Advanced Trauma Resuscitation

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There will be some patients that you cannot resuscitate....
Other patients you will be able to resuscitate

...though it may be difficult
Review...

- Primary survey: A * B * C * D * E
  - should take 2-3 minutes
- Airway
- Breathing
- Circulation
- Disability
- Exposure/Environmental
If there is no airway...there is no life.

While you are delivering high-flow 100% oxygen to patient (10-15 liter flow through face mask),...

- **Assess airway**
- Open airway with chin lift or jaw thrust – do NOT extend head.
Airway

- Is airway patent?
- Is airway obstructed?

  - **Intubation**
  - **Cricothyroidotomy**

  “If they ain’t breathin’, nothing else much matters.”
Airway -
Causes of obstruction

1. Tongue
2. Bilateral mandibular fracture
3. Debris
4. Neck hematoma
5. Laryngeal trauma
6. Tracheal tear
Airway -

Signs and symptoms of obstruction

- stridor
- accessory muscle use
- cyanosis
- subcutaneous emphysema
- agitation; confusion
- gasping
- panic
- unconsciousness
- apnea
Airway

- Maybe this patient has only SOME obstruction…
  If there is ANY doubt, **INTUBATE**.

- Other reasons to intubate
  - Glasgow coma scale < 9
  - combative
  - uncooperative patients requiring CT, aortography, etc.
B Breathing

Assess effort and effectiveness of breathing

- Inspection
  - check for midline trachea
  - oxygen saturation adequate?
  - paradoxical respirations
  - accessory muscle use

- Palpation
  - subcutaneous emphysema

- Percussion
  - Tympany

- Auscultation
  - equal, bilateral breath sounds?
Breathing difficulties: is it…
- Tension pneumothorax?
- Open pneumothorax?
- Hemothorax?

or

- Flail chest

Can’t always wait for CXR…treat the patient!
Breathing:
Tension pneumothorax

Suspect with:

- penetrating or blunt chest trauma.
- after intubation, high ventilation pressures.

S/S:

- decreased BrS on one side
- tracheal deviation away from decreased BrS
- respiratory distress
- shock
Breathing: Tension pneumothorax

What causes it?

- A build-up of air within one side of the pleural cavity due to accumulation of air or gas in the pleural cavity.

Causes an increase in intrathoracic pressure - results in massive shifts of the mediastinum away from the affected lung compressing intrathoracic vessels.

- Artery compression causes hypotension.

- Can lead to death.
Left tension pneumothorax

Shows up **black** on CXR.

Note -
- mediastinal shift
- air in thorax shows as black
- hemidiaphragm depressed from intrathoracic pressure
Breathing:

Tension pneumothorax

Treatment

- Needle decompression STAT
- Insert needle 2\textsuperscript{nd} or 3\textsuperscript{rd} ICS at MCL over TOP of rib; \textit{nerve}s and \textit{arteries run under the rib.}
- after air escapes and patient is stable, a chest tube will need to be inserted.
Breathing:

Open Pneumothorax

- Air moves in and out of an open chest wall.
- Place Vaseline gauze over wound, tape 3 of 4 sides of gauze to help air come out and prevent air from going in.

- Will eventually need surgery to repair defect in chest wall and a chest tube.
Breathing:

Hemothorax

- Shows up **white** on CXR.
- If hemothorax is small, watch.
- If large, insert chest tube.
- Thoracotomy may be necessary.
Breathing: 
**Flail Chest**

- Fracture of 2 or more ribs in 2 or more places.
- Look for *paradoxical respirations*
  
  : *deflation of the lung during inspiration and inflation during expiration.*

- Treated by supporting the chest with a tight chest wrap or temporarily laying the patient with the flail segment down against the exam table.
C Circulation

- Stop obvious bleeding
- Assess blood pressure; heart rate and rhythm
- Observe skin color, temperature and capillary refill
- Place 2 large bore peripheral IV’s
Circulation

- Assess for **cardiac tamponade**.
  - Acute distention of pericardial sac with blood; the pericardial sac does not stretch.

- **Cause of acute tamponade**: penetrating trauma involving the pericardium or blunt chest trauma), and myocardial rupture.
Circulation

- **Cardiac tamponade**
  - S/S: classical cardiac tamponade - three signs known as **Beck’s triad**:
    - Hypotension *decreased stroke volume*
    - JVD (jugular venous distension) *impaired venous return to the heart*
    - Muffled heart sounds *fluid inside the pericardium*
  - Also can have
    - Pulsus paradoxus: decrease of SBP of > 10 mmHg during inspiration.
Circulation

- **Cardiac tamponade**
  - If pulmonary artery catheter is present will see...
    - Equal right and left heart pressures
    - CVP and wedge are elevated and match

- Assess with FAST (Focused Abdominal Sonography for Trauma): sensitive and specific in the determination of traumatic pericardial effusion, thus effectively guiding emergent surgical decision making.
Circulation

- Cardiac tamponade
  - Treat: intubate, oxygenate, give volume.
  - If patient stable, non-emergency surgery for pericardial window.
  - If patient in extremis, attempt pericardiocentesis.

The overall risk of death depends on the speed of diagnosis, the treatment provided, and the severity of the tamponade.
D  Disability

Glasgow Coma Scale

Range 3-15

3 has no response to
15 is awake/oriented.
Trauma Score

Calculated from:

- **Respiratory rate**
  10-29 = 4, >29 = 3, 6-9 = 2, 1-5 = 1, 0 = 0

- **Systolic BP** (mmHg)
  >89 = 4, 76-89 = 3, 50-75 = 2, 1-49 = 1, 0 = 0

- **Glasgow coma scale**
  13-15 = 4, 9-12 = 3, 6-8 = 2, 4-5 = 1, 3 = 0

Maximum “good” score is 12
Trauma Score

- Indication of survival
  - 7.84 = 98.8% probability of survival
  - 7 = 96.9% probability of survival
  - 6 = 91.9% probability of survival
  - 5 = 80.7% probability of survival
  - 4 = 60.5% probability of survival
  - 3 = 36.1% probability of survival
  - 2 = 17.2% probability of survival
  - 1 = 7.1% probability of survival
  - 0 = 2.7% probability of survival
The difference between Trauma Score on arrival and best Trauma Score after resuscitation will give a reasonably clear picture of prognosis.
E Exposure/Environmental

- **Expose** the patient so that an adequate complete examination can be performed.

- **Temperature**: prevent the patient from becoming hypothermic; give warmed fluids, warming blanket; increase room temperature.
Review, cont...

- **Secondary survey**
  - lasts as long as needed.
  - full and complete physical assessment from head to toe
    - turn the patient to examine
    - log roll with 5 people: 3 at body, one at head, one examining
    - Full neurological examination

- Look for any localizing/ lateralizing signs
- Look for signs of cord injury
Look for...

Hidden Six

- Diaphragmatic injury
- Esophageal injury
- Blunt cardiac injury
- Traumatic aortic rupture
- Pulmonary contusion
- Major tracheobronchial disruption
ANESTHETICS IN TRAUMA PATIENTS
In the operating room

- In conjunction with the surgeon, and anesthesia members...
- The team approach is usually employed and multiple acts by multiple team players are carried out simultaneously.
- The anesthetist should direct the team players as to what is needed.
Throughout the entire assessment and operative process -

- Recognize the potential for cervical spine injury and maintain the spine in a safe neutral position until clinical examination and radiological findings exclude injury.
Some patients are harder to intubate than others...
Sometimes you have to get really creative!

Obviously, a surgical airway is needed when part of the face is missing.
Trauma patient is always considered a full stomach; only insert an endotracheal tube and *never use an LMA*. A rapid sequence induction is always needed (unless cricoid pressure is contraindicated).
Intubation, cont.

- Intubate patient for surgery if not already done

- Oral intubation requires 3 people
  - One to intubate
  - One to provide cervical immobilization
  - One to apply cricoid pressure
Resuscitation recommendations

► Start multiple, large-bore peripheral IV’s or central lines
  ► If there is penetrating torso trauma, start an IV above AND below diaphragm.
  ► Avoid IV placement so that the trauma is between the IV site and the heart.
► Start warmed IV fluids
Resuscitation recommendations

- Start an arterial line if not already done.
- Get labs, ABG’s
- Get a baseline and go from there
TEMPERATURE CONTROL IN TRAUMA PATIENTS

- Keep patient warm: warming blankets, fluid warmers, increase room temperature, wrap the head or exposed limbs, use a heated humidifier.

- Hypothermia worsens acid-base disorders, coagulopathies (platelet sequestration and red blood cell deformities) and myocardial dysfunction.
Resuscitation recommendations

- Evaluate clinical response to IV fluids
- Initiate invasive monitoring if there is an inappropriate response to volume replacement.
Patient history??

- Try to get at least an A.M.P.L.E. history:
  - Allergies
  - Meds
  - Past Illnesses
  - Last meal
  - Events

..... this may not be possible
Anesthesia in trauma

- If the patient is hemodynamically stable, general anesthetics are often started in small doses.

- If general anesthetics **cannot** be used, adjuncts to prevent recall may be used:
  - Midazolam 1 mg IV PRN
  - Scopolamine 0.3-0.4 mg IV
general anesthesia agents are titrated to maintain a MAP > 50-60 mmHg.

Fentanyl 2-4 mcg/kg IV throughout case PRN
Ketamine

- Inhibits excitatory neurotransmitter effects
- Dissociates the thalamus (relays sensory impulses from the RAS to the cerebral cortex) leaving the patient unable to process or respond to sensory input.
- Ketamine actually increases the blood pressure, heart rate, and cardiac output (by stimulating the SNS and inhibiting reuptake of norepinephrine).

BUT...

- Can increase myocardial work.
- Increases cerebral blood flow, oxygen consumption and ICP.
Etomidate

- depresses the reticular activating system (RAS)
- Mimics the inhibitory effects of GABA.
- Minimal effects on the cardiovascular system (slight decrease in BP)
- Decreases the cerebral metabolic rate, cerebral blood flow, and ICP. Cerebral perfusion pressure is well maintained.
**Muscle Paralytic**

- If there is any question, check with the surgeon regarding the possibility of extubating patient at the end of the case; dose your paralytic based on this information.

- Succinylcholine 1-2 mg/kg IV is standard depolarizing agent.

- However, if the patient is known to be acidotic, the serum K+ level may already be elevated and giving Succinylcholine may increase the serum potassium level.
Volatile gases

- Do not use nitrous oxide in trauma due to the possibility of a pneumothorax.

- Use 100% FiO2.

Cerebral blood flow (CBF)

- Increased CBF: Halothane > Enflurane > Isoflurane = Sevoflurane > Nitrous oxide > Desflurane
Regional Anesthetics

- Regional anesthetics are not usually used in trauma because of the sympathetic blockade and hypotension.
Adequate volume therapy appears to be a cornerstone of managing the trauma patient.

The use of crystalloids is currently recommended in trauma resuscitation.
Crystalloids, Colloids, and Blood Products

- **Crystalloid**: LR, NS
- **Colloids**: non-oxygen carrying
  - Albumen, Hespan, Dextran
- **Blood Products**
  - fresh autologous blood: ideal resuscitative fluid
  - stored allogenic blood (donated blood)
  - blood substitutes
Crystalloids

- $\frac{1}{2}$ life of crystalloid solution is 20-30 minutes.

- hypo-, iso-, and hyper-tonic solutions are available to treat trauma-related volume deficits.
Crystalloids

- **0.9% Sodium Chloride** contains 9 g/L Sodium Chloride (NaCl)
  - pH 5.0,
  - 154 mEq/L sodium
  - 154 mEq/L chloride.
  - osmolarity 308 mOsmol/L

“too much” NS can cause metabolic hyperchloremic acidosis.
Crystalloids

- **Lactated Ringers** has potassium, calcium and lactate in addition to sodium chloride which causes volume expansion.

- Metabolized to bicarbonate - avoid in alkalotic patients
  - pH 6.5
  - osmolarity 273 mOsmol/L
Colloids

Two types of colloids:

- **blood derived** include albumin and plasma protein fraction
- **synthetic colloids** include dextrose starches

- The half-life of a colloid is 16 hours.
Colloids

Blood Derived Colloids

- albumin - derived from pooled human plasma.
  - albumin 5%
  - albumin 25%
    - much higher cost than crystalloid solutions
    - small but significance incidence of adverse reactions (especially anaphylactoid reactions)

http://bja.oxfordjournals.org/cgi/reprint/85/6/887
Colloids

Blood Derived Colloids

- plasma protein fraction 5% (PPF)

- There is no risk of transmission of hepatitis or HIV with albumin or plasma protein fractions due to heat treatment to 60 degrees Centigrade for 10 hours.
Colloids
Synthetic Colloids

- **Dextran**: improve microcirculation by decrease blood viscosity and antiplatelet effects.
- **Antigenic**: associated with both anaphylactic and anaphylactoid reactions.

- Max. dose: 20 ml/kg/day
Colloids
Synthetic Colloids

- **Hetastarch**: less expensive than albumin.
  - Associated w/ urticarial & anaphylactoid reactions.
  - Contraindicated in patients with severe bleeding disorders (can interfere with platelet function and increase bleeding times), severe CHF (danger of fluid overload with fluid expander), or renal failure with oliguria or anuria.
    - **Hespan** (Hetastarch in sodium chloride)
    - **Hextend** (Hetastarch in sodium chloride)

- Max. dose: 20 ml/kg/day
Excessive fluid resuscitation, which can cause acute respiratory distress syndrome, abdominal compartment syndrome and brain edema, **should be avoided**.

This is where a CVP line is especially useful!
HEMODYNAMIC SUPPORT IN TRAUMA PATIENTS

- Hemodynamic support is an early goal in the treatment of the trauma patient.

- Hypotension in patients with hypovolemic shock should be treated aggressively with intravenous fluids, not vasopressors (unless hypotension is unresponsive to fluid therapy).
HEMODYNAMIC SUPPORT IN TRAUMA PATIENTS

- Depending on the heart rate, Ephedrine or Neosynephrine may be given.

- For refractory hypotension to ephedrine or neo, epinephrine, norepinephrine, dobutamine can be infused or bolused.

- Low-dose Dopamine can be used to increase renal blood flow. Higher doses of Dopamine can be given as an inotropic, vasoconstrictor.
Hemorrhage

More often than not, continued hemorrhage is the problem if the patient remains unstable.

Hemorrhage is a major cause of trauma deaths.

All hemorrhage stops.....eventually
Hemorrhage

- **Coagulopathy** exacerbates hemorrhage and is commonly seen during major trauma resuscitation, suggesting that current practice of coagulation factor transfusion is inadequate.

- **Reversal of coagulopathy** involves normalization of body temperature, elimination of the causes of disseminated intravascular coagulation (DIC), and transfusion with fresh-frozen plasma (FFP), platelets, and cryoprecipitate.
Blood Products

- **Universal donor**: O negative
- **Universal recipient**: AB positive

Mass transfusion: citrate toxicity = acidity and hyperkalemia; hypocalcemia.

decreased 2,3 DPG due to storage.

- **Trauma pack/uncrossmatched blood**: O negative
  After 2 u uncrossmatched, patient should NOT be given patient type-specific blood until blood bank determines levels of transfused anti-A and anti-B antibodies have decreased low enough to allow.
Hemorrhage

Factor 7

- Notes: 90 mcg/kg
- Dose: bolus over 5 minutes
- Mix: mix in sterile water
Hemorrhage

- **Desmopressin (DDAVP)**
  - Supplied: 4 mcg/ml
  - Mix: 0.3 mcg/kg in 50-100 ml NS
  - Amount per ml: depends on how it is mixed.
  - Dose: 0.3 mcg/kg give over 30 minutes.
  - Action: control of bleeding; increases factors 8 and 12, and von willebrand’s factor.
  - Notes: causes hypotension. Use regular tubing.
Lethal triad of trauma

Metabolic acidosis
accompanied by
coagulopathy and
hypothermia
Lethal triad of trauma

- Hypothermia (below 34°C) inhibits platelet function and slows coagulation factor activation.

- This self-perpetuating cycle is responsible for 80% of deaths in patients with major vascular injury and must be rapidly corrected to prevent a dismal outcome.
The base deficit, derived from blood gas analysis, gives an approximation of tissue acidosis, an indirect evaluation tissue perfusion.

However, BE has been shown to be an insensitive and slowly responsive indicator of changes in intravascular volume.
Lactate

- There is a relationship between increased blood lactate levels and the presence of oxygen debt (tissue hypoxia).

- The normal serum lactate level is approximately 1 mmol/L with a range up to 2 mmol/L.

- Values above 4-5 mmol/L are indicative of lactic acidosis.
Metabolic acidosis

- Inadequate organ perfusion (decreased oxygen delivery due to shock, hypothermia, ischemia) interferes with aerobic metabolism, producing lactic acid and metabolic acidosis.

- Acidosis adds to the overall lethality of preexisting injury primarily by depression of myocardial contractility and by impairment of coagulation.

- Acid-base imbalances will eventually resolve with hydration and improved organ perfusion.
**Metabolic acidosis**

- Acidosis pH < 7.20 is a direct myocardial depression
  - Reduces myocardial contractility
  - Dilates peripheral vascular resistance → hypotension
  - Leads to tissue hypoxia despite a shift to the right (acid)

**Metabolic acidosis is evidenced by a decrease in HCO3.**
Treatment of metabolic acidosis

- Any respiratory component of the acidosis should be corrected.
- Maximize tidal volume (and minute ventilation) to blow off acid.
- Increase respiratory rate to blow off acid. A PaCO2 of 30-21 range may be desirable.
- When you draw a ABG, check the PaCO2 and ETCO2 to see what the patient’s gradient is.
Two schools of thought on NaHCO3

- Treat a BD > -4 with bicarb while you are giving fluids.

- Or...

- Reserve administration of sodium bicarbonate for those patients with severe metabolic acidosis or evidence of cardiovascular instability.
a hint:

- Have a folded bath blanket on the floor and stack all your product bags when you are finished with them. Do the same with your colloid and crystalloid. It helps keep track of how much fluid and products have been given.
Thank you
The End