Traumatic Cardiac Arrest

Does CPR Play a Role?

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Nathan Powell, DO FACOS

Disclosures

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Traumatic Cardiac Arrest (TCA)

- A paradigm shift has occurred with regards to resuscitation in TCA
  - Futile attempts < More promising interventions
- Goal:
  - Rapidly and aggressively treat the common potentially reversible causes of TCA
  - Although overall mortality of TCA is still very high, outcomes in selected subgroups are improving
- Response to TCA resuscitation is time-critical and success depends on a well-established chain of survival
  - Includes advanced pre-hospital and specialized trauma center care

Traumatic Cardiac Arrest (TCA)

- TCA patients are on average:
  - Relatively young (~40 years)
  - Mostly males (~80%)
  - Relatively healthy (~60%)

- Younger age and better health status:
  - Salvageable cases = better recovery potential
  - Unsalvageable cases = underlines the economically and societal burden of productive life years lost
    - Successful transfer of these pts to organ donor programs

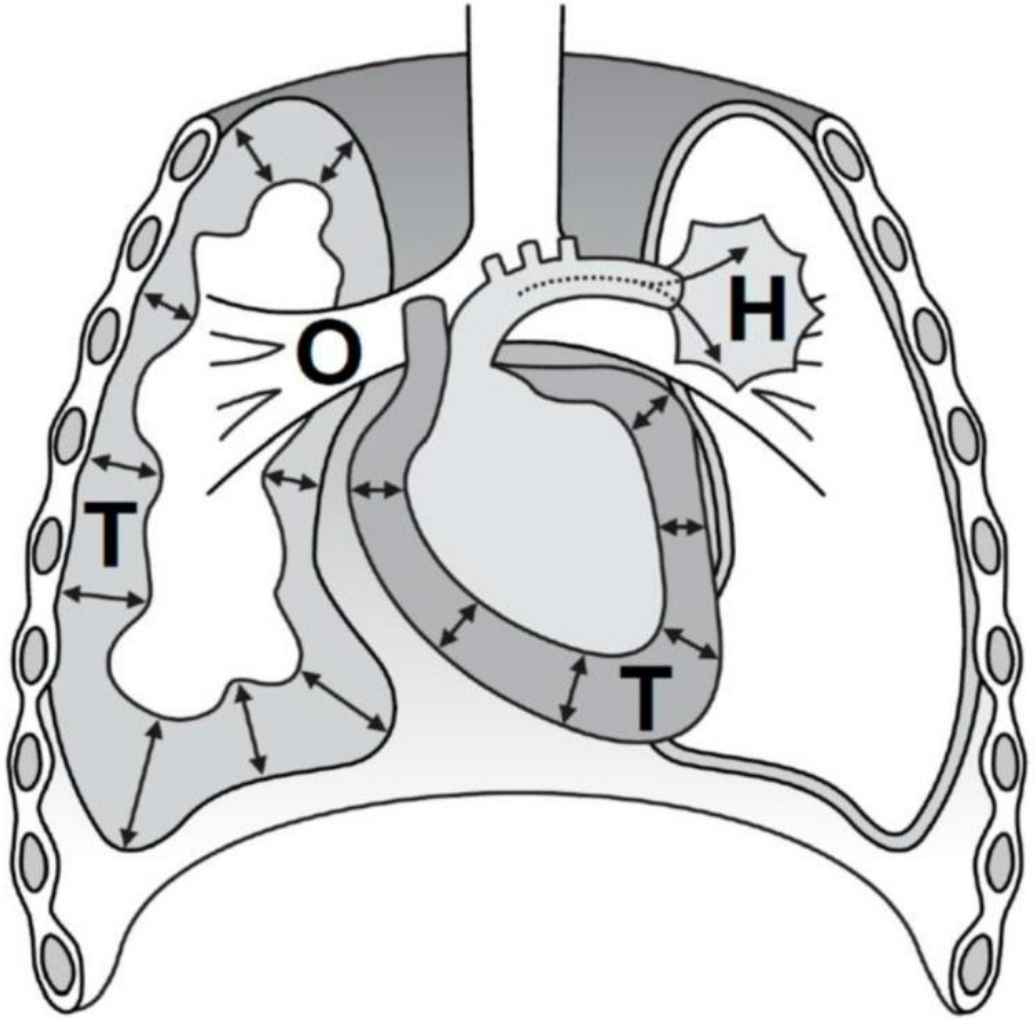
- Epidemiological differences exist between continents and countries
  - I.e. Epidemiological impact of TCA with firearms in the US vs European countries

Causes of TCA

- Divided into ***potentially reversible*** vs ***non-reversible*** causes
  - Often challenging to make this diagnostic decision upon arrival of the patient in the trauma center
- Prognosis of Outcome after TCA difficult to predict
- Termination of TCA therapy in those cases must not be considered as failure of the trauma team
  - Is rather as an ethical appropriate decision withholding valuable resources in a futile situation of medically senseless activism

Potentially Reversible Causes of TCA (H.O.T.T.)

- **H**ypovolemia (48%)
  - **H**emorrhage, until proven otherwise
  - Most common, potentially reversible cause of TCA
- **O**xygenation impairment (13%)
  - Requires the creation of a patent airway and optimizing oxygen supply
- **T**ension pneumothorax (13%)
  - May present in spontaneously breathing patients, but also rapidly develop after endotracheal intubation and mechanical ventilation
- **T**amponade of the pericardium, i.e., 'cardiac tamponade' (10%)
  - May both be caused by blunt or penetrating chest trauma



Factors Associated with Improved Outcomes

- Younger age
- Female sex
- Extremity injuries
- Lower ISS
- Reactive pupils
- Witnessed TCA
- Bystander CPR
- Short transport times
- Certain interventions, such as airway management
- Presence of a shockable cardiac rhythm (e.g., ventricular tachycardia)
- Cardiac motion on ultrasound

Factors Associated with Poor Prognosis

- Asystole (non-shockable rhythm with no cardiac motion) has the worst prognosis

- PEA without cardiac motion on POCUS has an extremely poor prognosis

Pseudo PEA

- Cannot always distinguish between TCA (complete cessation of blood flow) vs traumatic peri-arrest

- '**Pseudo PEA**' = state of severe hypotension with BP below the subjective/notoriously unreliable threshold of manual palpatory pulse detection
  - i.e. PEA with blood flow (when cross checked by POCUS)

- Pseudo PEA = comparably good prognosis vs asystole/true PEA
  - Particularly if *profound hypovolemia* is the cause and is rapidly treated
  - Conversely, maltreated pseudo PEA is likely to deteriorate into full cardiac arrest
  - Treating a pseudo PEA as true PEA with chest compressions and epinephrine may be detrimental (esp if hypovolemia is cause)

ABCD – One Size Fits All?

- ABC approach has been supported primarily by *consensus* rather than *scientific evidence*
- In busy urban trauma centers, ABCs are usually simultaneously with a large multispecialty team
- In rural and resource-limited environments, these often performed sequentially by a single physician
- In medical cardiac arrest, there has been a shift protocols (ie AHA) to prioritize perfusion through early compressions instead of securing the airway first
  - CAB approach has been shown to shorten time to restoring perfusion = better outcomes

AIRWAY

BREATHING

CIRCULATION

DISABILITY

- Response: AVPU or Glasgow Coma Scale
- PEARL
- Review ABCs
- Reversible drugs
- Blood Glucose
- Recovery position

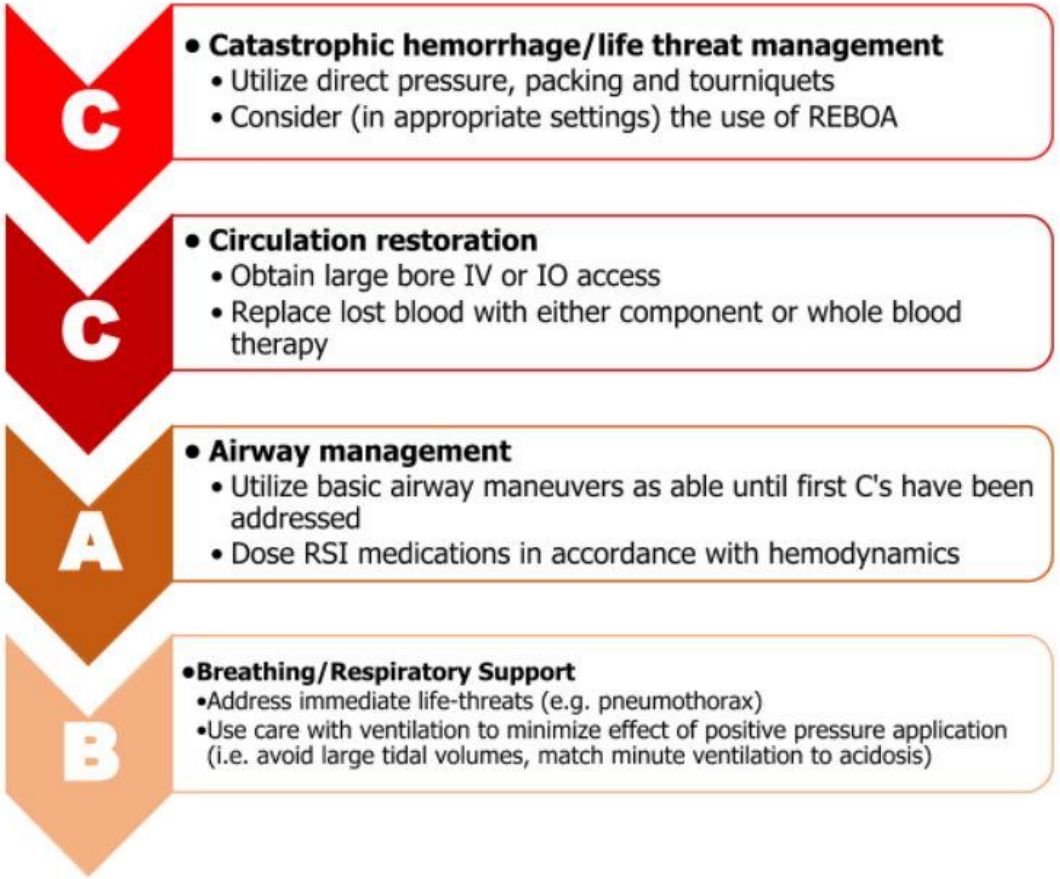
EXPOSE

ABCD – One Size Fits All?

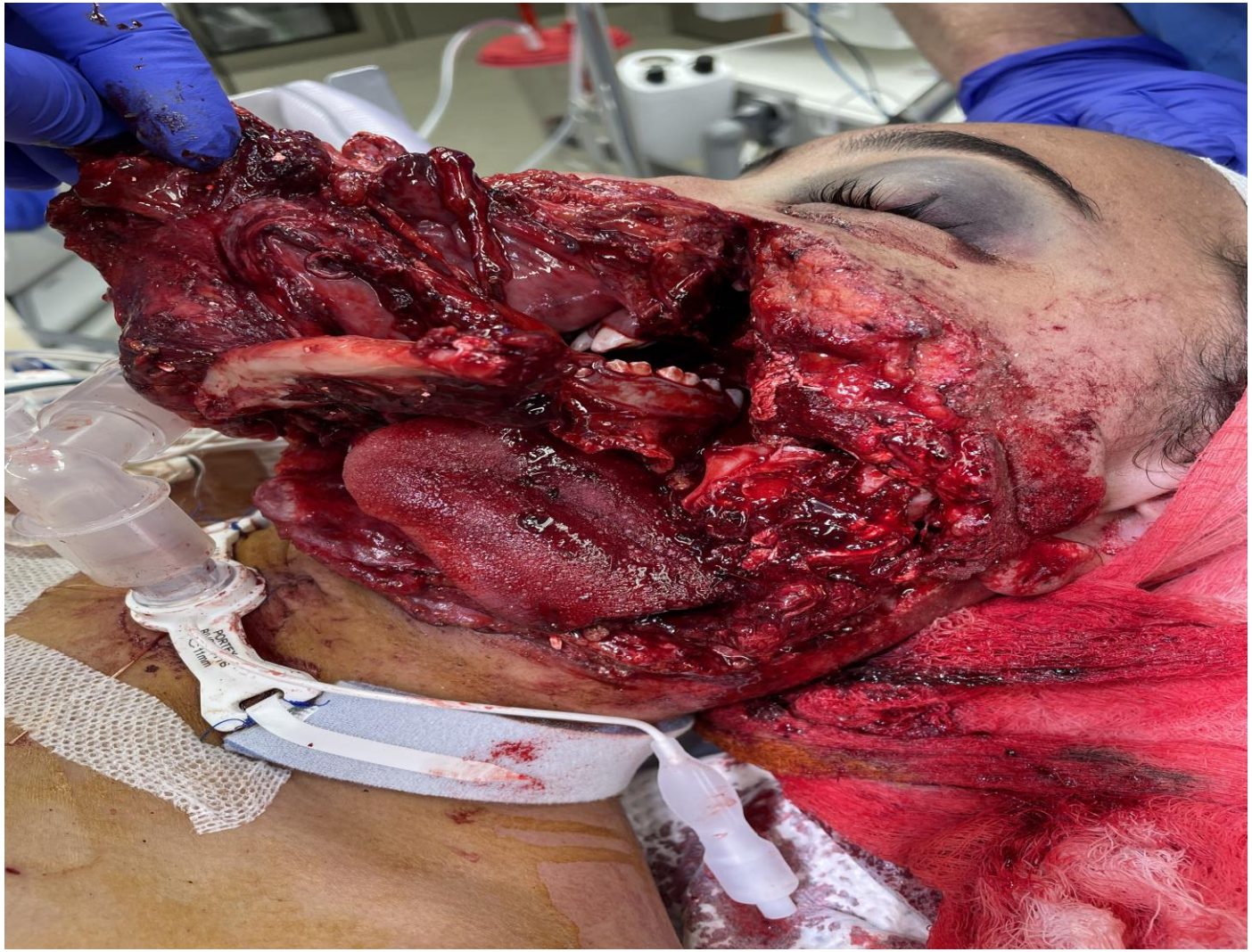
- What about with TCA?
- It gets muddy!

- Looking at H.O.T.T. -
  - Hypovolemia resembles a **C-problem**
  - Oxygenation impairment an **A/B-problem**
  - Tension pneumothorax a **B/C-problem**
  - Cardiac tamponade a **C-problem**

CAB NOT ABC


C
• Catastrophic hemorrhage/life threat management
• Utilize direct pressure, packing and tourniquets
• Consider (in appropriate settings) the use of REBOA
C
• Circulation restoration
• Obtain large bore IV or IO access
• Replace lost blood with either component or whole blood therapy
A
• Airway management
• Utilize basic airway maneuvers as able until first C's have been addressed
• Dose RSI medications in accordance with hemodynamics
B
•Breathing/Respiratory Support
•Address immediate life-threats (e.g. pneumothorax)
•Use care with ventilation to minimize effect of positive pressure application (i.e. avoid large tidal volumes, match minute ventilation to acidosis)

‘Airway’ Challenges in TCA



‘Airway’ Challenges in TCA

- Frequently ***functional***
  - Obstruction from sagging tongue, soft palate or epiglottis in unconscious or arrested victims
  - Gastric regurgitation, blood, or other materials
  - Generally, functional airway problems are relatively easy to manage
    - Standard airway maneuvers (e.g., jaw trust) and simple tools (e.g., oropharyngeal airway, suction devices)

- Less frequently, can be ***anatomical***
  - e.g., extensive maxillofacial injuries/direct trauma to the airway
  - Can be challenging to handle and may require expert support (e.g., an anesthesiologist) and specialized equipment (e.g., surgical airway sets)

‘Airway’ Challenges in TCA

- Studies indicate the detrimental effects of a traditional ABC approach with early endotracheal intubation, on hemodynamics and outcomes in critical trauma patients

- Intubation attempts in trauma patients may contribute to TCA!

- In the initial phase of TCA treatment it is pivotal to create an open (patent) airway for oxygenation, but not necessarily to create a secured airway (ETT)

‘Airway’ Challenges in TCA

- Intubation leads to:
  - Vasoconstriction loss
  - Vasodilation triggered by RSI
  - Reduced cardiac filling and output in pts already experiencing reduced blood volume
  - Loss of gasp for air
    - Physiologically, patients experiencing severe bleeding instinctively gasp for air, increasing venous return and cardiac output
  - PPV leads to worsening perfusion of end organs, higher lactate and worse base deficits

- Studies show intubation in the field led to
  - Longer vent requirements (CAB 10.4 days vs ABC 14.7 days)
  - Hospital LOS (CAB 16.7 days vs ABC 20.2 days)
  - ICU duration (CAB 11.7 days vs ABC 15.2 days)
  - Mortality rate (CAB 12.4% vs ABC 23%)

‘Airway’ Challenges in TCA

- We need to deliberately de-emphasize or postpone time- and resource-intense airway-securing maneuvers in the very initial phase of resuscitation, when an open, patent airway is present or can quickly be established non-invasively

- In a peri-arrest setting, delaying intubation:
  - Saves critical resources (personnel, time)
  - Limits the detrimental cardiovascular effects of drug-assisted intubations and PPV
    - Particularly in under-resuscitated, hypovolemic patients

Think ‘RBI’, not ‘RSI’ with peri-arrest

(RBI = ‘Resuscitation Before Intubation’)

Caveats to Intubation Delay

- Some situations demand urgent invasive airway management:
  - Pt actively vomiting
  - Highly agitated
  - Significant maxillofacial/neck/airway burn trauma
  - Significant TBI

‘Breathing’ Challenges in TCA

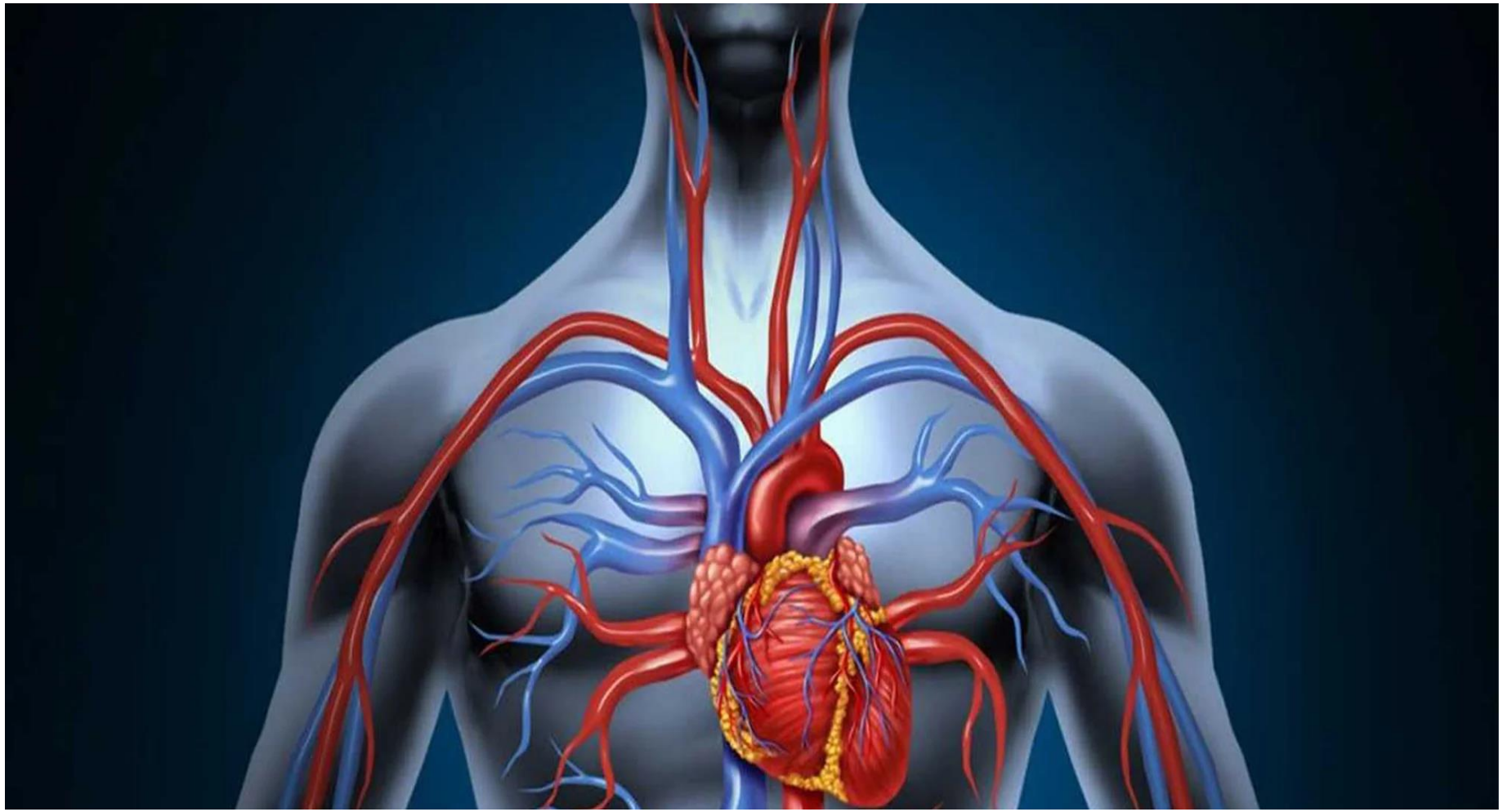
‘Breathing’ Challenges in TCA

- Tension PTX (13%)
- Massive HTX
- Traumatic diaphragmatic rupture
- Multiple rib fractures (flail chest)
- Aspiration of blood

‘Breathing’ Challenges in TCA

- Administering 100% high flow oxygen to all TCA patients is advocated
- PPV may aggravate hypotension and hypoperfusion by impeding venous return to the heart, particularly in hypovolemic patients
  - PPV may rapidly convert a rather harmless, even undetected pneumothorax into a life-threatening tension pneumothorax, becoming a secondary trigger of TCA itself
- Low tidal volumes, minimal PEEP levels, and slow respiratory rates may help optimize cardiac preload
- Ventilation should always be monitored with continuous waveform capnography and adjusted to achieve target end tidal CO_2 levels after ROSC

‘Circulation’ Challenges in TCA



‘Circulation’ Challenges in TCA

- Most commonly due to hypovolemia, mostly by exsanguination (50%), cardiac tamponade (10%), cardiac contusion

- 5 places you can bleed to death
  - Chest
  - Abdomen
  - Pelvis/Retroperitoneum
  - Long bone fxs
  - On the street

‘Circulation’ Challenges in TCA

- Injury by electric currents can cause TCA
  - Classically by inducing cardiac arrhythmias, even without anatomical cardiac damage
  - In electro-induced arrhythmias, such as VF, standard ALS algorithms apply for resuscitation

- With hypotension/TCA, must assume hypovolemia/hemorrhage until proven otherwise
  - Hemostatic resuscitation and hemorrhage control are the priorities
  - Pelvic binder
  - REBOA
  - Resuscitative thoracotomy, pericardotomy, aortic cross clamping, internal cardiac massage with simultaneous transfusion
    - The chance of survival is about 4x higher in cardiac stab wounds than in GSW
    - Survival rates from severe trauma-related ER thoracotomies from 7% in blunt trauma to >50% in not yet arrested patients

Damage Control Resuscitation

- Includes permissive hypotension, resuscitative coagulation management, and damage control interventions
- Patients with TBI may require higher blood pressures
- Peri-arrest BP management in the context of TCA is challenging, poses dilemmas, and should be individualized based on patient and trauma characteristics

Cardiac Rhythms in TCA

- Asystole (~40%) and PEA (~25%) are the prevalent ECG rhythms in TCA

- Shockable rhythms such as VF are rare (~7%), but associated with a better prognosis
  - Like medical cardiac arrest, shockable rhythms should be shocked also in TCA immediately
  - A shockable rhythm in patients with trauma may indicate a medical rather than traumatic etiology of the arrest

Chest Compressions in TCA

- Controversial
- Chest compressions, both manual and device assisted, are likely less effective in hypovolemic subjects
- “Don’t pump an empty heart”


the office

Chest Compressions in TCA

- Animal studies show that in hypovolemic low flow states, chest compression may not only be ***ineffective***, but even ***harmful***
- Chest compression in obstructive TCA etiologies, e.g., tension pneumothorax and cardiac tamponade, are likely also less effective
- Considering the economics of resuscitation, resources (e.g., time and personnel) may be allocated to more beneficial, high-yield interventions, instead of performing ineffective or even harmful chest compressions
- Chest compressions should take a lower priority than immediate treatment of reversible causes in TCA, e.g., controlling hemorrhage

Chest Compressions in TCA

- Use of epinephrine w/ TCA did not improve prehospital ROSC, and was associated with decreased short-term survival and decreased 7-day survival

- In general , we need to de-prioritize the immediate initiation of chest compressions and epinephrine administration, as conventionally stressed in medical cases of CA

Caveats to Withholding Chest Compressions in TCA

- Notable exceptions where CPR should be continued with TCA:
  - Medical causes of arrest
  - Cardiac contusions, MI
  - Asphyxiation (e.g., burial under sand or in a crowd crush)
  - Electricity injuries
  - Isolated traumatic brain injury

‘Disability’ Challenges in TCA

- Loss of cerebral function in TCA may result from:
  - Direct cerebral trauma
  - Extra cerebral processes, e.g., LOC after cerebral hypoperfusion in cardiac arrest following other causes

- Spinal injuries
  - Particularly C3/C4/C5 (feed the phrenic nerve) can cause insufficient breathing, respiratory arrest, and ultimately TCA

When NOT to Resuscitate TCA

- Withhold resuscitation, if:
  - No signs of life for at least 15 min
  - Catastrophic injuries, e.g., penetrating head injury, loss of brain tissue

- Consider terminating resuscitation, if:
  - No ROSC after potentially reversible TCA causes were addressed
  - No cardiac motion in POCUS, even with organized ECG activity present, after the reversible causes of TCA were addressed

- Prolonged resuscitation efforts in futile TCA cases unnecessarily increase risks for:
  - Stick or cut-injuries
  - Infections
  - Psychological trauma
  - Drain-limited system resources (e.g., personnel, ER capacity, and blood products)

My Algorithm for TCA

- Stop Compressions
- Create an open (patent) airway, not necessarily intubate
- Ensure adequate IV access/IO, MTP
- B/L routine chest decompression (“finger thoracostomies”)
  - Predominantly with blunt trauma
- POCUS/FAST, assess for SOL, source of hemorrhage, and r/o cardiac tamponade
- +- REBOA if (+) pulse and peri-arrest
- +/- resuscitative thoracotomy (and/or clamshell thoracotomy), pericardotomy, cross-clamp aorta, internal cardiac massage
- OR with ROSC

It Starts With You!!