



## 5 Causes of Hypotension in Trauma:

- Hemorrhagic, Tamponade, Tension Pneumothorax, Neurogenic, Toxicologic

## Management of Traumatic Intracranial Hemorrhage

- Initial Stabilization
  - Airway
    - intubate if patient not protecting airway
    - GCS  $\leq 8$
    - Stabilize pre-intubation hypoxia and hypotension prior to induction and PPV
  - Breathing
    - *Maintain physiologic levels of Oxygen and CO<sub>2</sub> to avoid 2° Brain Injury*
      - high oxygen potentially leads to free radical damage
      - elevated CO<sub>2</sub> can cause vasodilation of carotid arteries and  $\uparrow$  cerebral blood flow which can lead to increased intracranial pressures
  - Circulation
    - *Hypotensive*
      - Goal MAP  $> 80$  to maintain cerebral perfusion pressure
      - $MAP = (SBP + 2 \times DBP) / 3$
      - Fluids, vasopressors as needed
      - Most patients with an ICH are hypertensive, if hypotensive, must find and treat cause
    - *Hypertensive*
      - Increases perfusion pressure, can worsen ICH
      - Nicardipine gtt and arterial line to keep SBP  $< 180$
- Subsequent Management
  - Reverse Anticoagulation
    - Warfarin: Vitamin K, FFP, Prothrombin Complex Concentrate (PCC)
    - Aspirin/Antiplatelets: consider desmopressin, platelets
    - Other potential options if patient on direct thrombin inhibitor or Xa inhibitor:
      - PCC, idarucizumab aka Praxbind (dabigatran), dialysis (dabigatran)
  - Increased ICP
    - Signs/symptoms:
      - Cushing's triad (irregular respirations, HTN, bradycardia), "blown" dilated pupil, AMS
      - CT showing mid-line shift, blood, loss of sulci, signs of herniation
    - Treatment options:

- The most important intervention is RAPID surgical evacuation of space occupying lesions- avoid delays, plan early
- Elevate head of bed to 30°, control pain/sedation
- Hyperventilation to PCO2 30-35 is only an anecdotal temporizing measure, do not use routinely
- Hypertonic saline
  - 250 mL 3% over 10 minutes, re-dose as needed
  - 30 mL 23% “bullet” push
- Mannitol: 1 g/kg, potent diuretic, avoid if patient hypotensive
- Seizures
  - Treat all clinical seizures emergently with benzodiazepines (2-4 mg lorazepam or 5-10 mg midazolam)
  - Consider EEG monitoring to diagnose subclinical seizures
  - Discuss anticonvulsants with neurosurgery
    - Levetiracetam (Keppra) or phenytoin (Dilantin)

### Penetrating Neck Trauma

- Anatomy to know:
  - Zone 1- below the cricoid, difficult to explore, ideally CTA first, IR vs OR if positive
  - Zone 3- above the angle of the mandible, difficult to explore, ideally CTA first, IR vs OR if positive
  - Zone 2- between 1 and 3, easily accessible, to OR if hard signs
    - CTA or observation if no hard signs
- Does it go through the platysma?
  - If no, simple wound care is fine.
  - **If yes → assess for hard vascular signs**
    - Unstable vitals or signs of hard vascular injury? → **to the OR**
      - Severe/pulsatile active bleed, expanding hematoma, bruit/thrill, hemodynamic shock
      - Also look for neurologic dysfunction and protect the airway early if any expanding neck masses/hematomas
        - Beware of voice changes, stridor, airway bleeding
    - No hard vascular signs → CTA neck
      - Obvious injury on CTA → to the OR
      - Concerning trajectory → admit for bronchoscopy, upper GI scope, monitoring
      - No obvious injury **and** non-concerning trajectory → observation vs home
- Former Dogma: mandatory exploration if platysma penetrated, now has evolved from mandatory to selective approach with improved imaging modalities (CTA)
- Zone 1 and 3 injuries are much more complicated surgical approaches, so CTA and IR may be chosen over exploration depending on the capabilities of the institution. Institutions that can go to OR rapidly for status changes can choose to observe rather than explore borderline cases.

### Thoracic Trauma

- Main principle at the bedside is to detect and treat immediate/reversible life threats

- Tension PTX
- Massive hemothorax
- Cardiac tamponade
  - Unstable patient may have an aortic injury, but will likely need to obtain CTA Chest to diagnose
- Unstable Vitals
  - First two actions considered/completed in unstable patients with thoracic trauma:
    - **Needle decompression/chest tube placement**
      - Needle decompression/chest tube can be performed prior to imaging in unstable patients with suggestive clinical signs of hemothorax or pneumothorax (no lung sliding on US, decreased breath sounds, obvious chest trauma, etc.)
    - **US of heart to evaluate for tamponade**
      - Thoracotomy or pericardiocentesis if pericardial fluid present
- Stable Vitals
  - With portable CXR, eFAST -> find and treat immediate life threats:
    - Tension PTX
    - Massive hemothorax
    - Cardiac tamponade
    - Aortic Injury
  - If a chest tube is placed, assess initial output/vital signs for OR thoracotomy indications:
    - Initial output > 1-1.5 L
    - 150- 200 mL/hr output for 2-4 hours
    - Failure to evacuate hemothorax
    - Persistent hemodynamic instability
- Consider CT/CTA chest *in stable patients*, especially to evaluate for aorta/mediastinal injury.
  - Nexus Chest CT Rule- blunt thoracic trauma (if all negative, identifies very low risk population)
    - Abnormal CXR
    - Sternum, rib, scapula, or thoracic spine tenderness
    - Deceleration > 40 mph or fall from > 20 ft
- Treatments: intubate, chest tube, pericardiocentesis, ED or OR thoracotomy to relieve tamponade and treat unstable hemothorax
- Diaphragmatic injury: can be difficult to diagnose, XR chest may show visceral herniation, CT AP is only about 80% sensitive
  - If missed, can lead to herniation of viscera
  - Surgical exploration is ultimately the most accurate diagnostic (and therapeutic) modality
- Traumatic arrest?
  - Penetrating mechanism
    - *Consider thoracotomy if:*
      - Witnessed loss of vital signs or loss within last 10 minutes (in ED or en route)
      - Signs of life: pupillary response, BS reflexes, PEA

- Thoracotomy interventions: pericardiotomy (specify pericardial incision anterior to phrenic nerve), repair of ventricle, cardiac massage, intracardiac epi, internal paddle defibrillation (20-50 J), cross clamp aorta, cross clamp hilum, pressure on intercostal bleeding vessels
- *No thoracotomy if*: No signs of life and pulseless for > 10 minutes
- Blunt mechanism
  - Thoracotomy in blunt trauma has poor survival rates. Consider in patients with signs of life or who lose vitals in ED. Patients with prehospital loss of vital signs + blunt mechanism do not survive

### Abdominal Trauma

- Penetrating trauma
  - GSWs:
    - Go directly to OR if peritoneal penetration due to the high incidence of visceral injury
    - Bedside wound exploration should only be performed by a specialist and should not involve blind probing
  - Stab wounds:
    - Peritonitis, evisceration → OR
    - Stable vitals → CT A/P → +/- OR
    - Unstable vitals or positive FAST → OR
- Blunt trauma
  - Negative CXR and FAST → CT vs observation
  - Free air on CXR → OR
  - Positive FAST, *stable* vitals → CT
  - Positive FAST, *unstable* vitals → OR

### Pelvic Trauma

- Obtain AP pelvis XR to assess for fracture
- If pelvic fracture present:
  - Consider pelvic binder if pelvis is open.
    - Closing the pelvis tamponades bleeding vessels if pelvis open
  - Obtain large bore access above pelvis
  - Determine disposition
    - Hemodynamically Unstable
      - Volume resuscitation with blood, consider tranexamic acid/anticoagulation reversal
      - IR if isolated pelvic bleed
        - Must activate and plan for IR early
      - OR if other injuries (intraabdominal +FAST, peritonitis)
    - Hemodynamically Stable
      - CT AP with contrast: look for blush/extravasation → +/- IR
- Beware
  - Open book, vertical shear, posterior element disruption
    - High propensity for vascular damage

- Consider retrograde urethrogram prior to Foley placement if suspected urethral injury
- May have little sign of external trauma, always get a pelvic XR in major trauma
  - Look elsewhere for traumatic injuries
- During trauma exam do not rock on the pelvis to open it more, compress it toward the midline when assessing for instability
- The mortality of a patient who is hypotensive and bleeding from a pelvic fracture is 15-40%
- **Patients who remain unstable despite resuscitation may have active arterial bleeding**

### Vascular Extremity Trauma

- Control hemorrhage with:
  - Direct or proximal pressure
  - Careful packing
  - Tourniquets
  - Pressure dressings
  - Hemostatic dressings
    - Blind clamping can lead to nerve injury, don't do it
- Hard signs of vascular injury → OR
  - Absent pulse, pulsatile hemorrhage, expanding hematoma, limb ischemia (5P's), bruit/thrill, hypotension
  - Hard signs reflect high probability of vascular injury requiring surgical repair
  - These are time sensitive → OR angiography can be performed and saves time
  - Most surgical injuries manifest ≥ 1 hard sign
  - Motor or sensory deficits are often the first sign of arterial injury since the nerve and artery are usually adjacent
    - injury to the artery causes nerve ischemia
- Soft signs of vascular injury → CTA → +/- OR
  - Unequal/diminished pulse, nonexpanding hematoma, history of large blood loss at scene, isolated nerve injury, proximity to vessel, diminished capillary refill
  - Soft signs are equivocal findings that used to be considered significant but have been demonstrated to be less significant and are more likely due to injury of adjacent muscle, bone, nerve, soft tissue
  - Arterial Pressure Indices (APIs) are complementary to physical exam and must be checked.  $API < 0.9$  indicates vascular injury
    - Doppler-measured arterial systolic BP in injured limb divided by pressure in uninjured limb

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