

# Trauma

The trauma patient has a high risk of life threatening injuries requiring prioritized diagnosis and immediate treatment according to the ATLS algorithm.

## ANESTHETIC CONSIDERATIONS:

1. **Potential difficult airway**
  - a. Airway Obstruction/disruption
  - b. Inability to protect airway
  - c. C-spine precautions
  - d. Aspiration Risk:
    - i. Full stomach/uncooperative/combative/intoxicated patient
2. **Inadequate Oxygenation and Ventilation**
  - a. Pneumothorax
  - b. Hemothorax
  - c. Flail chest
  - d. Other injuries: pulmonary contusion/hemorrhage, diaphragmatic injury
3. **Hemodynamic Instability and Shock**
  - a. Hypovolemia and possible massive transfusion (1:1:1 ratio)
  - b. Obstructive causes (tension PTX, tamponade)
  - c. Consider Cardiogenic (cardiac contusion)
  - d. Consider Neurogenic (acute traumatic spinal cord injury)
4. **Associated injuries of trauma patient**
  - a. Traumatic brain injury
  - b. C/T/L -spine instability
5. **Other considerations**
  - a. Hypothermia
  - b. Hematologic complications – DIC
  - c. Embolic complications – fat embolus (long bone #), DVT/PE

## ANESTHETIC GOALS:

1. Appropriate resuscitation according to ATLS algorithm with simultaneous diagnosis and treatment of life threatening conditions.
2. Recognize potential for intraoperative complications related to trauma and associated injuries
3. Maintain intraoperative normothermia.
4. Prevention of secondary CNS injury from hypoxemia or hypotension (TBI and SCI)
5. Arrange for appropriate postoperative observation and disposition
6. Postoperative analgesia

## HISTORY

1. AMPLE history from patient or EMS personnel
2. Details of Trauma and Injury
  - a. Blunt vs. penetrating
    - i. MVC
      1. Speed, ejection, status of other passengers/drivers
      2. Elapsed time since incident
      3. Extrication
    - ii. GSW
      1. Location, number of entry sites
      2. Exit wounds
    - iii. Stabbing
      1. Location of entry sites
      2. Instrument used
    - iv. Inhalational Injury and Burns
      1. Concomitant exposures
      2. CO, cyanide toxicity
      3. Airway burns and inhalational injury
  - b. Airway
    - i. Definitive (ETT – placement confirmed?)
    - ii. Non-definitive (combitube, LMA, etc.)
    - iii. Not necessary (supplemental O<sub>2</sub>)
  - c. IV access
    - i. 2 large-bore peripheral IVs (16g or larger)
  - d. Resuscitation thus far
    - i. Airway
    - ii. Ventilation/breathing
    - iii. Fluid
    - iv. Drugs
  - e. Summary of Known Injuries

## PHYSICAL

- ATLS algorithm
- Simultaneous diagnosis and treatment
- Primary Survey
  - Oxygen, Vitals, C-spine precautions, IV access
  - Airway
    - Patency, facial injuries

- Tracheal deviation
    - Hoarseness, stridor, hypersalivation, subcutaneous emphysema
  - Breathing
    - Obvious life threatening chest injuries
      - Airway obstruction
      - Tension pneumothorax
      - Open pneumothorax
      - Massive hemothorax
      - Flail chest
      - Cardiac tamponade
      - Diaphragmatic Rupture
  - Circulation
    - Establish 2 large bore IV's
    - 2L crystalloid bolus for initial fluid resuscitation and reassess
    - Vitals and adequacy of peripheral perfusion
    - Look for sources of blood loss:
      - Chest , Abdomen, Pelvis, Long bones, Extremities
  - Disability
    - GCS
  - Exposure and Cover
- Investigations
- Secondary survey

#### Immediately Life Threatening Injuries or Conditions (Require immediate attention and treatment) :

- Inadequate airway protection
- airway obstruction
- tension pneumothorax/ open pneumothorax
- flail chest with hypoxemia
- massive hemothorax
- cardiac tamponade
- severe hypothermia
- severe shock from hemorrhage unresponsive to initial fluid resuscitation

#### Simplified diagnosis / treatment of potential life threatening injuries

- **Pneumothorax:** (Simple) Hyper-resonant chest, reduced / absent breath sounds, but neck veins down and trachea central, hypoxemia → Treatment: Chest tube
- **Tension Pneumothorax:** Neck veins dilated, trachea deviated, absent / reduced breath sounds, hyper-resonant chest, hypoxemia, hypotension → Treatment: immediate needle decompression followed with Chest tube
- **Tamponade:** Evidence of chest trauma, dilated neck veins, muffled heart sounds, and decreased arterial blood pressure (possibly even pulseless electrical activity) (Beck's triad) → Treatment: Needle pericardiocentesis , cardiology / CVT consult for drain / window etc
- **Massive Hemothorax:** hypoxic, shocky, stony dull chest, absent breath sounds and deviated trachea → Treatment: ensure iv access, chest tube
- **Flail Chest:** paradoxical chest wall segment motion during spontaneously ventilation → Treatment: if associated with hypoxemia, intubate
  - **Open Chest:** wound finding of simple pneumothorax but open wound + sucking with spontaneous
  - Ventilation → Treatment: occlusive dressing + chest tube

#### INVESTIGATIONS

- Trauma labs:
  - CBC c/diff, Lytes, BUN, Cr, Glucose, **ABG, X-match**, tox screen
  - Liver enzymes, troponin, CK
- Imaging:
  - C-spine + CXR (specifically for thoracic trauma) + abdo/pelvis/long bones as injuries dictate
  - CT Cspine/Chest/Abdo/Pelvis (if patient stable, consider CT to evaluate extent of thoracic injuries eg pulm contusions, rib #, TBT, esophagus, arch etc)
- Special Tests
  - Echo (if hemodynamic or conduction concerns to r/o pericardial effusion/tamponade)
  - FAST ultrasound

#### OPTIMIZATION

- **Emergent vs. Urgent vs. Elective**
  - Consider postponing elective/urgent cases until Airway/Breathing/Circulation have been appropriately investigated and optimized
  - Emergent cases must proceed to the OR
- **Airway**
  - secure airway in safe manner if indicated
    - airway obstruction (present or imminent)
    - respiratory failure (present or imminent secondary to injuries)
    - decreased level of consciousness
    - combativeness posing danger to self/others
    - presenting to OR for urgent/emergent operative management of injuries
  - consider:
    - difficult airway
    - full stomach
    - Cspine precautions
- **Breathing**
  - Ensure adequacy of oxygenation and ventilation
  - Consider inhalational injury in the correct context

- **Circulation**
  - Ongoing reassessment of hemodynamic stability
    - Frequent vital checks – HR, BP, RR, O2 sat
  - IV access:
    - 2 large bore peripheral IVs at minimum
    - consider large bore central venous access for hemodynamic monitoring and vasopressor/inotrope administration
    - consider invasive BP monitoring
  - Ongoing reassessment of blood loss and fluid replacement
    - Consider salvage surgery if clinically indicated
    - Ongoing hypotension despite fluid replacement and free fluid in abdomen on CT/FAST is an indication for exploratory laparotomy
  - Consider administration of (uncrossmatched) blood if persistent hypotension despite >2L crystalloid bolus
- **Disability**
  - GCS <8 → secure airway
  - C spine precautions
  - Evaluate for traumatic brain injury
    - Possible increased ICP
  - Evaluate for traumatic spinal cord injury
- **Extremities**
  - Long bone injuries and #
  - Pelvic fracture

#### ANESTHETIC OPTIONS

- None
- Local
- Regional
- Neuraxial
- **GA**

#### ANESTHETIC SETUP

##### Drugs

- 4 units O- or cross-matched blood in room
- Standard emergency and induction medications
  - Consider:
    - Epinephrine, norepinephrine, vasopressin, dobutamine
    - Labetalol, hydralazine, nitroglycerin, nitroprusside (BP and ICP management)

##### Equipment

- Expert help (anesthesia tech, another anesthesiologist)
- Monitors:
  - CAS + 5-lead
  - Art-line
  - CVP
  - large bore IV x 2
  - TEE or PA catheter
  - Foley catheter
  - temperature probe
- Infusion pumps
- Level one rapid infuser
- cell saver
- blood/fluid warmer
- forced air warming blanket

#### MANAGEMENT OF GENERAL ANESTHESIA

##### Induction

- Initial resuscitation and recognition of the above injuries is key
- Consider underlying pathology and method of induction:
  - Awake intubation for patients with difficult airway (possible tracheostomy in laryngeal injury)
  - Fiberoptic intubation or awake tracheostomy in patients with impossible airway or laryngotracheal injury/disruption
  - Spontaneous ventilation induction vs. awake: Large BPF, tamponade
  - RSI for others (All above with C-spine control)
- Etomidate or Ketamine are reasonable choices if patients are hypovolemic

##### Maintenance

- Possible need for lung separation (BPF, Aortic reconstruction, repair of mediastinal structure)
- Vigilance for intra-operative complications:
  - Hypotension
    - Bleeding, tension pneumothorax, neurogenic shock, cardiac injury
    - Citrate toxicity, hypothermia, anaphylaxis, transfusion reaction
    - Pre-existing disease (i.e. CAD and ischemia)
  - Hypothermia
    - Use blood, air warmers and increase room temperature
    - Monitor central temperature
  - Coagulopathy
    - Dilutional, DIC, platelet dysfunction

- Secondary to hypothermia, acidosis
- Electrolyte or acid / base disturbance
- Monitor blood work frequently

## Emergence & Disposition

- High acuity observation unit or ICU
  - ICU monitoring indicated with prolonged hypotension, coagulopathy, massive transfusion
  - Post-operative ventilation may be required depending on extent of injuries and surgery
- Chest trauma requiring pneumonectomy has mortality nearing 100%
  - intra-op deaths secondary to uncontrolled hemorrhage, acute RV failure, air embolism
- Analgesia:
  - Epidural often utilized to optimize respiratory function if rib fractures, flail chest, post-thoracotomy
  - Intercostal nerve blocks, intrapleural catheter
  - IV opioids, Tylenol, NSAIDs

## PATHOPHYSIOLOGY

1. **A/W emergency and indications for intubation**
  - Head trauma with decreased or LOC
  - Midface trauma
  - laryngeal trauma
  - Chest trauma affecting ventilation
  - Risk of aspiration (vomiting, bleeding)
2. **Pneumothorax/ Hemothorax**
  - Chest tube management.
  - Indications for surgery:
    - associated mediastinal injury
    - blood loss >1500mL in first hours after injury or 200ml/h \* 2-4h
    - persistent blood transfusion
  - Hemorrhage usually results from injured intercostals arteries, internal mammaries
3. **Tracheobronchial Injury**
  - Usually evidenced by pneumothorax with massive air leak, often hemodynamic instability
  - Blunt injury usually occurs within 2.5cm of carina, may initially be unrecognized
  - Subcutaneous emphysema, pneumomediastinum, pneumopericardium, pneumoperitoneum without apparent cause should direct to TBT injury
4. **Traumatic Aortic injury**
  - Most common site distal to left subclavian artery due to shear forces between the mobile heart and aortic arch, and the immobile descending thoracic aorta
  - Surgical repair required due to high risk of rupture (days – hours post injury)
  - Best outcomes associated with partial bypass LA – descending aorta
5. **Rib Fractures**
  - Ribs fracture 1-3: associated with a/w injury, great vessels injury
  - Ribs fracture 4-9: associated with pneum/hemothorax, pulmonary contusion
  - Ribs fracture 9-12: associated with liver and spleen injury
  - Therapy directed at decreasing pulmonary morbidity\_ pain, splinting, hypoxemia, atelectasis, pneumonia
  - Elderly (>55years) have twice the mortality and morbidity vs. younger patients with similar injuries
  - Epidural analgesia should be used in elderly or in any with severe pain, or if any pre-existing pulmonary disease (decrease M&M by 6% in >55yo population)
  - Flail chest –not all require PPV for internal chest stabilization, use usual ETT / PPV criteria
6. **Pulmonary Contusions**
  - Can resolve without sequelae, or can evolve into pneumonia or ARDS
  - PEEP as tolerated to manage hypoxemia due to increased shunt
  - Associated pulmonary injury – contusions, laceration, hemopneumothorax and use lung protective ventilatory strategies (high volume, low pressure, permissive hyperCO2)
7. **Cardiac Injuries**
  - Can EXCLUDE blunt cardiac injury if hemodynamics are stable, no indication of conduction disturbance or arrhythmias on ECG
  - Once diagnosed, manage as acute ischemic injury – continue resuscitation, careful use of fluids, coronary vasodilators, symptomatic treatment of rhythm disturbances
  - Consider cardiology consult for angiography / -plasty / stent
  - Rupture of chambers – usually atria (assoc with blunt and penetrating cardiac trauma) have high pre-hospital mortality, exsanguinate into thoracic cavity
  - Surviving patients often present with pericardial tamponade, these are highly unstable, often diagnosed with FAST or during ER thoracotomy
  - Relief of tamponade, suture or x-clamp of laceration / injury to restore vital signs enough to get to OR for hemostasis / chest closure
8. **Subdural hematoma**
  - Tear of veins from surface of brain traveling to venous sinus (bridging veins)
  - Does not cross the midline
  - Can cause severe damage to the brain
9. **Epidural hematoma**
  - Tear of arteries (most common middle meningeal artery), mostly located in temporal or temporoparietal region
  - Biconvex
  - Patients with severe brain injury (GCS 3-8) are emergent (diagnosis and treatment simultaneously)

## REFERENCES

- Miller
- ATLS book
- Fouche, Tarantino. Anesthetic Considerations in Chest Trauma Chest Surgery Clinics of North America; May 1997, 7 (2) pp. 227 – 238
- Devitt, J. Blunt Thoracic Trauma: Anaesthesia, assessment and management Canadian Journal of Anaesthesia; 1993, 40 (5 part 2) pp. R29 – R35