress. He or she may run out of ideas. In such situations, suggestions by other team members especially assistants and scrubs can prove to be invaluable. Just run the suggestion through to the operating surgeon first

before barking orders to circulating nurses, orderlies or house officers. "Mr X, would you like a 3/0 suture for that?"... and if the affirmative is signaled then execute the instruction. This not only avoids confusion but also aids in efficiency and saves resources.

Team updates

It is common practice to change directions midstream through an operation in trauma surgery. The situation dictates a remedy and not otherwise, in contradistinction with elective surgery where steps are planned and followed sequentially. It is important for the surgeon to be able to think beyond the operative field and react accordingly. This reaction must be made known to the anaesthetist as well as the operating team. The surgeon also needs feedbacks from the "head of the bed", to brief him on the physiology of the patient. If he/she is not briefed voluntarily, then make an effort to ask about how the patient is doing. This means a lot in influencing the direction, strategy, and tactics of the operation, it may result in a damage control operation vs a definite operation. Thinking three steps ahead will keep the team ready for action, just remember to verbalize thoughts. Keep the words simple and clear, "I am going to pack the liver and apply TAC dressing" or "I am going ahead with bowel resection and anastomosis, this is going to take a while" etc.

B. Communication with the patient or next of kin

Not all cases present with the opportunity to speak to a fully conscious and lucid patient before an emergency trauma operation. If at all possible every effort should be made to spend time talking to the patient or to his/her next of kin. In any case if it was not done prior to a lifesaving operation, it should be done post-operatively. The most important principle behind communicating with the patient or next of kin is OPEN DISCLOSURE. Inform them of all that has transpired during the surgery and do not hide information. Below are some points that may help, pay attention to the four "Rs":

1. Plan the meeting and words to use to convey the situation (pay attention to racial and religious sensitivities)
2. Involve everyone who is involved in the care of the patient.
3. Be open, honest and keep the discussion confidential.
4. Allow sufficient time, do not rush the process.

5. Avoid jargon and technical words, refer to established and verified facts only (do not guess/confabulate).
6. **RECOGNITION**: Give a clear explanation of the whole sequence of events till that point, acknowledge the patient's or next of kin's response
7. **RESPONSIBILITY**: Demonstrate ownership of care and explain if other teams are/ will be involved in the care process.
8. **REGRET**: sincere expression of regret about what has happened to the patient i.e "We are very sorry that you had this accident..." etc
9. **REMEDY**: explain further management, re-operations, follow-ups, rehabilitation, debilitation, etc
10. Ensure that the patient or next of kin is kept updated on progress or decline
11. Documentation of the communication.

Communications with the patient and/or next of kin should be noted in the patient's records. It should contain the items as below:

1. Time, date, venue, persons in attendance
2. Summary of communication
3. Salient details of what the patient/family was told
4. Patient's/family's response
5. Further action/management plan

C. Documenting and recording trauma cases in case notes and medical reports

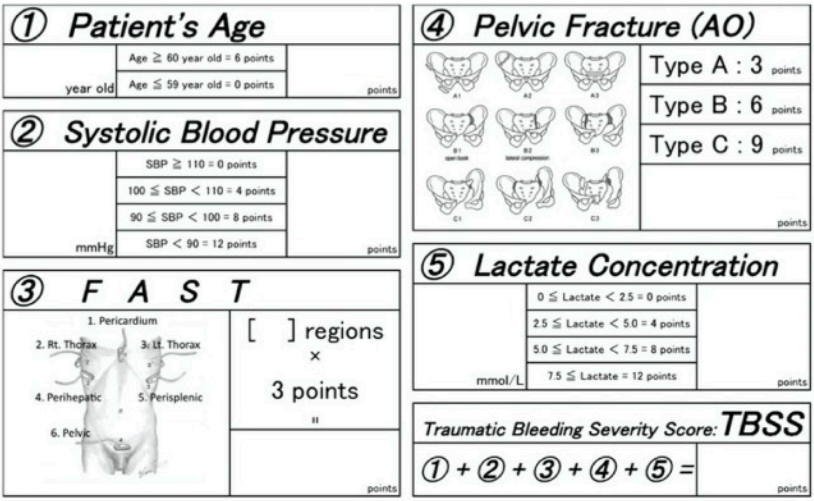
In the world of trauma, a form of "lingua franca' or common language is used worldwide to write down communications and facts. Many systems had been developed but the "MIST" system emerged as the most simple and popular way of writing and communicating facts about trauma cases in case notes as well as between medical personnel involved. The beauty of this system lies in its adaptability to use, even in medical reports.

M	**Mechanism**	In the world of trauma, there are only 3 mechanisms of trauma, namely, **blunt, penetrating and blast**. Additional information in history may be added if told by the patient him/herself, for instance motor vehicle accident, stabbed, shot with a gun etc. However this should only be recorded if volunteered by the patient. Doctors should not speculate or confabulate facts in the case notes. If the history is not certain, records should state, for example "Blunt trauma, further mechanism unknown". It is not unreasonable to derive at blunt/penetrating/blast injury, as all can be ascertained by patterns, wounds, injuries etc without relying on history. **DO NOT SPECULATE HISTORY**. If the information is derived from a third party, the documentation MUST state the source of this information, for instance, "History from the Investigating Officer, ASP XYZ, Royal Malaysian Police, ".
I	**Injuries**	This is the list of evident injuries that were detected up to that point in time. This list will change with time and care process as more injuries are detected. Early in the phase of care it may be simple and crude, for instance in ED, it may look like "distended abdomen, bruises over left flank, deformed right thigh", while after the operation it may look like "Grade IV splenic injury with left zone II retroperitoneal hematoma and closed fracture of the mid shaft of the right femur". This goes on to be more and more detailed and descriptive as more investigations are done on the patient.
S	**Signs**	Current significant signs, which will encompass vital signs, O2 sats, and other clinical signs that are significant at that juncture, i.e.. GCS, limb perfusion, peritonitis and others
T	**Treatment**	This notes down what treatment has been given so far. This also varies with the stage of care of the patient. In ED it may look like " O2 by NP 3l/m, 1 unit blood ongoing...etc", while in the post-operative period might look like "post laparotomy and splenectomy 8 hours on IVD maintenance rate... etc etc"

Peculiarities in medical reports

1) Medical reports should follow the MIST format but **encompass the whole spectrum of care till discharge**, the "S" portion to be reported only if and where it is significant.
2) DO NOT SPECULATE on the mechanism, avoid "alleged snatch theft/MVA/ robbery...." unless the patient volunteers this fact. If uncertain, a medical report should only state "Blunt force trauma, further mechanism unknown" or "Penetrating trauma to the abdomen, circumstances unknown", etc. Medical Officers are not Investigating Officers and unless the person preparing the medical report is an eyewitness to the incident, the rest of the story is hearsay.
3) DO NOT use jargon and minimize medical terms. It is preferable to report a femur fracture as a "broken thigh bone" etc.
4) Be exact. DO NOT report "multiple", note exact numbers and positions as well as sizes (of wounds/holes etc). Positions must be reported in reference to 2 axis (X and Y, being recognizable landmarks of the body, i.e. nipple, symphysis, umbilicus, etc). Rib fractures must be reported in the number of ribs involved and not as "multiple ribs". The laterality of injury must be correct (right vs left).
5) DO NOT conclude anything, a medical report is only descriptive, avoid words such as "patient will be paralyzed for life" but may describe as "upon discharge, patient was paralyzed below the waist". A specialist report with expert assessment will be requested for information beyond the norm.

Predicting the need for massive transfusion in trauma



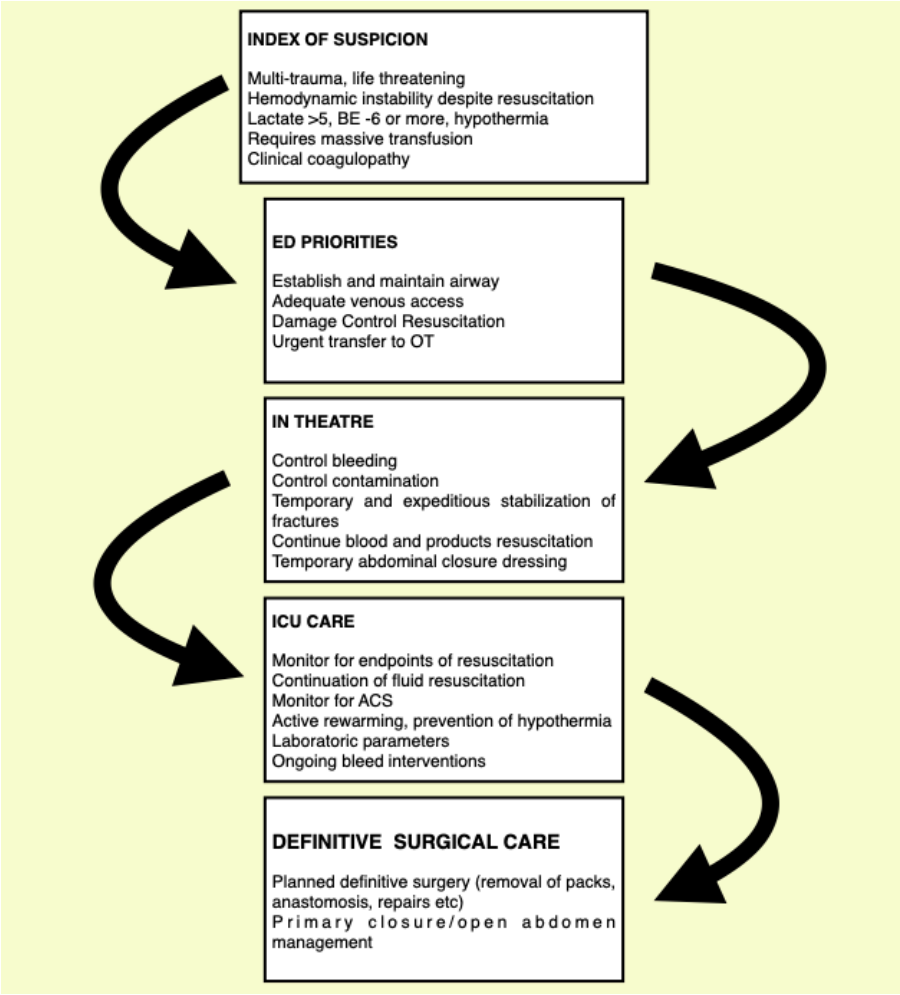
The Trauma Bleeding Severity Score (TBSS)

Score is calculated after 1000 mls of IV crystalloid initial resuscitation

Cut-off score is 15, i.e. sensitivity of 97% and specificity of 96% of patient requiring massive transfusion Arrangements should be made with blood bank in anticipation of massive transfusion if score of 15 or more is attained

* This score was validated for blunt trauma

Damage Control Surgery Considerations



The Conduct of Crash Operations

Preparations

- All crash operations are in the supine position with arms stretched out on rests
- Skin preparation according to area of interest, however if uncertain the patient should be prep'd from chin to knees
- Ensure good lighting - headlight if required
- Ensure availability of vascular clamps of multiple sizes
- Sets for laparotomy as well as thoracotomy must be available in the operating room (*see list of instruments for selected trauma operations)
- OT Trauma trolley must be wheeled into the operating room
- Drape the table (wide exposure) but do not use towel clips
- For penetrating cardiac injuries, clean and drape patient BEFORE induction
- Trauma packs should be opened prior to incision

The Crash Laparotomy

- Midline approach (a transverse approach can be used in a previous scar in a patient in extremis)
- Rapid entry
- Pack both upper quadrants and pelvis
- Do not attempt to suck blood with multiple suckers
- Once abdomen is packed, the operating team shall pause for the anesthetic team to catch up on fluid administration
- As hemodynamics improve, start removing packs beginning with the area least likely to have injury and achieve hemostasis sequentially in this order
- All other sources of contamination should be secured by the most expeditious means without resorting to definitive procedures
- Once all bleeding and contamination is secured, a callout is made to the anaesthetist to update physiological parameters
- Operating surgeon to decide at this juncture to abbreviate operation or to proceed to definitive surgery based on physiological parameters
- If DCS is performed, abdominal closure is via a modified vacuum dressing system

The Crash Thoracotomy

- Access is via an anterolateral incision through the 4th-5th ICS curving below the nipple from the sternal edge to the table laterally with the patient supine
- Cross clamping of the hilum can be done with a vascular clamp, if bleeding is seen from the lung parenchyma
- Bleeding deep with the lung must be secured within and not via suturing of the surface of the lung, this applies to large air leaks as well
- A tractotomy can be performed with a linear cutting stapler to gain a deep bleeding lesion or air leak
- The pericardium should be opened and the contents inspected, (internal cardiac massage and intracardiac injections if required can be administered)
- The heart (and opposite thorax) can be accessed by extension into a clamshell incision
- Chest wall bleeds can be packed initially and bleeding points sutured individually
- The pleural (+/- pericardial) spaces should be drained before closure
- Modified vacuum dressings are a rare necessity in very selected cases

The Exsanguinating Pelvic Fracture

Extra Peritoneal Pelvic Packing

- Access is variable according to presence of other injuries (midline, Pfannensteil, bilateral Lanz)
- The extra-peritoneal space is entered, this is usually facilitated by the large hematoma present
- The pelvis is packed partially, beginning as far caudal lateral to the bladder, this will attenuate bleeding and aid visualisation of the iliac arteries
- The external iliac artery is traced upwards to its bifurcation
- A hemo-clip is applied to the INTERNAL iliac artery as it takes off from its parent vessel
- The packing is completed to a snug fit to ensure that arterial flow to the limb is not impeded
- Wound is dressed, the fascia is not closed

Bleeding Neck Wound or from Major Vascular Landmarks

- DO NOT blindly apply clamps
- Apply digital pressure directly on the bleeding point, keep pressure on throughout the process of cleaning, draping and gaining proximal and distal control
- Avoid the use of pneumatic tourniquets in OT
- Patient should be supine with the head turned to the opposite side for neck wounds, for upper limbs the arm should be extended on an arm board, lower limbs should be flexed slightly at the hip and knee with external rotation
- Standard visual exposures should be used to gain proximal and distal control of vessels
- Always have a healthy uninjured limb (lower limb preferably, for vein graft donor site), prepared and draped

Equipment and Instruments

Basic Considerations

- It is impossible to predict the need and use of a particular instrument or instrument set for a trauma operation
- For blunt and penetrating trauma to the torso, a "big/large" set should be opened and a thoracotomy set should be readied in the OT where the patient is operated on
- Trauma lap pads ("trauma packs") should be at hand in sets of 10 to 12 per pack for crash operations
- It is not necessary to have more than one sucker system although if available may be used
- Supplementary vascular instruments should be readied on standby if required, these include vascular clamps of various sizes and shapes, vessel loops, embolectomy catheters of various sizes, butterfly needles of various sizes, radiological contrast material, nasogastric tubes (as temporary shunts), Foley's catheters (sizes 10,12, 14, 16, 18) as balloon tamponades, sterile condoms etc
- Adjuncts to hemostasis; includes topical homeostatic agents (such as, Surgicel™, Gelfoam™, Flosseal™ matrix etc)

Peripheral vascular trauma (injuries involving vessels distal to the groin or axilla), injuries to the neck requiring formal neck exploration (excluding debridement only procedures)

Basic plastic set
Micro-vascular set
Bulldog clamps
Small deBakey clamps
Small Satinsky clamps
Adson self retaining retractors (x2)
Vessel loops
Snare and hooks
Vein harvesting cannula (x1)
Disposable syringes 1, 3, 5, 10 mls
Fogarty cathethers sizes 2, 3, 4
Ligaclips - small and medium with short handled applicator
Heparinized saline in large quantities
Vascular access cannulae ("Branula") 20G, 18G (x2)

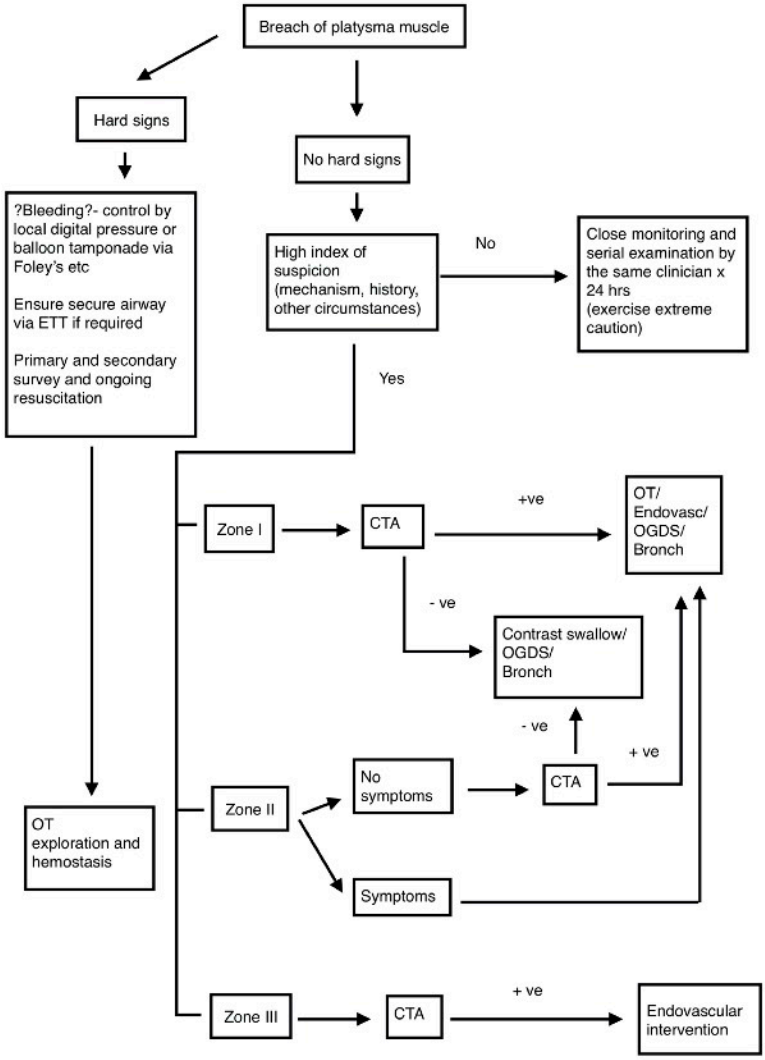
Operations for chest injuries/access to chest for resuscitative reasons/access into the mediastinum-pericardium (e.g "thoracotomy/sternotomy/thoracolaparotomy" etc)

Large set
Thoracotomy set
Large/medium deBakey clamps
Large/medium Satinsky clamps
Soft bowel clamps
Vessel loops
Snares and hooks
Linear staplers 55, 60, 80, 100
Linear cutting staplers 55, 60, 65, 80, 100
Foley's catheter size 10, 12, 14
Sterile condom
Disposable syringes 10 and 20 mls
Surgicel snow™
Floseal hemostatic matrix™
Gelfoam topical hemostat™
Bone wax (large pieces)
Bone shears
Gigli saw
Leibsche knife and mallet
Trauma packs (square)
Large ligaclips with long handled applicator
Pledgets
Skin stapler
Sutures:
- Polypropylene 0, 2/0, 3/0, 4/0, single needled
- Ethibond™ 2, 0
- Sternal wires + (sternal wire/patella wire set)
- Safil™/Vicryl™ 2/0, 3/0, 4/0 or similar

Headlight and power source

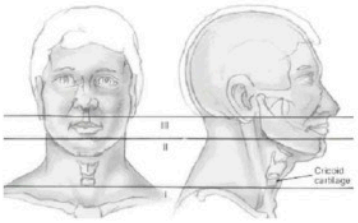
Trauma Cases Algorithm

Penetrating neck injury



Zones and signs of penetrating neck injury

Anatomic zones in penetrating neck injury	
Zone I	Clavicle-sternum to cricoid cartilage
Zone II	Cricoid cartilage to angle of mandible
Zone III	Angle of mandible to base of skull



Hard signs of penetrating neck injury
Airway compromise
Massive subcutaneous emphysema or bubbling through wound
Expanding or pulsatile hematoma
Active bleeding
Shock
Neurological deficit (central)
Hematemesis

Blunt Cerebrovascular Injury (BCVI)

High risk profile

Any neurologic abnormality not explained by a diagnosed injury

Blunt trauma presenting with epistasis suspected of arterial origin

Asymptomatic patients with significant blunt head trauma with the following:

- **GCS <8**
- **Petrous bone fracture**
- **Diffuse Axonal Injury**
- **C1 - C3 fracture**
- **Fracture through the foramen transversarium**
- **C-spine fracture with subluxation/rotational component**
- **LeFort II - III fractures**

Screening/diagnostic modality

Gold standard - four vessel cerebral angiogram

Four vessel cerebral CTA may be substituted provided CT has 8 or more multi detectors

Duplex scan is NOT and adequate screening modality

Grading

Gr I: intimal irregularity and < 25% narrowing
Gr II: dissection/intramural hematoma with > 25% narrowing
Gr III: pseudoaneurysm
Gr IV: occlusion
Gr V: transection with extravasation

Treatment options

Gr I and II
- anti thrombotic agents (aspirin/heparin), both seemingly have equivalent results
- heparin should be given WITHOUT loading dose
- aPTT goals have not been established by studies
- conversion to warfarin (if heparin chosen) titrated to INR of 2 - 3 for 3 to 6 months

Grade III
- may rarely resolve without intervention
- invasive treatment should be considered
- early neurological deficit and accessible carotid lesions should be treated invasively (operative/radiological)

Grade IV
- Neurological damage
- Conservative

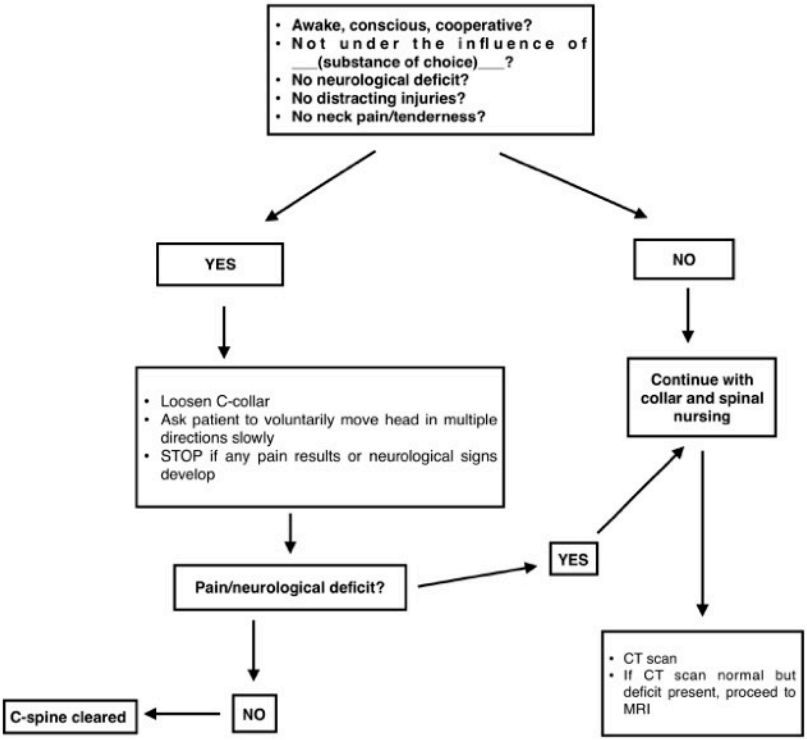
Grade V
- Management to arrest exsanguination

Follow up

first follow up imaging of Gr I - II should be performed 7 days post injury

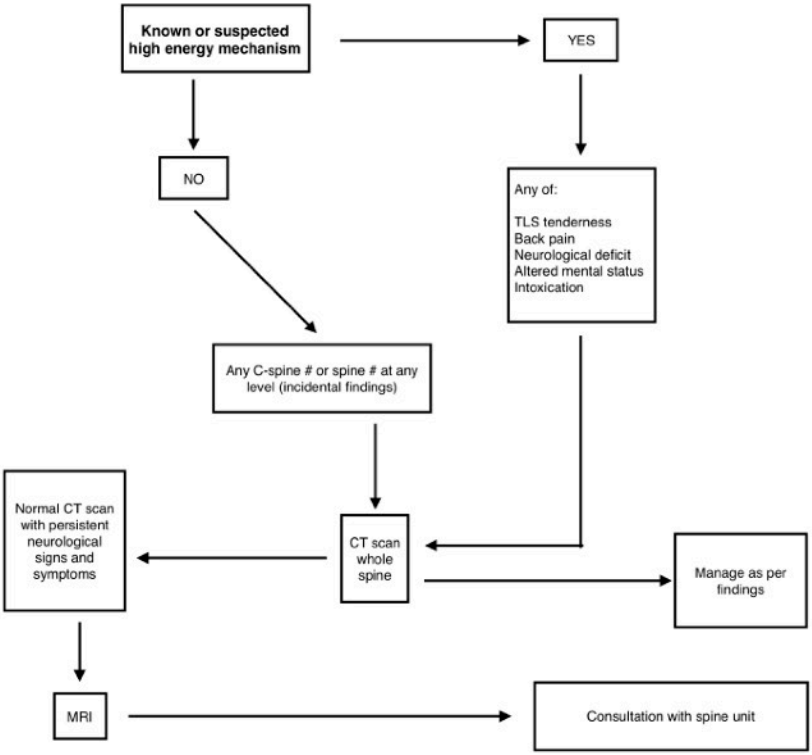
there is no data on subsequent follow up timing and frequency

Clearing the Cervical Spine

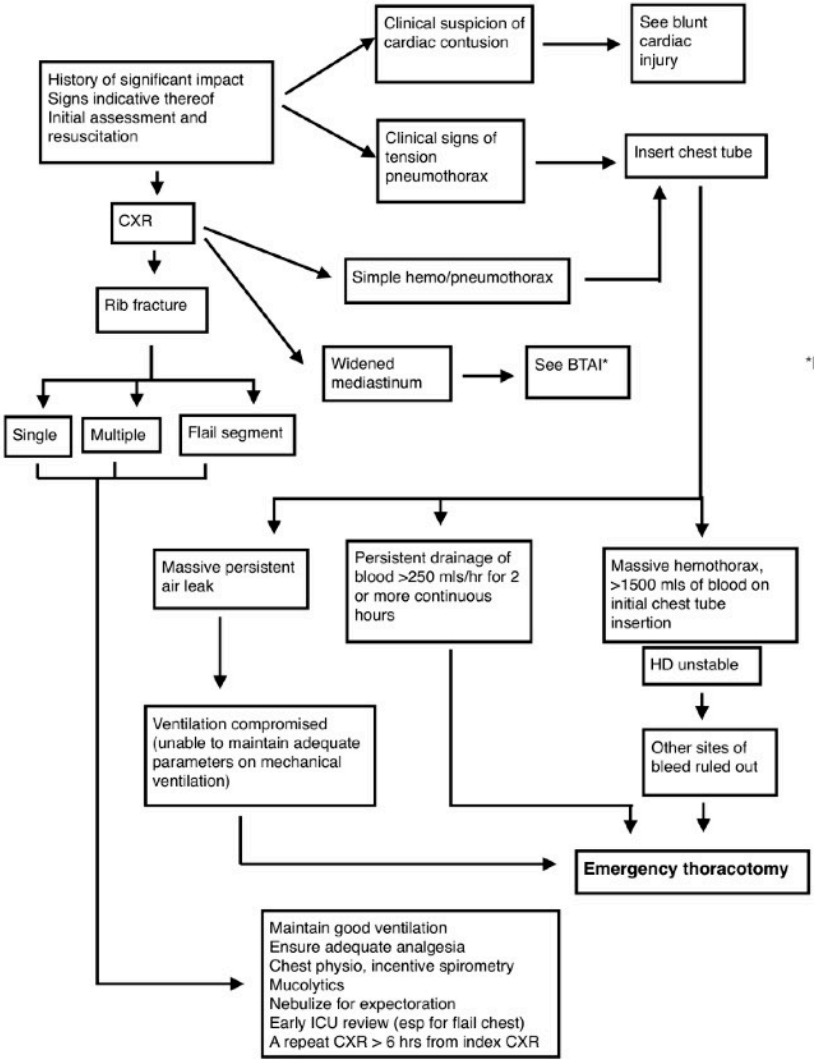


*Assume all trauma patients to have C-spine injury until proven otherwise !!

Thoracolumbar spine screen in blunt trauma

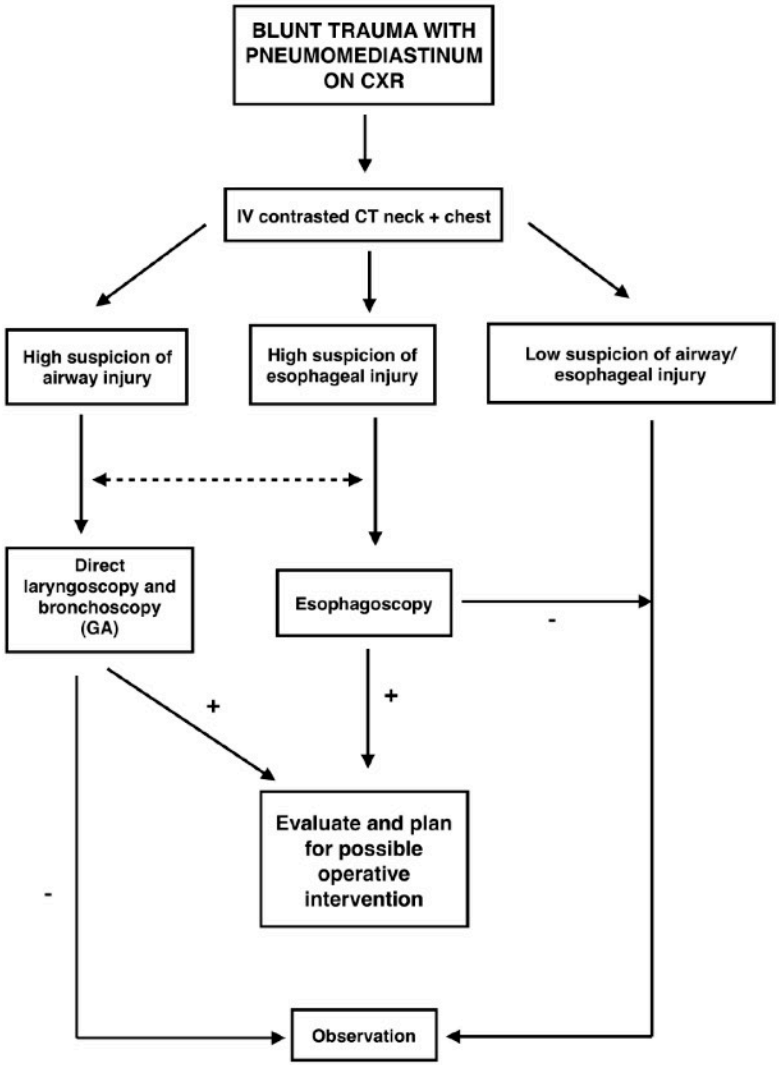


Blunt Chest Injury

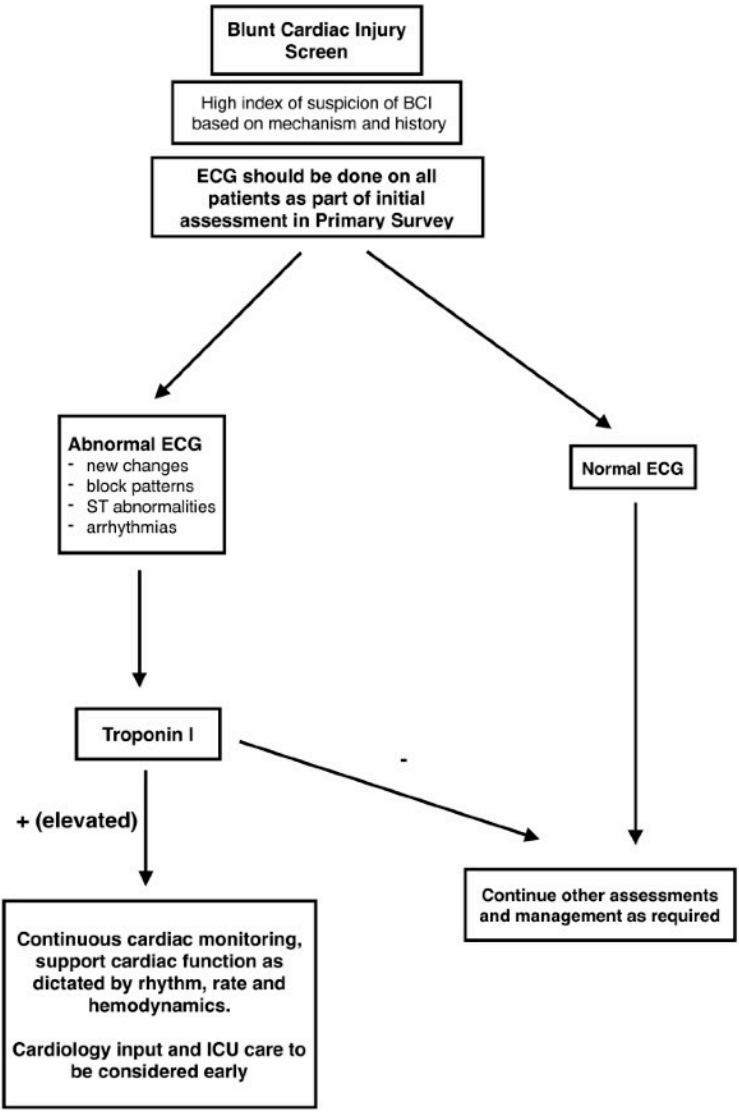


**Blunt Thoracic Aortic Injury (BTAI)*

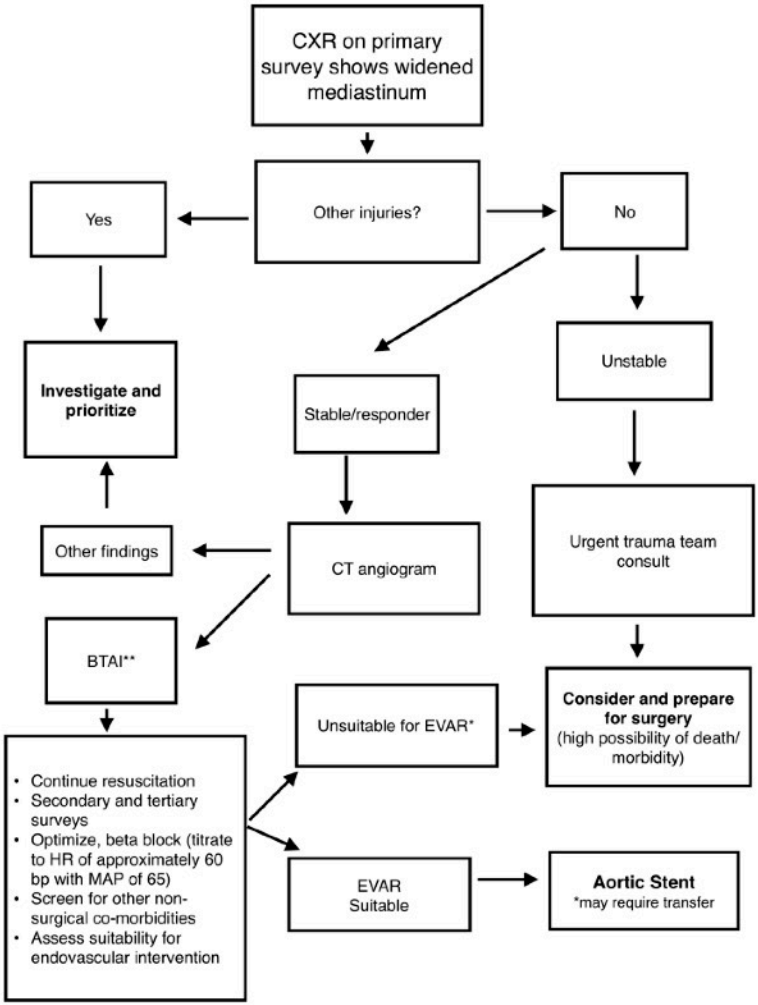
Blunt trauma with pneumomediastinum



Blunt Cardiac Injury



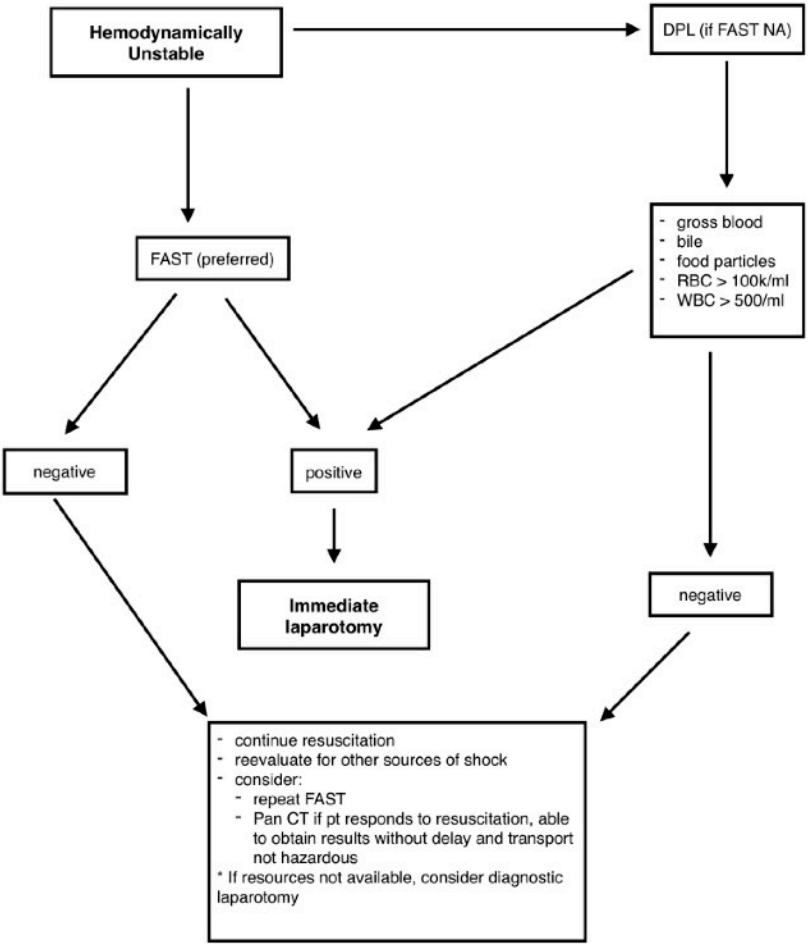
The Widened Mediastinum (BTAI)**



*EVAR – endovascular aneurysm repair (pseudoaneurysm in the context of trauma)

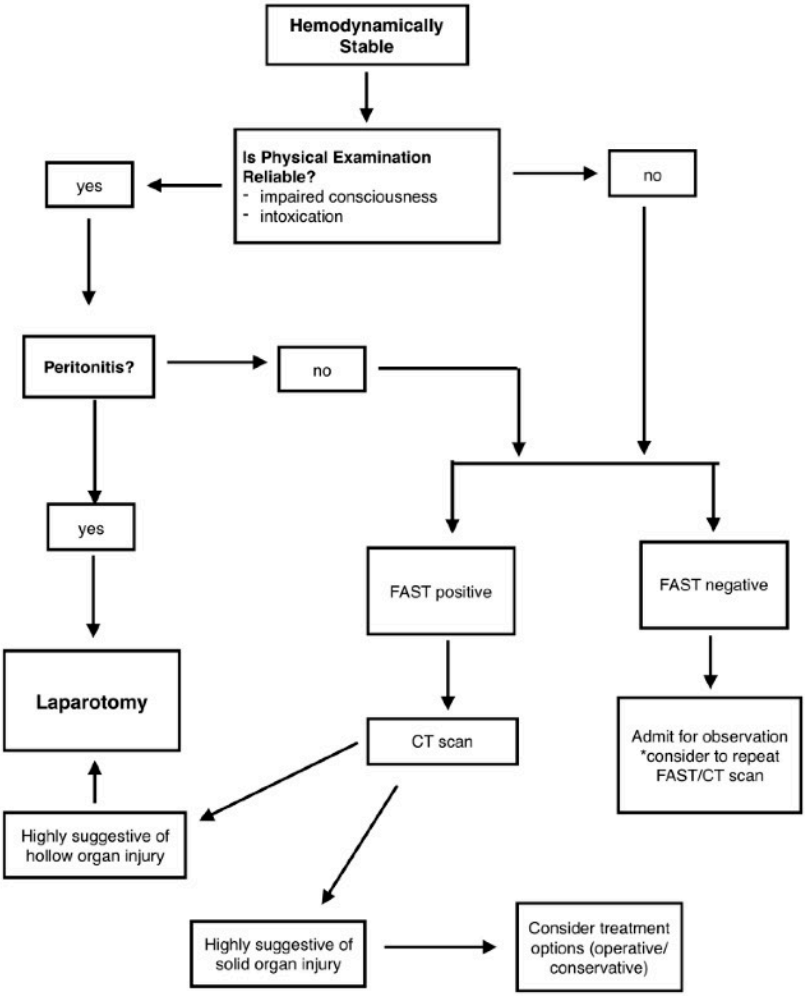
**blunt thoracic aortic injury

Blunt Abdominal Trauma – Haemodynamically Unstable

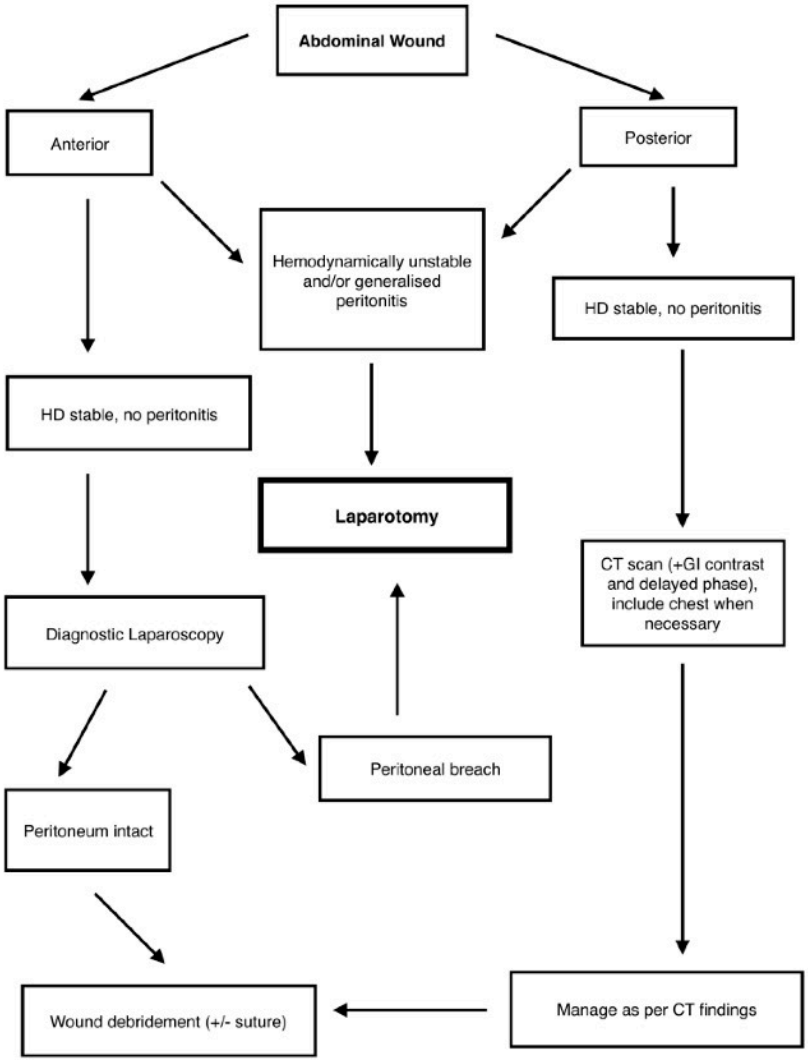


FAST: Focus Abdominal Sonography for Trauma, mainly to look for free fluid in the peritoneal cavity. Not to diagnose solid organ injury.

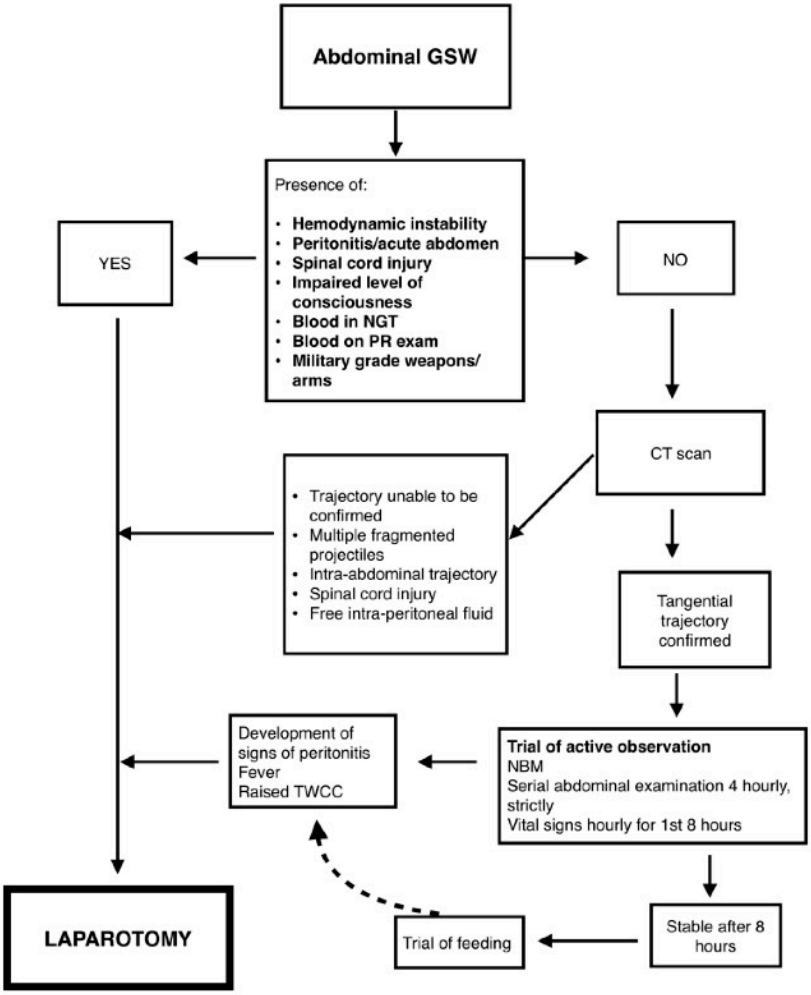
Blunt Abdominal Trauma – Haemodynamically Stable



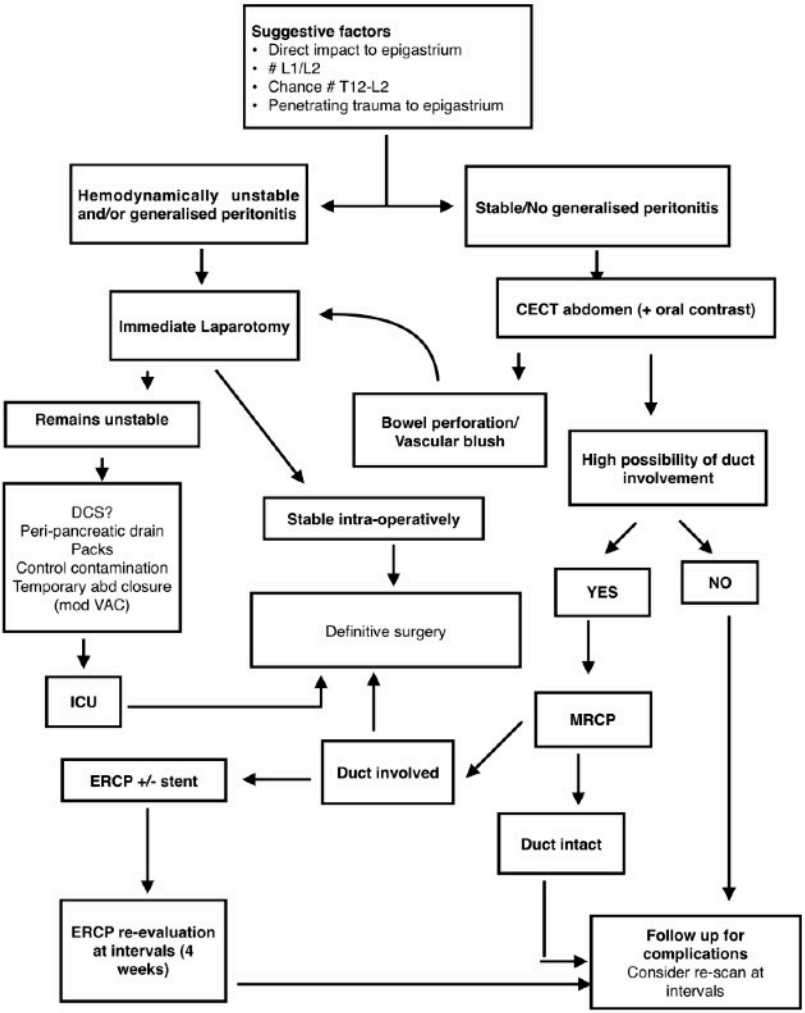
Abdominal Stab Injury



Gunshot wound to the abdomen



Blunt Pancreatic Trauma



Non-operative management for liver and spleen injury due to blunt trauma, recommendation, and guides:

Applies to liver and splenic injuries :

1) All hemodynamically unstable patients or patients with signs of peritonitis should be taken to the operation theatre for surgery.

2) A routine laparotomy is not indicated for the hemodynamically stable patient without signs of peritonitis, presenting with an isolated injury to the liver or spleen.

3) All hemodynamically stable patients with blunt abdominal trauma planned for non-operative treatment must have a contrasted CT scan done to identify and grade the severity of injury to the liver or spleen.

4) The severity of injury as suggested by grade, neurologic status, age and/or presence of associated injuries are not absolute contraindications to a trial of non-operative treatment, provided the patient remains hemodynamically stable

5) Non-operative treatment should only be considered in an environment that provides capabilities for safe monitoring, serial clinical evaluations and available OT to operate emergently

6) The clinical condition of the patient, such as the presence of persistent SIRS, drop in haemoglobin, development of jaundice, and persistent abdominal pain, following non- operative management, should prompt a re-evaluation imaging and dictate the frequency of such follow-up.

7) VTE prophylaxis is not contraindicated, the timing is based on clinical judgement.

Applies to liver injury

8) *Angioembolization may be considered as first-line intervention for the transient responder to resuscitation as an adjunct to a potential operative intervention

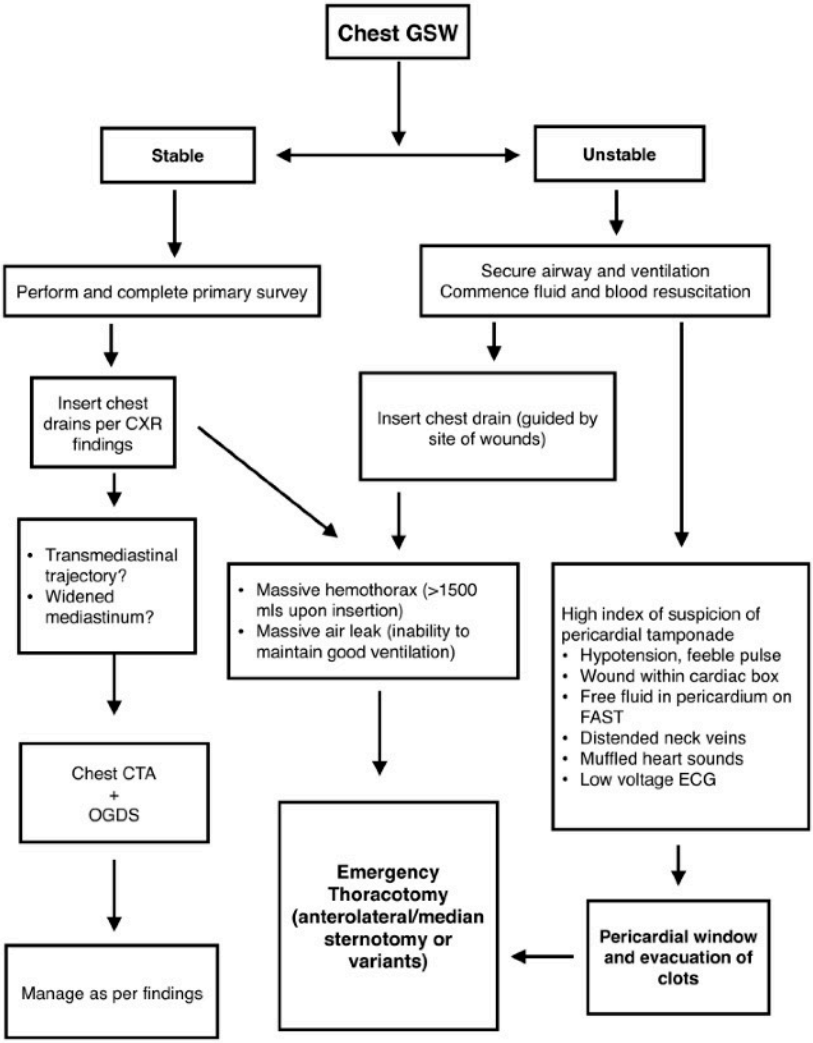
9) *Angioembolization is indicated for the hemodynamically stable patient planned for non operative treatment if a vascular blush is detected during a CT scan

10) Interventional modalties such as ERCP, *angiography, percutaneous drainage, laparoscopic drainage, may be required to manage complications such as bile leaks, billomas, or abscesses resulting from non-operative management.

Spleen Injury

11) *Angiography and embolization is indicated for AAST Grade III or higher injury, presence of contrast blush, moderate hemoperitoneum or other evidence of ongoing bleeding and can be used as an adjunct in the investigation and management of vascular abnormalities such as pseudo aneurysms.

Gunshot wound to the chest



ORGAN INJURY SCALES

INJURY SEVERITY SCORE (ISS) & NEW INJURY SEVERITY SCORE (NISS)

The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an AIS and is allocated to one of six body regions (Head, Face, Chest, Abdomen, Extremities (including Pelvis), External). Only the highest AIS score in each body region is used. The 3 most severely injured body regions have their score squared and added together to produce the ISS score.

The ISS score takes values from 0 to 75. If an injury is assigned an AIS of 6 (unsurvivable injury), the ISS score is automatically assigned to 75. The ISS score is virtually the only anatomical scoring system in use and correlates linearly with mortality, morbidity, hospital stay and other measures of severity.

As multiple injuries within the same body region are only assigned a single score, a proposed modification of the ISS, the "New Injury Severity Score" (NISS), has been proposed. This is calculated as the sum of the squares of the top three scores regardless of body region. The NISS has been found to statistically outperform the traditional ISS score.

Major Trauma is defined as those patients in whom there is significant risk loss of life. The globally accepted definition of “Major Trauma” are injuries with an ISS of more than 15. (ISS > 15)

• *Baker SP et al, "The Injury Severity Score: a method for describing patients with multiple injuries and evaluating emergency care", J Trauma 14:187-196;1974*

An example of the ISS and NISS calculation is shown below:

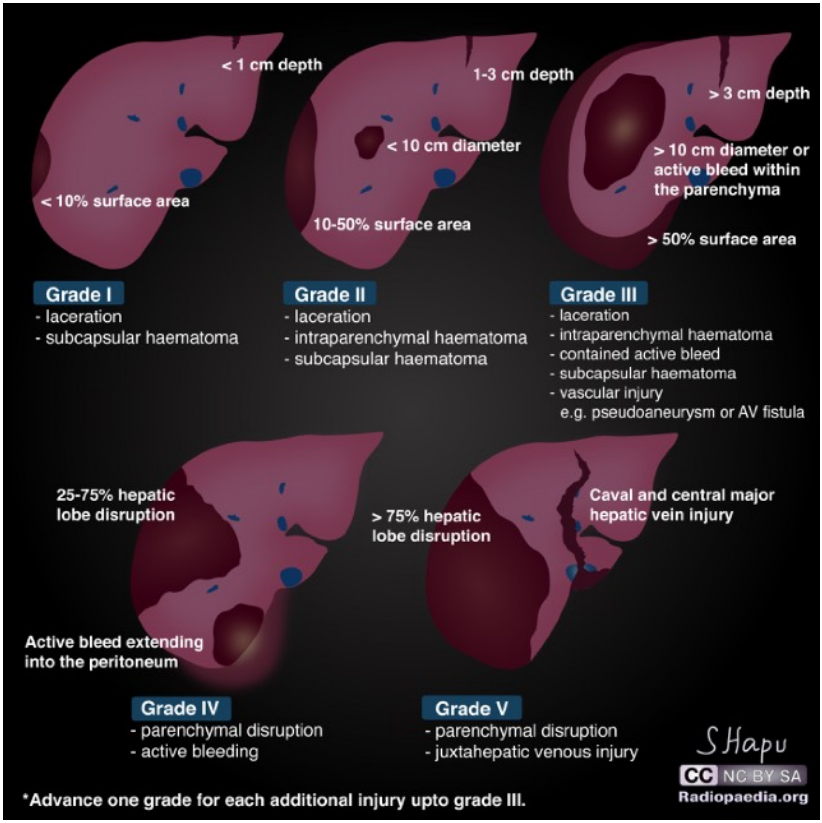
Region	Injury description	AIS	Square top three
Head & Neck	Cerebral concussion	3	9
Face	Mandible fracture	2	4
Chest	Right 3-5th ribs fracture	3	9
Abdomen	More than 3 cm liver laceration Complex splenic injury	3 5	9 25
Extremity	Fractured femur	3	9
External	multiple abrasion wound	1	1
	ISS : Head inj^2+Chest inj^2+Spleen inj^2	43	
	NISS : Chest inj^2+Liver inj^2+Spleen inj^2	43	

LIVER INJURY SCALE

Grade*	Injury type	Injury description	AIS 90
I	Haematoma	Subcapsular, <10% surface area	2
	Laceration	Capsular tear, <1 cm parenchymal depth	2
II	Haematoma	Subcapsular, 10-50% surface area : Intraparenchymal, <10 cm in diameter	2 2
	Laceration	Capsular tear, 1-3 cm parenchymal depth, <10 cm length	2
III	Haematoma	Subcapsular, >50% surface area or expanding Ruptured subcapsular or parenchymal hematoma Intraparenchymal hematoma >10 cm or expanding	3 3 3
	Laceration	>3 cm parenchymal depth	3
IV	Laceration	Parenchymal disruption involving 25-75% of hepatic lobe or 1-3 Couinaud's segments within a single lobe	4
V	Laceration	Parenchymal disruption involving >75% of hepatic lobe or >3 Couinaud's segments within single lobe	5
	Vascular	Juxtahepatic venous injuries; i.e., retrohepatic vena cava/central major hepatic veins Hepatic avulsion	5 6

* Advance one grade for multiple injuries up to grade III

LIVER INJURY



Picture courtesy of Dr Sahinta Hapugoda, radiopedia.org, RID: 51390

LIVER INJURY – criteria for non-operative management (NOM)

1. Haemodynamic stability
2. No peritoneal signs
3. Reliable exam (neurologically intact)
4. CT delineation of injury, quantity intraparenchymal blood, no associated intraperitoneal injury
5. <2 units blood transfusion
6. CT scan follow-up showing resolution of injury
7. Proper facilities and support services

PRACTICE POINT:

Arterial blush or pooling contrast on CT likely to fail conservative management.
Grade > 3 - repeat CT if indicated, accordingly
Grade 4-5 - repeat CT scan 48-72 hrs

Repeat CT scan for Grade 4-5 at 2/52 and 6/52 to assess healing or complications like biloma etc

**AAST (American Association for the Surgery of Trauma) Liver injury scale 2018*

SPLEEN INJURY SCALE

Grade*	Injury type	Injury description	AIS 90
I	Haematoma	Subcapsular, <10% surface area	2
	Laceration	Capsular tear, <1 cm parenchymal depth	2
II	Haematoma	Subcapsular, 10-50% surface area :	2
		Intraparenchymal, <5 cm in diameter	2
	Laceration	Capsular tear, 1-3 cm parenchymal depth which does not involve a trabecular vessel	2
III	Haematoma	Subcapsular, >50% surface area or expanding	3
		Ruptured subcapsular or parenchymal hematoma	3
		Intraparenchymal hematoma >5 cm or expanding	3
	Laceration	>3 cm parenchymal depth or involving trabecular vessel	3
IV	Laceration	Laceration involving segemental or hilar vessels producing major devascularization (>25% of spleen)	4
V	Laceration	Completely shattered spleen	5
	Vascular	Hilar vascular injury which devascularizes spleen	5

* Advance one grade for multiple injuries up to grade III

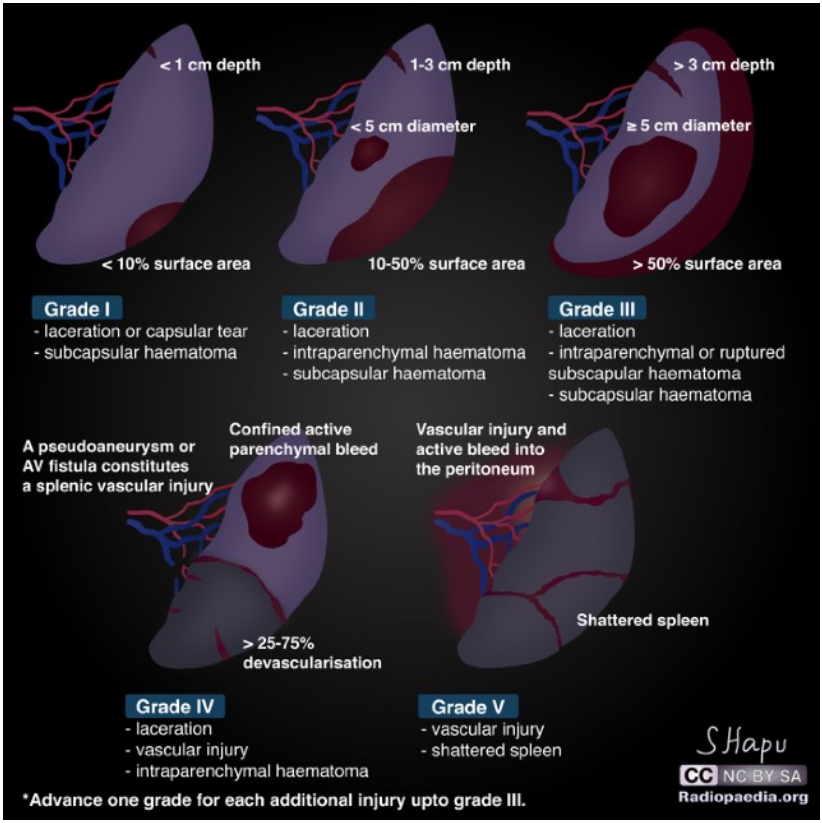
PANCREAS INJURY SCALE

Grade*	Injury type	Injury description	AIS 90
I	Haematoma	Minor contusion without duct injury	2
	Laceration	Superficial laceration without duct injury	2
II	Haematoma	Major contusion without duct injury or tissue loss	2
	Laceration	Major laceration without duct injury or tissue loss	3
III	Laceration	Distal transection or parenchymal / duct injury	3
IV	Laceration	Proximal transection or parenchymal injury involving ampulla	4
V	Laceration	Massive disruption of pancreatic head	5

* Advance one grade for multiple injuries up to grade III

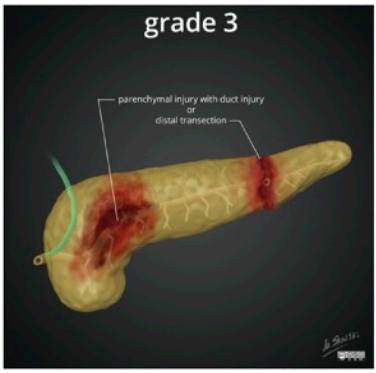
Proximal pancreas is to the patient's right of the SMV.

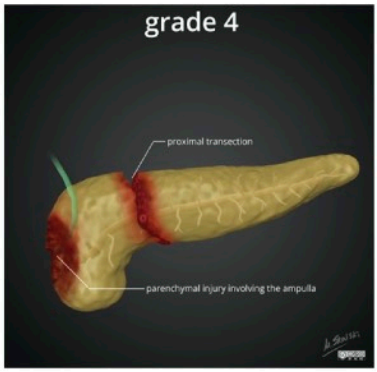
Splenic Injury



Picture courtesy of Dr Sahinta Hapugoda, radiopedia.org, RID: 51390

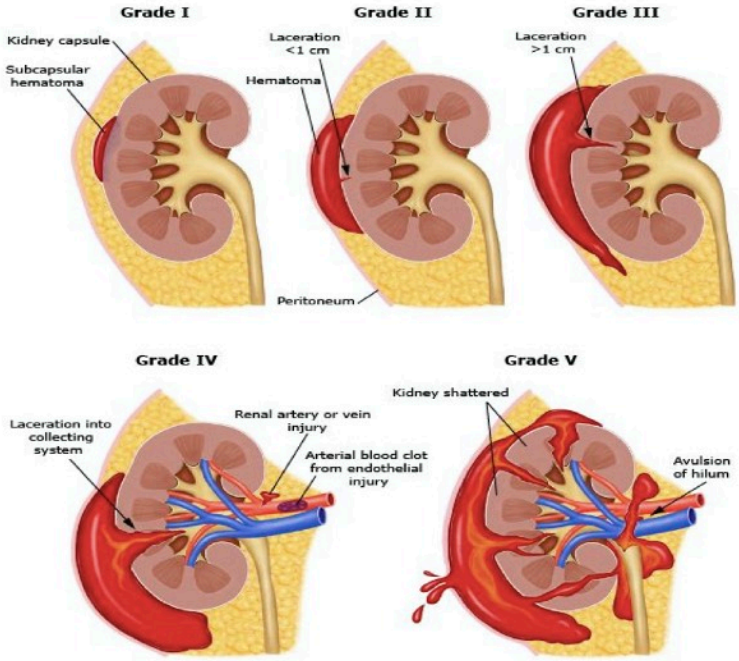
Pancreatic injury





KIDNEY INJURY

Grade*	Injury type	Injury description	AIS 90
I	Contusion	Microscopic or gross hematuria	2
	Haematoma	Subcapsular, nonexpanding without parenchymal laceration	2
II	Haematoma	Nonexpanding perirenal hematoma confined to renal retroperitoneum	2
	Laceration	<1 cm parenchymal depth of renal cortex without urinary extravasation	2
III	Laceration	<1 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation	3
IV	Laceration	Parenchymal laceration extending through the renal cortex, medulla, and collecting system	4
	Vascular	Main renal artery or vein injury with contained hemorrhage	4
V	Laceration	Completely shattered kidney	5
	Vascular	Avulsion of renal hilum which devascularizes kidney	5



Small bowel Injury

Grade*	Injury type	Injury description	AIS 90
I	Haematoma	Contusion or hematoma without devascularization	2
	Laceration	Partial thickness, no perforation	2
II	Laceration	Laceration < 50% of circumference	3
III	Laceration	Laceration > 50% of circumference	3
IV	Laceration	Transection of small bowel	4
V	Laceration	Transection of small bowel with segmental tissue loss	4
	Vascular	Devascularized segment	4

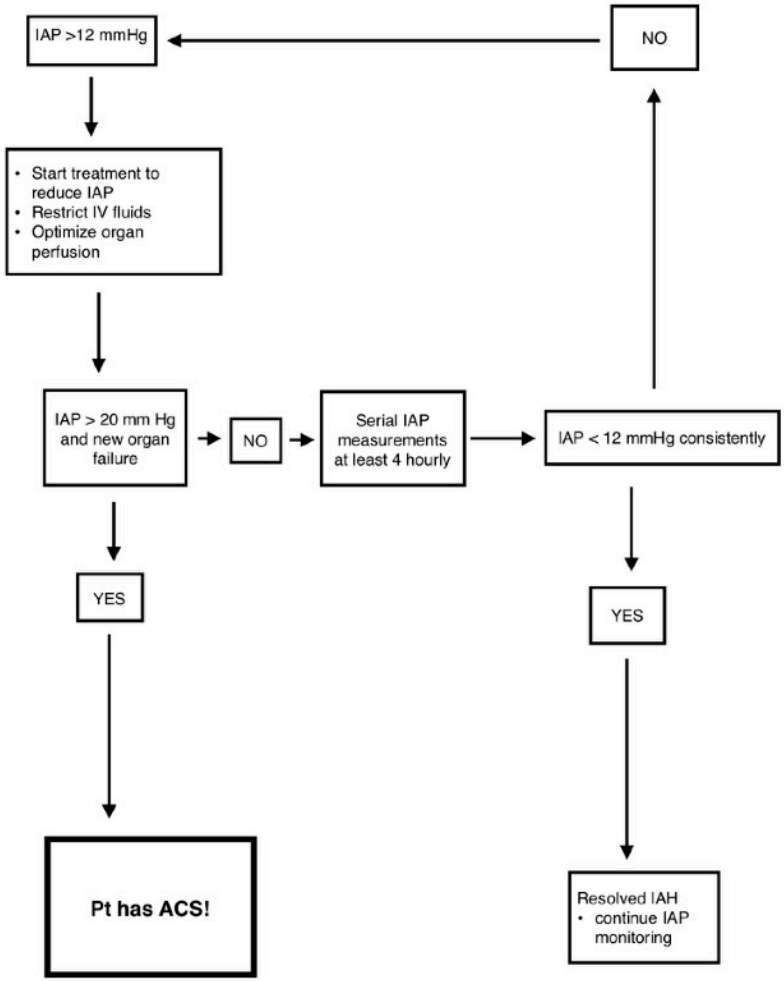
* Advance one grade for multiple injuries up to grade III

Lung injury

Grade*	Injury type	Injury description	AIS 90
I	Contusion	Unilateral, <1 lobe	3
II	Contusion	Unilateral, single lobe	3
	Laceration	Simple pneumothorax	3
III	Contusion	Unilateral > 1 lobe	3
	Laceration	Persistent (>72 hrs), air leak from distal airway	3-4
	Haematoma	Nonexpanding intraparenchymal	
IV	Laceration	Major (segmental or lobar) air leak	4-5
	Haematoma	Expanding intraparenchymal	
	Vascular	Primary branch intrapulmonary vessel disruption	3-5
V	Vascular	Hilar vessel disruption	4
VI	Vascular	Total, uncontained transection of pulmonary hilum	4

* Advance one grade for multiple injuries up to grade III Hemothorax is scored under thoracic vascular injury scale

Intraabdominal hypertension



Abdominal compartment syndrome and Intraabdominal hypertension

Definitions used in ACS algorithm

IAH: intra-abdominal hypertension
ACS: abdominal compartment syndrome
IAP: intra-abdominal pressure
APP: abdominal perfusion pressure (MAP-IAP)
Primary ACS: a condition originating in the abdomen-pelvic region that frequently requires urgent surgical or radiological intervention
Secondary ACS: conditions that does not originate from the abdomen-pelvic region
Recurrent ACS: ACS that recurs after surgical or medical management of ACS

Medical management options to reduce ACS

Improve abdominal wall compliance
- Sedation and analgesia
- Neuromuscular relaxation
- Avoid head of bed > 30 deg

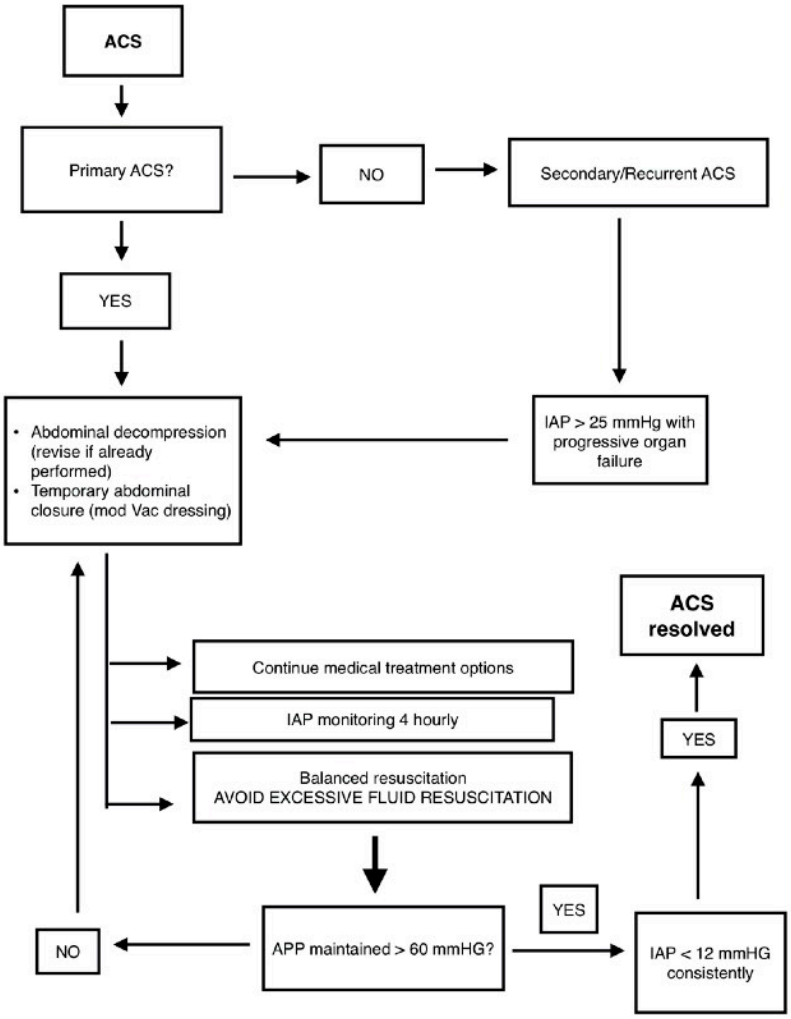
Evacuate intraluminal contents
- Nasogastric suction
- Rectal decompression
- Prokinetic agents

Evacuate abdominal fluid collections
- Paracentesis
- Percutaneous drainage

Correct positive fluid balance
- Avoid excessive fluid resuscitation
- Diuretics
- Colloids/hypertonic fluids
- Dialysis

Organ support
- Maintain APP > 60 mmHg with vasopressors
- Optimize ventilation
  Consider using volumetric preload indices
- Use transmural (tm) airway pressures
  1) $P_{plat\ tm}$ = Pplat - IAP
  2) $PAOP_{tm}$ = PAOP - 0.5 IAP
  3) CVP_{tm} =CVP-0.5IAP

Abdominal Compartment Syndrome (ACS)



Diagnostic criteria for ACS

Requires 2 components:
1. Sustained intra-abdominal pressure > 20 mmhg.
2. Organ failure attributable to elevated intra-abdominal pressure.

How to measure ?

Direct measurement: Insert intra-peritoneal catheter attached to manometer or pressure transducer.

Indirect measurement: Insert CBD into urinary bladder and fill with 50 mL saline. Connect to manometer or pressure transducer. Level at symphysis pubis.

Intra-abdominal hypertension (IAH) grade

Grade	Pressure / mmHg
Normal	< 12 mmHg
Grade I	12 - 15
Grade II	16 - 20
Grade III	21 - 25
Grade IV	> 25
ACS	> 20 with new organ dysfunction/failure

REFERENCE:

Coccolini et al.World Journal of Emergency Surgery (2018) 13:7

DIAGNOSTIC PERITONEAL LAVAGE INTERPRETATION

Use the open method. (refer to “Procedures” section)
If you are doing it in the presence of pelvic fracture, do a supraumbilical diagnostic peritoneal aspirate instead of a lavage.

Sensitivity > 95 percent.

Positive if :

RBC > 100 000/ mm3
WBC > 500 / mm3
ALP > 2 IU/L
Amylase > 20 IU/L (175 IU/L)

Bowel perforation WBC : RBC > 150 Cell count ratio > 1

Nb.

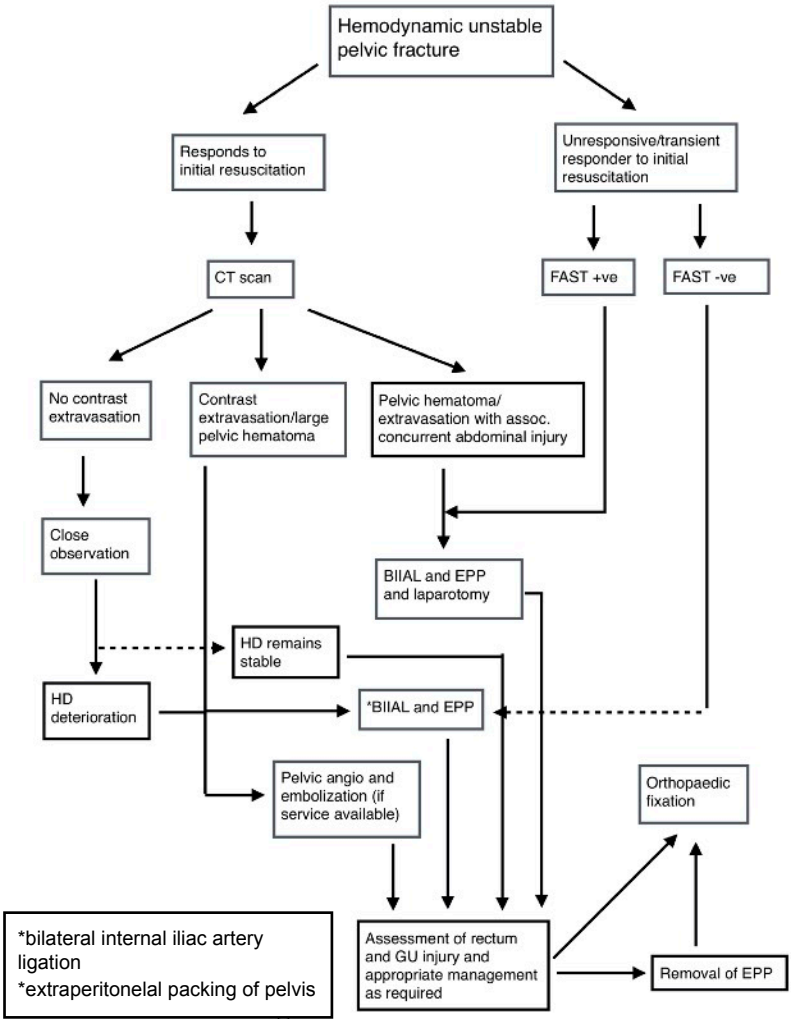
RBC 100 000/mm^3 approx 25-30 mL frank intraperitonel blood

Cell count ratio = Lavage fluid/ peripheral blood WBC : RBC ratio

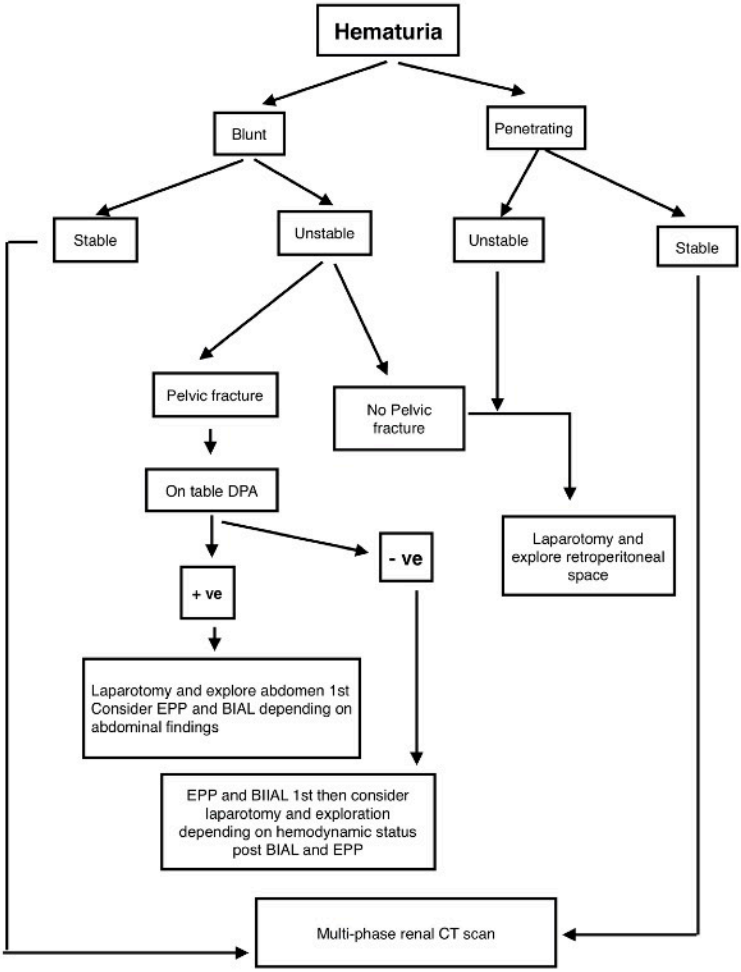
PRACTICE POINT:

Still a useful test when CT scan or FAST scan not available.
Improves detection of hollow viscus injury.

HAEMODYNAMICALLY UNSTABLE PELVIC FRACTURE



HAEMATURIA IN TRAUMA PATIENT



Abdominal and pelvic trauma with suspected genitourinary system injury

Imaging for patients with blunt abdominal/pelvic trauma :

- Low risk (microscopic hematuria only): no imaging study (**conditional recommendation**)
- Moderate risk (gross hematuria): retrograde CT cystography is recommended
- High risk (gross hematuria with pelvic fracture): retrograde CT cystography is recommended

Management of intra-peritoneal bladder rupture:

- Operative repair is recommended

In patients sustaining blunt abdominopelvic trauma with extra-peritoneal bladder rupture:

- Simple extra-peritoneal rupture: non-operative management is recommended (**conditional recommendation**)
- Complex extra-peritoneal rupture: operative management (**conditional recommendation**)

* Simple extra-peritoneal rupture (definition): single full thickness tear of the bladder

** Complex extra-peritoneal rupture (definition):

- multiple defects
- involvement of bladder neck
- proximity/involvement of ureteric orifice
- proximity to an implant
- relative large defect

Imaging for post operative bladder repair in blunt abdominal and pelvic trauma:

- Low risk of leak (operative repair of simple intra-peritoneal or extra-peritoneal rupture): no routine cystography follow up (conditionally recommend)
- Moderate risk of leak (operative repair of complex intra-peritoneal or extra-peritoneal bladder rupture): follow up retrograde CT cystography is recommended
- High risk of leak (non-operative management of simple extra-peritoneal bladder rupture): retrograde CT cystography is recommended

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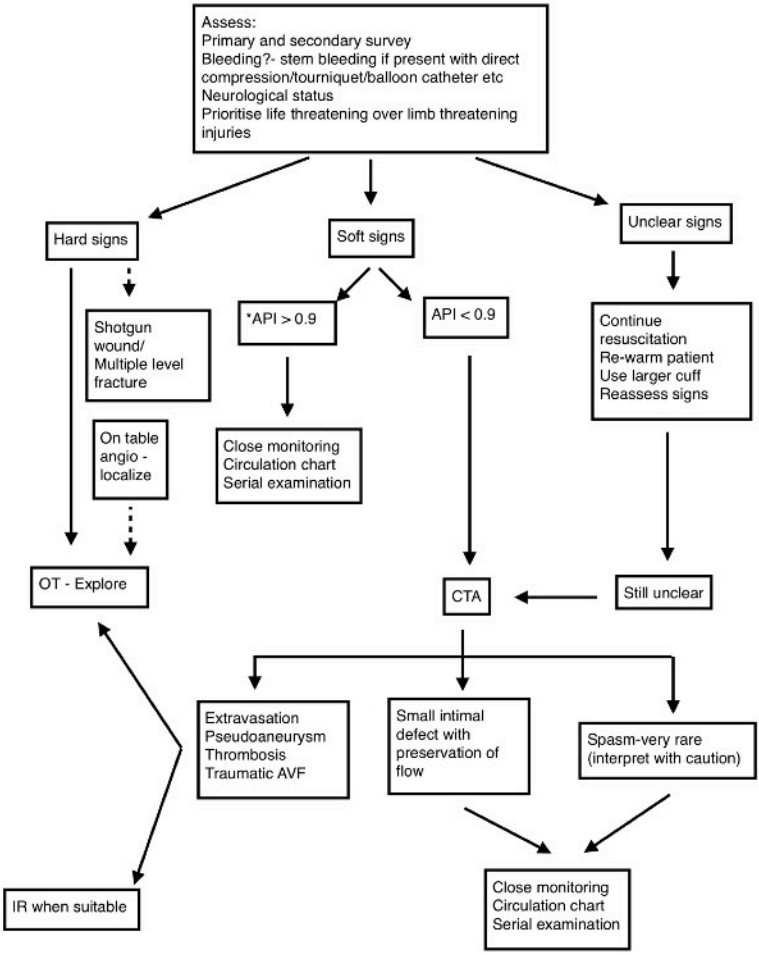
PERIPHERAL VASCULAR INJURY

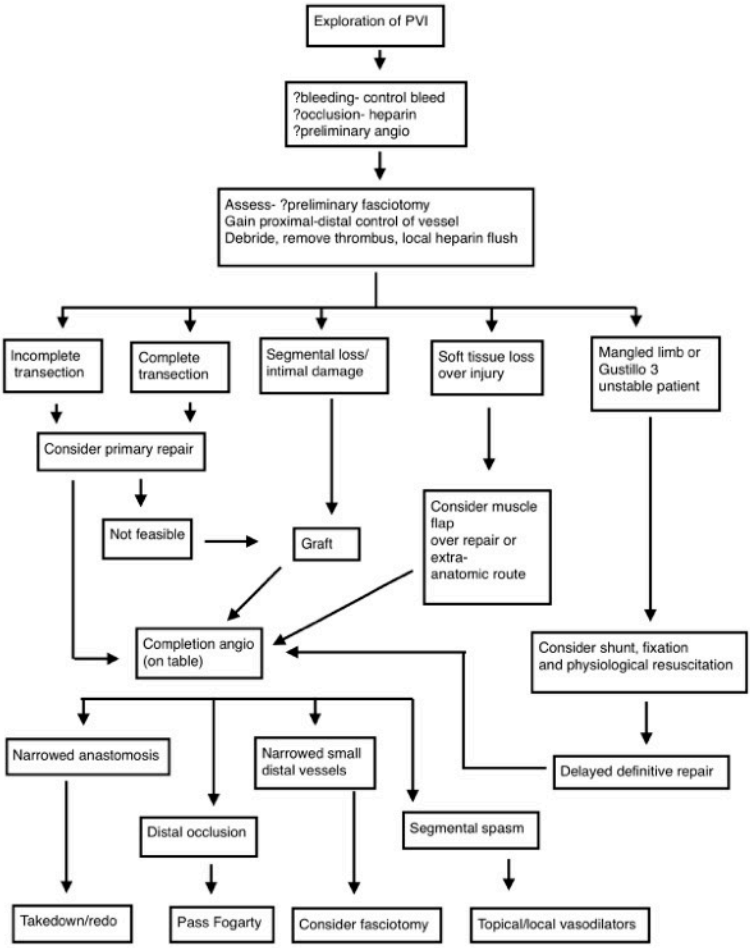


*arterial pressure index defined as the ratio of Doppler arterial pressure distal to the injury to the Doppler arterial pressure of an uninjured upper limb

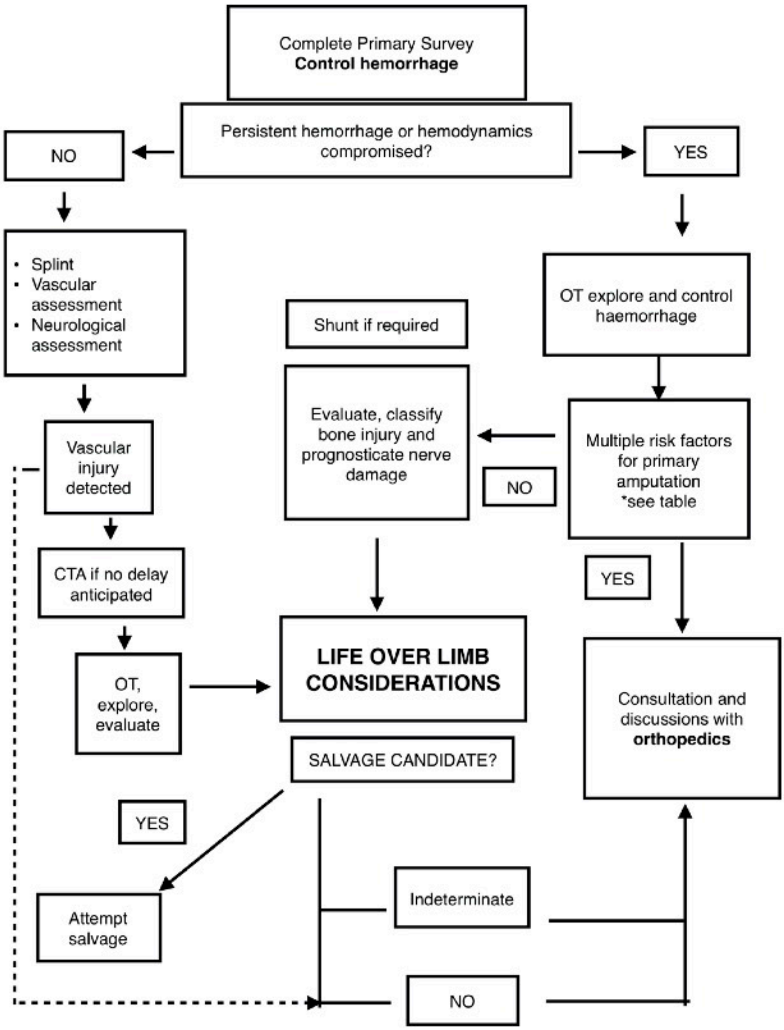
Peripheral Vascular Injury

Hard Signs	Soft Signs
External bleeding	History of arterial bleed at the scene or in transit
Rapidly expanding hematoma	Proximity of penetrating wound or blunt injury to a known artery
Any of the classical signs of arterial occlusion (pulseless, pallor, paresthesia, pain, paralysis)	A small, non pulsatile hematoma over an artery
Palpable thrill or audible bruit	A neurological deficit originating to a particular nerve that runs along a known artery

Surgical exploration of peripheral vascular injury



THE MANGLED EXTREMITY



Predictors Associated With the Need for Primary Amputation

Systemic Factors

- Age >50 yrs
- High energy transfer mechanism
- Persistent hypotension (<90 mm Hg)

Bones

- Gustillo type IIIA and significant tissue loss/nerve injury, assoc with fibular # and displacement of >50% and comminuted segmental # or high probability of bone graft requirement
- Gustillo type IIIB and IIIC tibial fractures
- Type III compound pilon #
- Type IIIB compound # of ankle
- Severe open injury of hindfoot or midfoot

Soft tissues

- Large circumferential tissue loss
- Extensive closed soft tissue loss or necrosis
- Compartment syndrome resulting in myonecrosis

Neurologic

- Confirmed nerve disruption, particularly tibial nerve

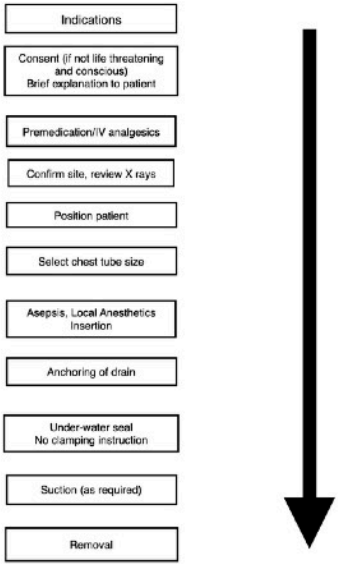
Vascular

- Prolonged warm ischemia time (> 6 hours)
- Degree of vascular segmental loss
- Proximal vascular injury
- Absence of viable distal anastomotic site

**Factors are not independent, no weight is given over one another*

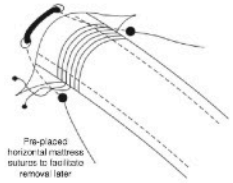
CHEST TUBE INSERTION

Chest tube workflow



Indications	Pneumothorax Tension pneumothorax Hemothorax Pneumo-hemothorax Post thoracotomy Hydrothorax Empyema Parapneumonic effusions
Equipment	Gloves and gown Skin aseptic solutions Sterile drapes Gauze swabs Syringes and needles Local anesthetics (Lignocaine 1 or 2%) Scalpel and blade Suture (Silk 1 or 0) Sterile "suturing set" Chest tube Connecting tubing Underwater sealed drainage system Sterile water for system Dressing
Consent	A brief explanation of the procedure to the patient Under extreme life saving conditions or in the unconscious patient omit this step, explain to next of kin if present
Premedication	IV opioids, usually Morphine or Pethidine or Fentanyl with or without short acting benzodiazepine (ie Midazolam) should be given for comfort)
Confirm site	Make sure insertion is on the correct side of the chest CXR must be available prior to insertion EXCEPT for tension pneumothorax
Position the patient	Arm abducted away from chest
Insertion site	"Safe triangle" Lateral: mid axillary line Medial: anterior axillary line Base: 4th or 5th ICS 

Drain size	Choose a size that is suitable for the patient and the material drained Although size 32 is preferred for removal of blood and fluids, studies show no difference in efficacy, size 28 is generally used to drain air in the adult patient The smaller the drain, the more comfortable it is for the patient
Asepsis	Adhere to aseptic techniques even in an emergency setting One dose of intravenous antibiotics may be given although there are no conclusive data on this matter
Insertion	Should not involve the use of force Seldinger technique may be used if appliance is available Blunt dissection must be used to enter pleural cavity (use curved haemostat) Incision should be of the same diameter or slightly larger than the chest tube Position of the tip should be towards apex if draining air and basal if draining fluid. However, studies show that the position of the tip does not have bearing of its efficiency in evacuating the pleural cavity. If the patient is being ventilated on high PEEP values, consider disconnecting the ventilator just before breaching the parietal pleura to avoid injury to the lung DO NOT use "purse string" sutures Anchor tube securely by winding suture repeatedly around the tube at approximately the same level. DO NOT create a "Roman Sandal" hitch. Removal sutures may be pre-placed



- **anchor tube at a single point**
- **DO NOT "purse string"**

REFERENCES

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TRAUMA SURGERY PLAYBOOK

GUIDES AND ALGORITHMS

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