Pearls and Pitfalls in the Diagnosis and Treatment of Traumatic Shock

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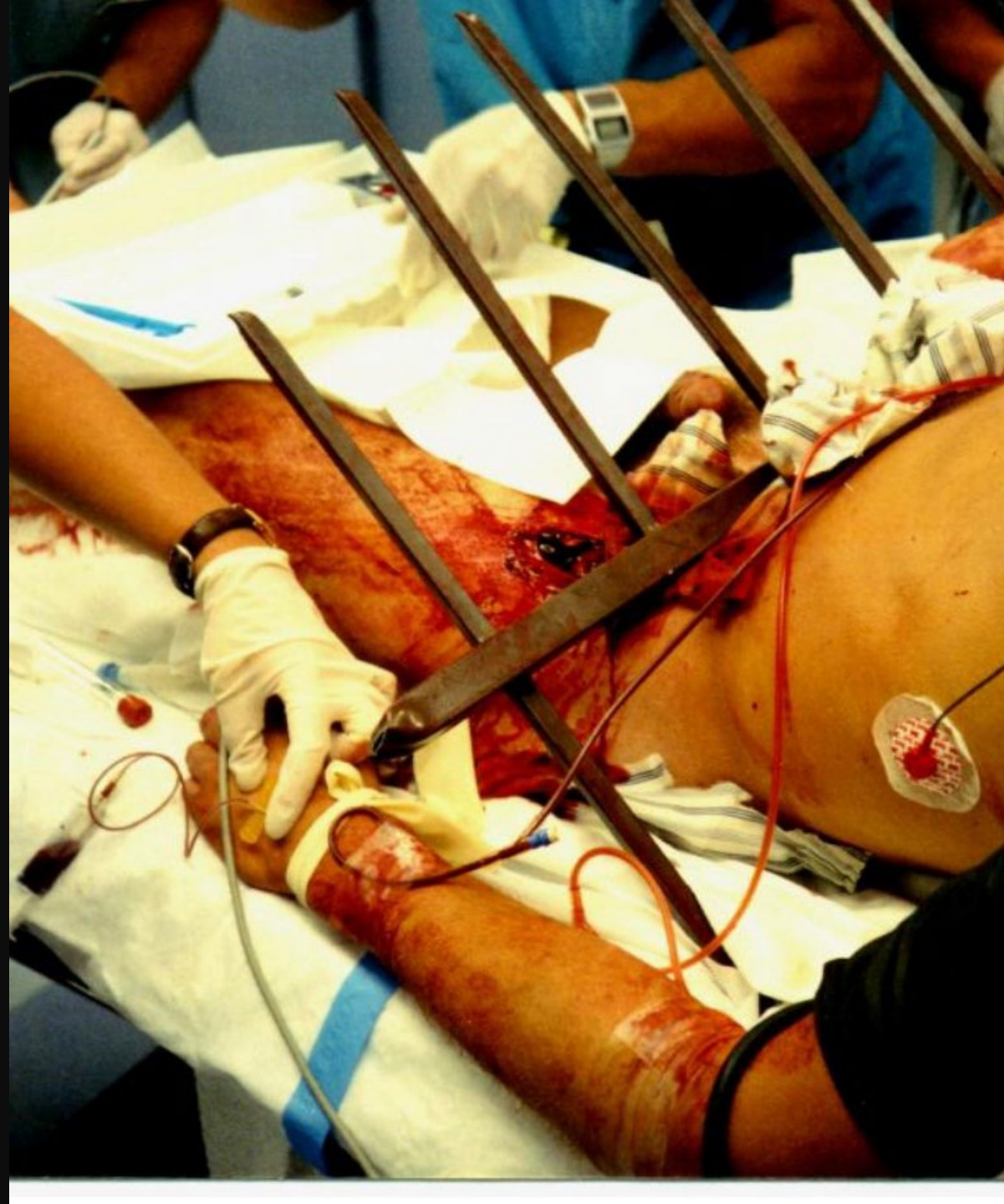
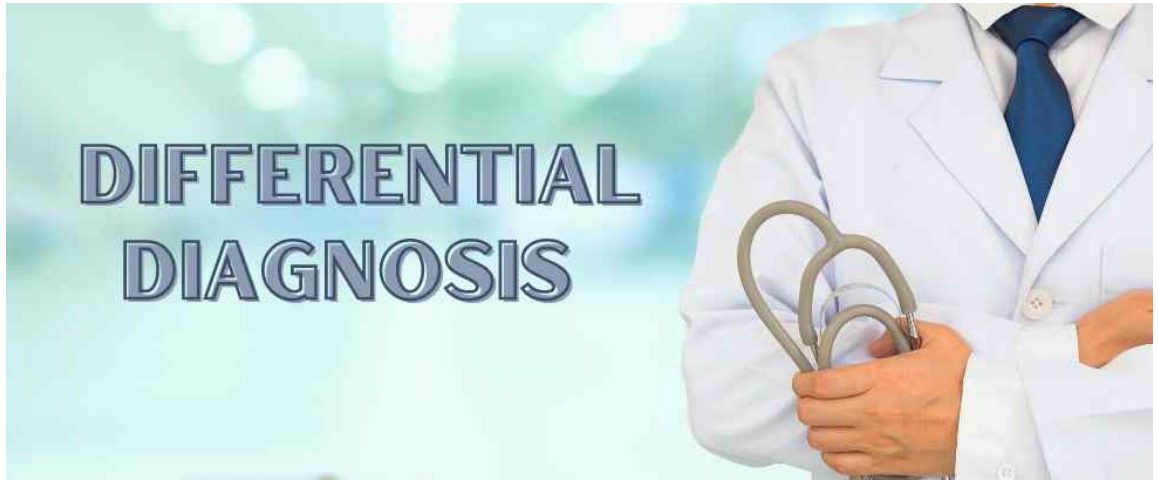
Traumatic Shock

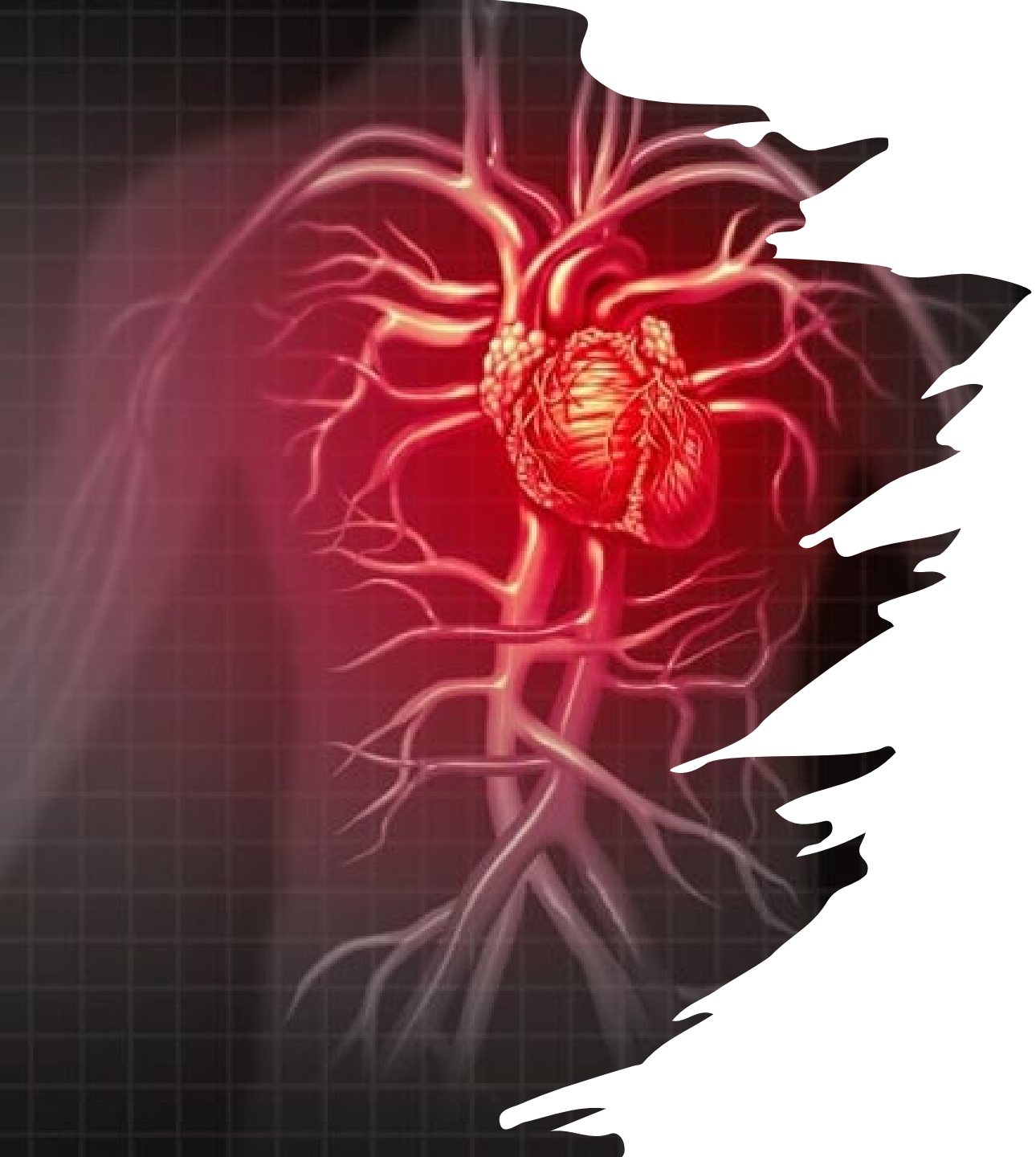
- Definition of shock
  - Inadequate tissue perfusion
    - Not enough oxygen getting to the tissues to sustain aerobic metabolism
    - Results in dysfunction of organs vital to survival
  - Not defined by hypotension



Traumatic Shock

- Hemorrhage
  - Most common cause
- Pericardial tamponade
- Tension pneumothorax
- Spinal cord injury
- Pharmacologic/toxicologic agents
- Fat or air embolism





Pitfall # 1

- Not recognizing the shock state
  - Waiting for hypotension
- Earlier signs of shock
  - Tachycardia
    - Bradycardia has also been well described
  - Poor perfusion
    - Cool extremities
    - Weak pulses
    - Prolonged capillary refill
  - Narrow pulse pressure
  - Altered mental status

ABC’s?

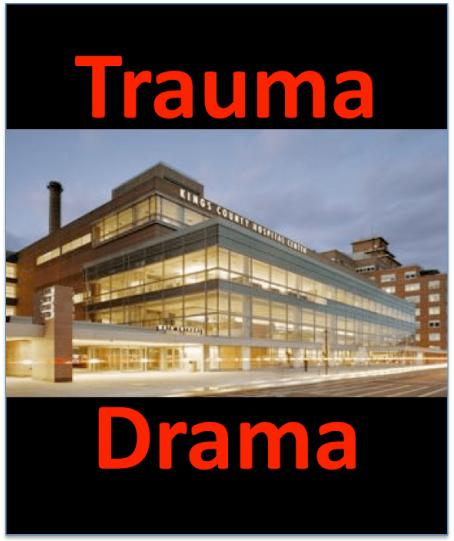
- Critical airway compromise
  - “Dynamic airway”
    - Hypoxia despite intervention
    - Evolving occlusion
      - Burns
      - Expanding hematoma
- If not
  - Hemodynamic optimization is the goal
    - Prior to intubation

Pitfall # 2 – Intubation before Resuscitation

- Intubation
  - Increases intrathoracic pressure
    - Decreasing right atrial pressure
  - Hemorrhagic shock
    - Low venous return will decrease further with PPV
      - Mosier et al
        - West J Emerg Med, 2015
  - Pre-intubation hypotension is a risk factor for post-intubation cardiac arrest
    - Kim et al
      - PLoS One, 2014

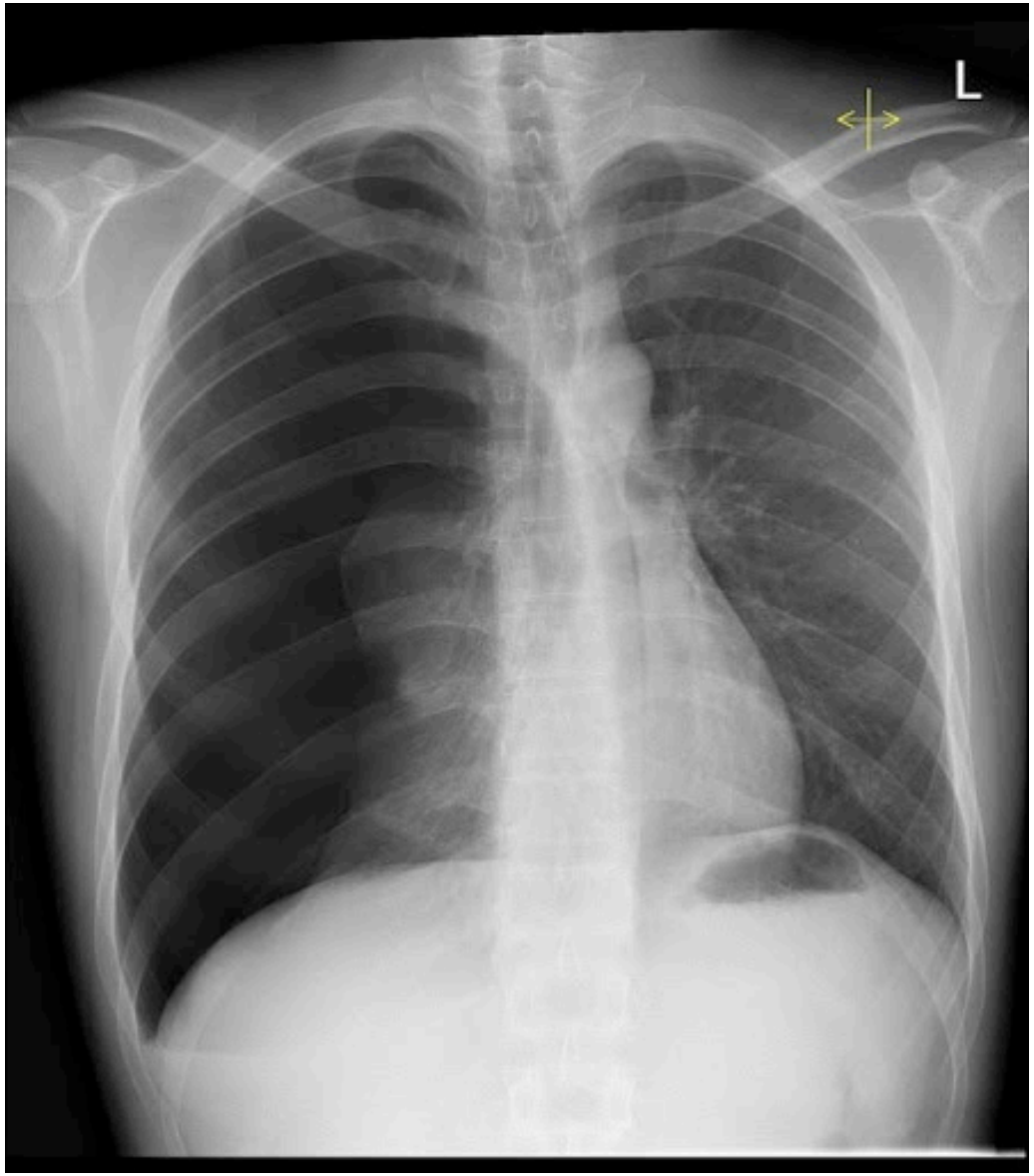
Optimize Hemodynamics

- Blood products
- Induction agent
  - Both the use of and the dose of etomidate were associated with hypotension
    - Paralytic was not associated with hypotension
      - Neither was ketamine
        - Kim et al
          - Am J Emerg Med, 2019



Airway First?

- GCS < 8?
  - Related to trauma?
- Tension pneumothorax or pericardial tamponade
  - Intubate or ventilate?



Pitfall # 3 – Missing Hemorrhage

- Not appreciating the extent of the hemorrhage
  - At the scene
  - Retroperitoneum
  - Long bones
  - Scalp
  - Chest
  - Abdomen

Pelvic Fractures

- Retroperitoneal hemorrhage from a pelvic fracture can be occult
- Potential value of a pelvic x-ray

Pitfall # 4

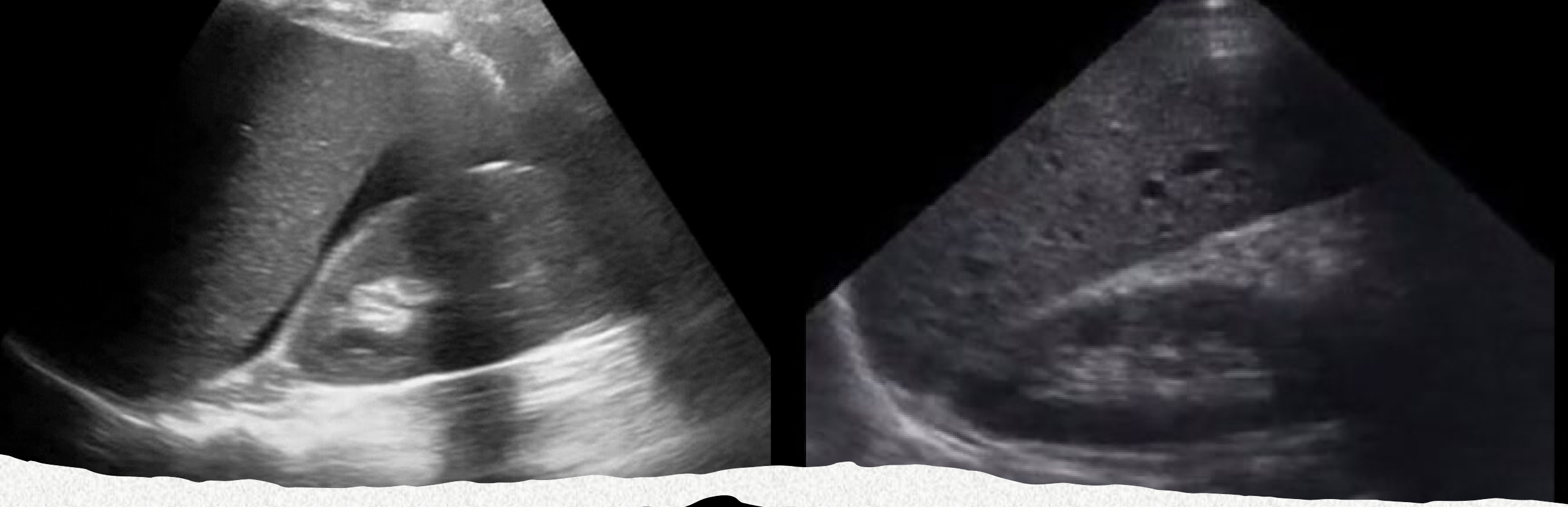
- Over-reliance on single set of normal vital signs
    - Trends are more important
        - Guy et al
            - Resuscitation, 2011

Geriatrics

- Hard for them to express “abnormal” vital signs by ATLS criteria
  - SBP 90 mmHg?
    - 110 is better
      - Eastridge et al
        - J Trauma, 2007
      - Edelman et al
        - Shock, 2007
  - Respect the well-appearing geriatric patient with “normal” vital signs

Circulation

- Single low blood pressure predictor of badness
  - Need for OR and mortality
    - EMS or ED
      - Seamon et al
        - J Trauma, 2010
      - Biliello et al
        - J Trauma, 2011
      - Newgard et al
        - Acad Emerg Med, 2020



Pitfall # 5

- Not understanding the limitations of imaging

POCUS/e-FAST

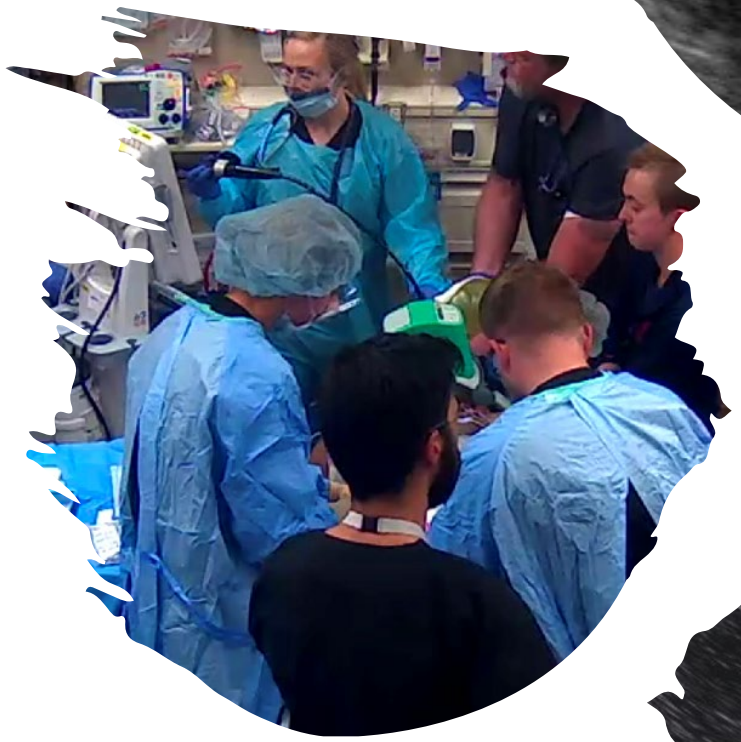
- Lots of information!
  - Intra-abdominal hemorrhage
  - Pneumothorax
  - Pericardial tamponade
  - IVC assessment
    - Flat – assume shock
- Like repeat EKGs, repeat e-FAST is your friend!

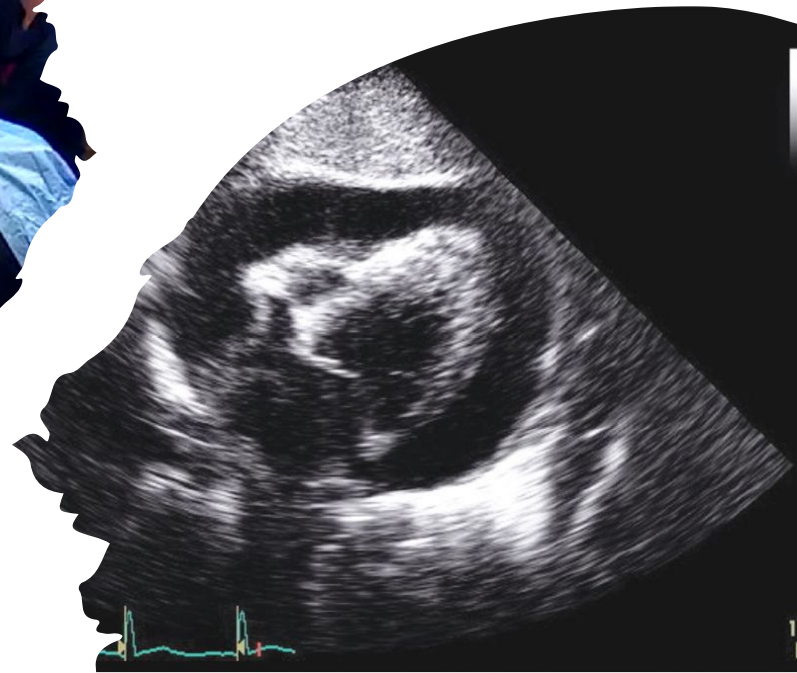
POCUS

- Positive helps!
  - Normal less so
    - Positive and unstable
      - OR if available
    - Positive and stable
      - CT and/or transfer
- Debate on value in stable patients
  - Evolution of traumatic injury
  - Can be helpful
    - Stable and negative
      - Done

eFAST in Trauma

- Diagnostic accuracy of eFAST in the trauma patient: a systematic review and meta-analysis
  - Netherton et al
    - CJEM, 2019
- Findings
  - eFAST is effective at
    - Ruling in
      - Intra-abdominal free fluid
      - Pneumothorax
      - Pericardial fluid
    - Ruling out
      - Pericardial fluid

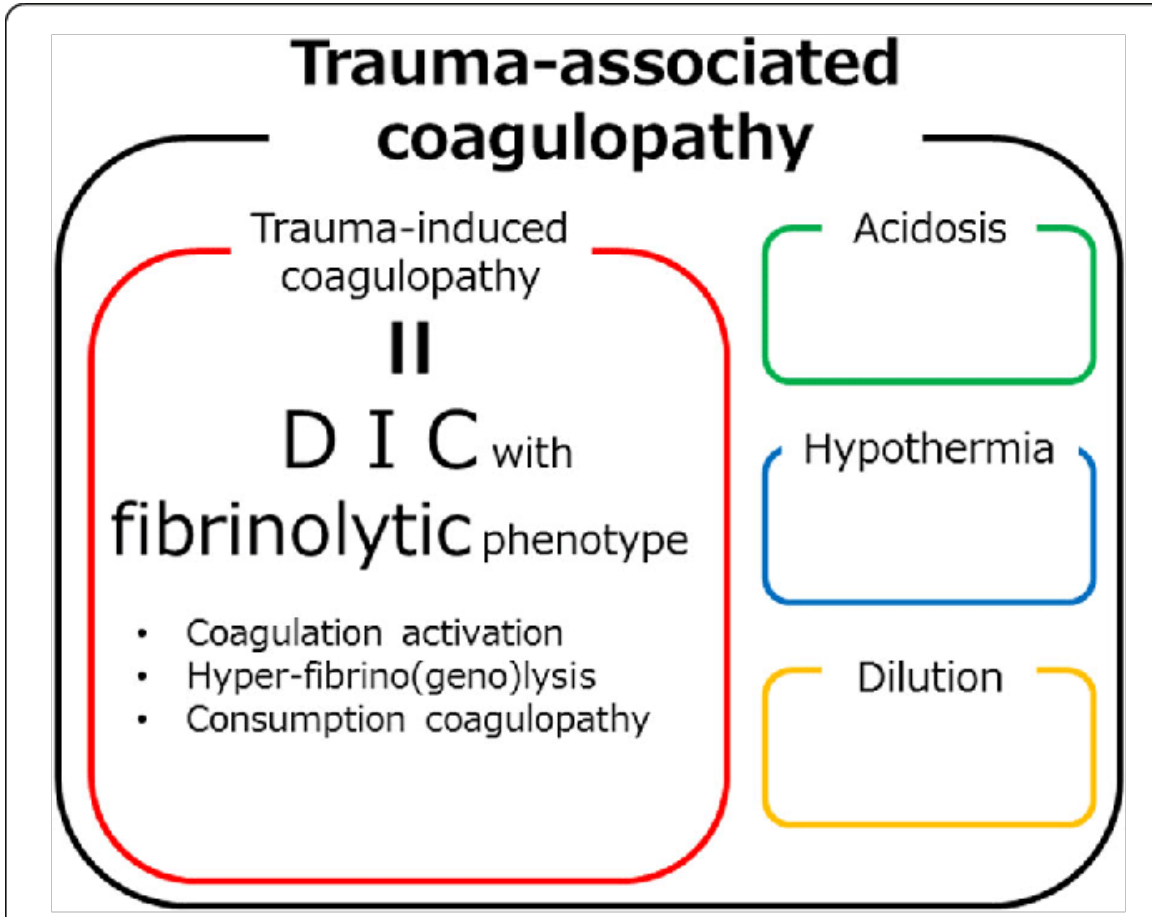




Pitfall # 6 – Focusing on the Obvious Injury

Pitfall # 7 – Failing to Prevent TIC

- Crystalloids
- Transfusion ratios
- Components
- Hypothermia



Trauma Induced Coagulopathy (TIC)

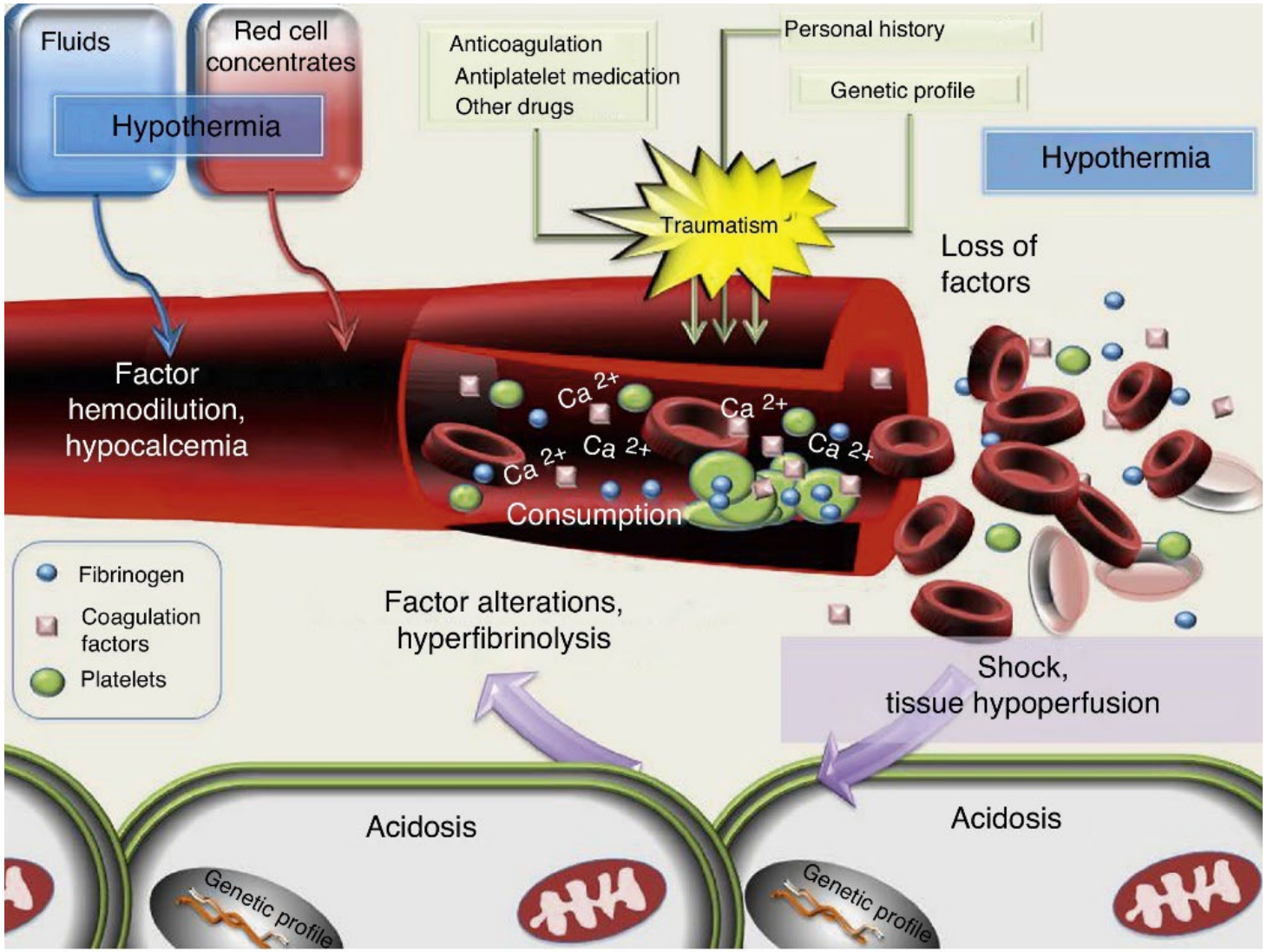
- More common than you might think
  - 10-30% of severely injured patients
- Leading cause of mortality after resuscitation
  - Walsh et al
    - J Clin Med, 2021
- Does not look the same in every patient
  - Woolley et al
    - Transfusion, 2020
- Standard coagulation studies are not adequate
  - Veiges et al
    - Scand J Trauma Resusc Emerg Med, 2016

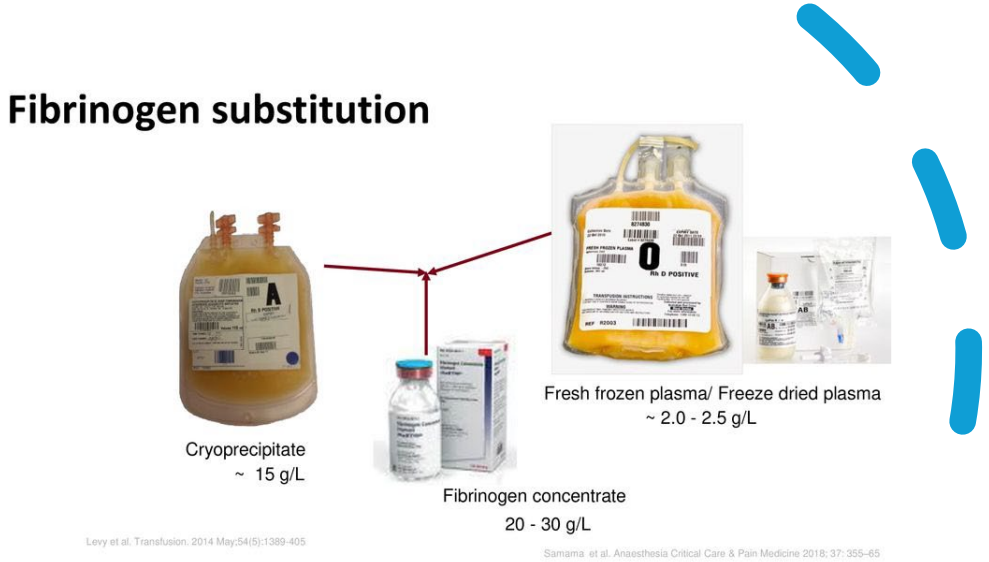
Crystalloid Harm

- Demonstrated harm
  - Dilutional coagulopathy
  - Anemia
  - Extravasation
  - Interference with protective glycocalyx of the endothelium
    - Naumann et al
      - Shock, 2018
    - Spinella et al
      - Transfusion, 2019

Hemostatic Resuscitation

- Early use of blood products in a balanced ratio
  - 1:1:1
    - Limited crystalloid
      - Holcomb et al
        - JAMA, 2015
- Any crystalloid?
- “Triad of death”
  - Metabolic acidosis
  - Hypothermia
  - Coagulopathy
    - Crystalloid makes them all worse!





Trauma Induced Coagulopathy

- Not all blood components are depleted equally in hemorrhage
  - Martini et al
    - J Trauma Acute Care Surg, 2020
- Early fibrinogen derangement a cause of TIC?
  - Early fibrinogen and platelet therapy appears to enhance the stability of the fibrin-platelet plug
  - Significant investigation focusing on early administration of fibrinogen concentrate in major trauma patients
    - Curry et al
      - Crit Care, 2018
    - Spahn et al
      - Crit Care, 2019

Permissive Hypotension

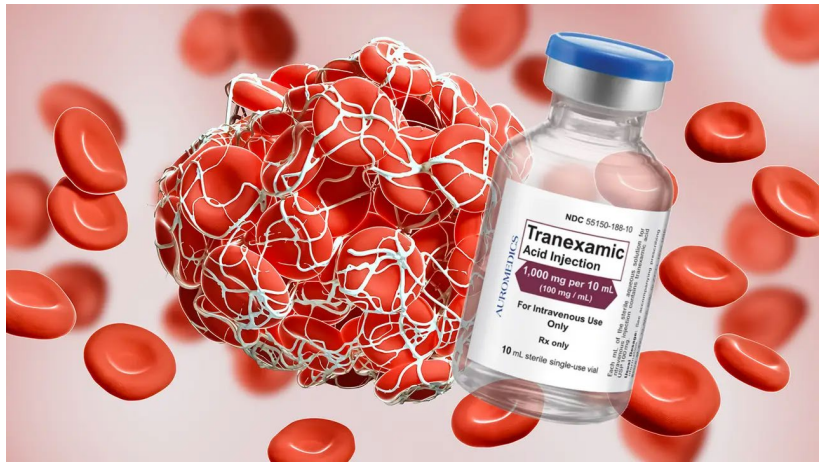
- Controlled resuscitation
  - Lower than “normal” blood pressure
    - SBP 80-90 mmHg
      - MAP of 50
  - Lower mortality
  - Less likely to develop multi-organ dysfunction or ARDS
    - Tran et al
      - J Trauma Acute Care Surg, 2018
    - Owattanapanich et al
      - Scand J Trauma Resusc Emerg Med, 2018

Trauma Resuscitation

- European Guideline on management of major bleeding and coagulopathy following trauma
  - Rossaint et al
    - Crit Care, 2023
  - 39 recommendations
  - Recommendation 13 – Initial phase
    - Restricted volume replacement
      - SBP 80-90 (MAP 50-60)
      - Severe TBI
        - MAP of 80

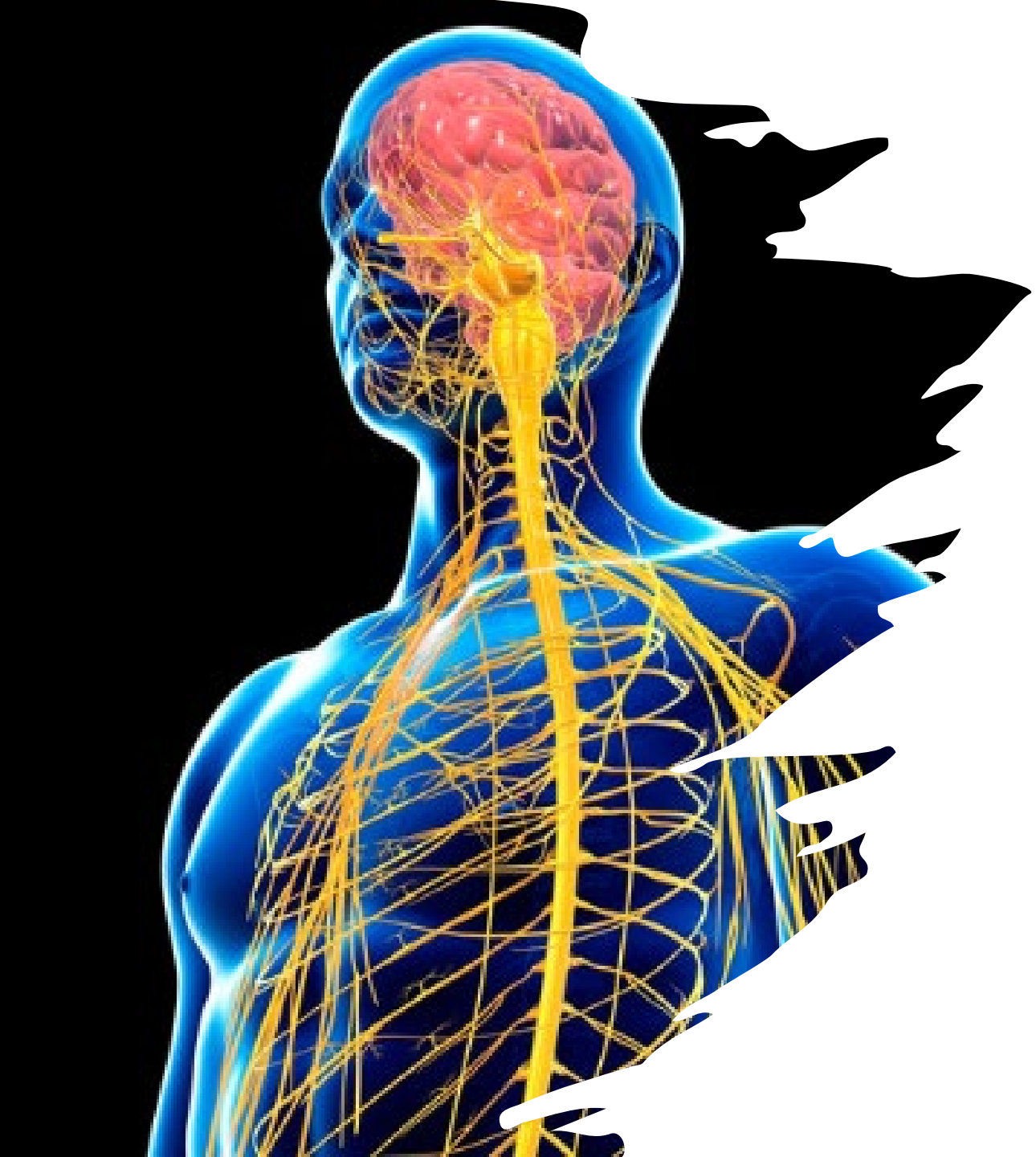
TXA

- Tranexamic acid for traumatic injury in the emergency setting: A systematic review and bias-adjusted meta-analysis of randomized controlled trials
  - Fouche et al
    - Ann Emerg Med, 2024
  - TXA use leads to a reduction in 1-month morality
    - No significant vascular occlusive events



Time for a New Standard?

- Current management
  - One size fits all
    - 1:1:1/TXA for all
- Viscoelastic testing appears to be superior in combat trauma victims
  - Lammers et al
    - J Trauma Acute Care Surg, 2020
- Goal-directed therapy may improve outcomes
  - Cochrane et al
    - Diagnostics, 2020



Pitfall # 8 – Jumping to Conclusions

- Neurogenic Shock
  - Diagnosis of exclusion
  - Not typically tachycardic
    - Loss of sympathetic tone
      - But shock may not be tachycardic
  - Hypotension is from loss of PVR
    - Skin may be warm

CPR in Trauma Patients?

- Effect of cardiopulmonary resuscitation on perfusion in a porcine model of severe hemorrhagic shock
  - Greiffenstein et al
    - J Trauma Acute Care Surg, 2024
  - CPR did not improve end-organ oxygenation/perfusion but did diminish skin perfusion
    - Corroborates existing literature on the potential detrimental effects of CPR in patients suffering from hemorrhagic shock

Take Home

- Hemorrhage until proven otherwise
  - May need to look for it
- Don’t wait for hypotension
  - Pay attention to trends
- Avoid pre-intubation hypotension
  - Resuscitate before you intubate
  - Relieve obstructive causes first
- Respect the well-appearing geriatric trauma patient

Take Home

- Know your limitations
  - Imaging
- Beware of the less obvious injuries
- Think about TIC early
  - Low/no crystalloids
  - Mind your ratios
  - Components

Thank You!

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