Shock in the Pediatric Trauma Patient

Wellstar

Disclosures

- I have nothing to disclose

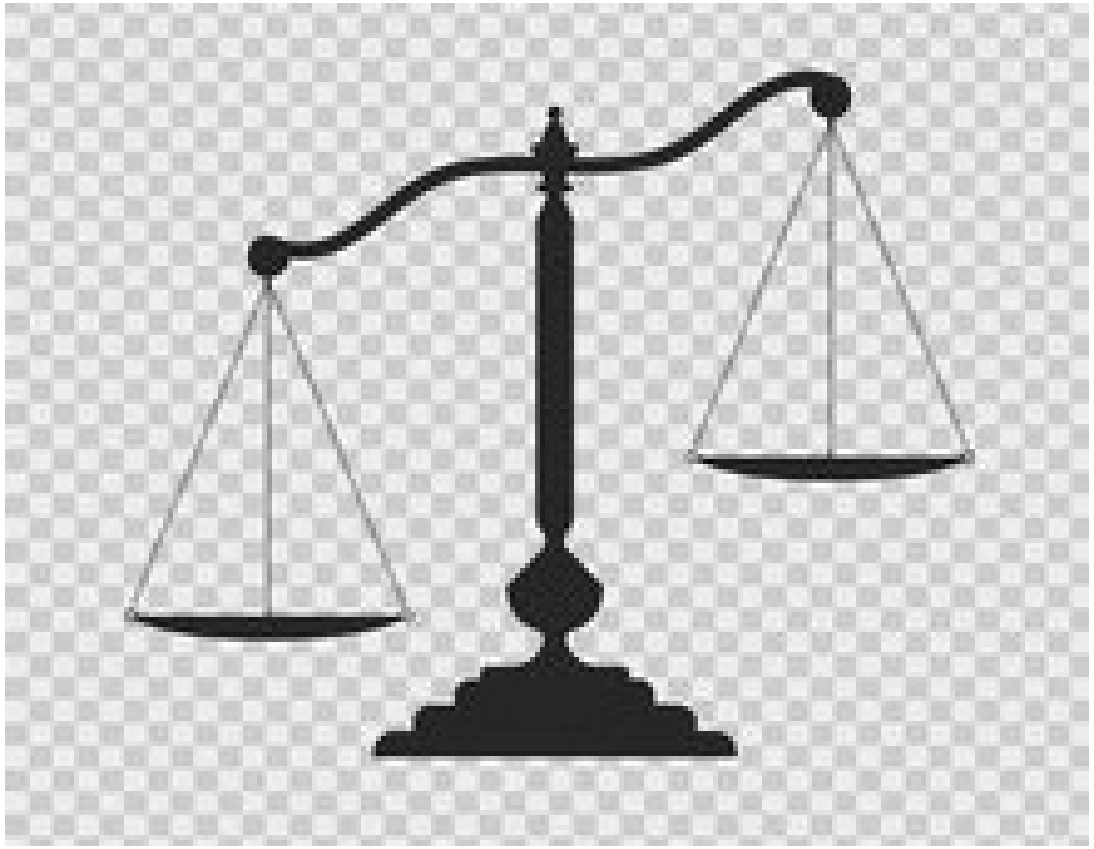
Objectives

- Review the pathophysiology of shock and discuss the most common causes of shock in the trauma patient.
- Discuss priorities of care for a patient in shock.
- Describe current standards for treating shock in trauma patients.
- Review current evidence and upcoming trends in shock management.

Shock

- “Post-injury collapse” was recognized as early as ancient Greece and Rome – by Hippocrates and Galen
- 1737 French military surgeon Henri-François Le Dran – *choc* - described the impact or jolt after GSW and the sudden collapse
- Civil War surgeons recognized shock as a consequence of blood loss after injury
- “A momentary pause in the act of death” - Harvard surgeon and professor John Warren Collins 1800’s
- 1900’s – World War 1 – death thought due to “wound toxins” after injury – not just blood loss
- Modern understanding of shock – World War 2
- R Adams Cowley – shock as a treatable, reversible process – The Golden Hour

Shock



- Imbalance of oxygen supply and oxygen demand
- Leads to cell dysfunction and death → leads or organ dysfunction and death → can lead to death

Shock

#1 Priority for shock

RECOGNIZE it!!!

Early recognition and intervention improves survival!

Shock

- #1 cause in the trauma patient – **hemorrhage**
- Where can life-threatening bleeding happen?
  - Chest
  - Abdomen
  - Pelvis/Retroperitoneum
  - Long bones
  - External

Other causes of shock

- Obstructive –
  - Tension Pneumothorax
  - Cardiac Tamponade
  - PE
- Distributive –
  - Neurogenic
  - Anaphylaxis
- Cardiogenic –
  - Blunt cardiac injury
  - MI

Care Priorities for Trauma Patients

Primary Survey – recognition and stabilization of IMMEDIATE LIFE THREATS

- X – e**X**sanginating e**X**ternal hemorrhage
- A – Airway
- B – Breathing
- C – Circulation
- D – Disability
- E – Environment and Exposure

Secondary Survey –

- Thorough head to toe assessment

Nursing care for patient in shock

- Recognition
- Address bleeding
- IV access/IO access
- Blood replacement – 10-15 mL/kg
  - Whole blood
  - MTP
- Monitoring – VS, response to interventions

Recognizing Shock in Children

- Pale
- Delayed CRT
- Skin cool, mottled extremities
- Increased HR
- Altered LOC
- Hypotension – late sign
- Shock Index

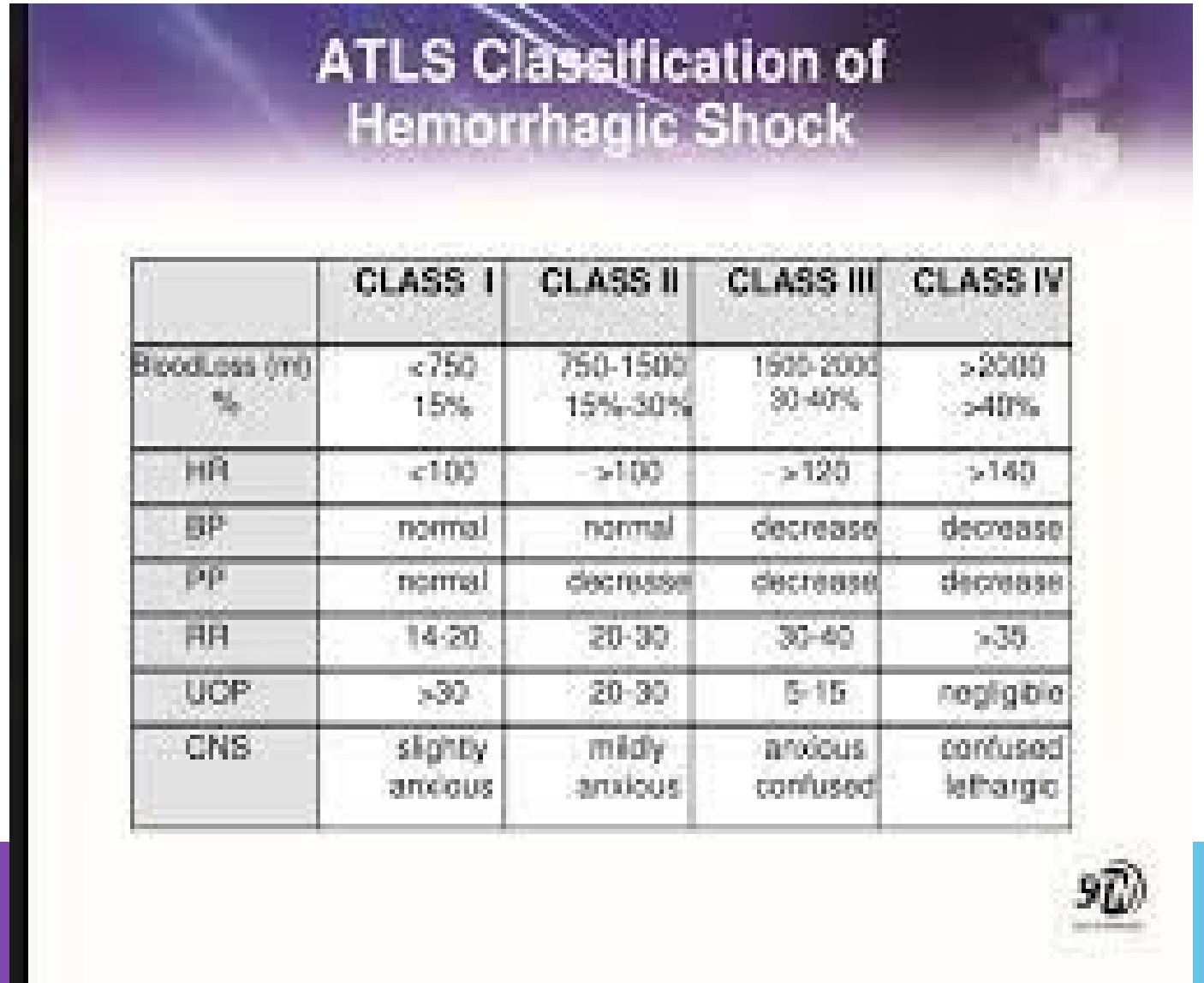
Shock Index in Children

Shock Index – Pediatric Adjusted (SIPA)

- HR/SBP
  - Ages 0–6: SIPA ≥ 1.22 is abnormal
  - Ages 7–12: SIPA ≥ 1.0 is abnormal
  - Ages ≥ 13 SIPA ≥ 0.9 is abnormal

- Less useful in younger children (0-4)

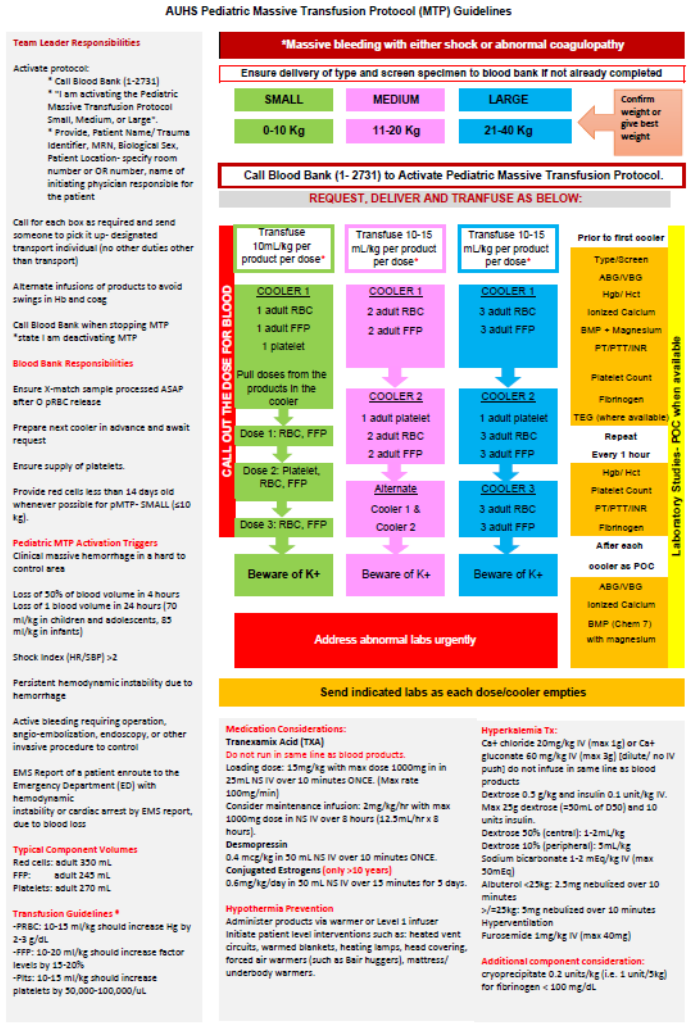
Classes of Shock



	CLASS I	CLASS II	CLASS III	CLASS IV
Blood loss (ml) %	<750 15%	750-1500 15%-30%	1500-2000 30-40%	>2000 >40%
HR	<100	>100	>120	>140
BP	normal	normal	decrease	decrease
PP	normal	decrease	decrease	decrease
RR	14-20	20-30	30-40	>35
UOP	>30	20-30	5-15	negligible
CNS	slightly anxious	mildly anxious	anxious confused	confused lethargic

Wellstar

Volume Resuscitation



AUHS Pediatric Massive Transfusion Protocol (MTP) Guidelines

Team Leader Responsibilities

Activate protocol:
* Call Blood Bank (1-2731)
* "I am activating the Pediatric Massive Transfusion Protocol Small, Medium, or Large"
* Provide, Patient Name/ Trauma Identifier, MRN, Biological Sex, Patient Location- specify room number or OR number, name of initiating physician responsible for the patient

Call for each box as required and send someone to pick it up- designated transport individual (no other duties other than transport)

Alternate infusions of products to avoid swings in Hb and coag

Call Blood Bank when stopping MTP "state I am deactivating MTP

Blood Bank Responsibilities

Ensure X-match sample processed ASAP after O pRBC release

Prepare next cooler in advance and await request

Ensure supply of platelets.

Provide red cells less than 14 days old whenever possible for pMTP- SMALL (≤10 kg).

Pediatric MTP Activation Triggers
Clinical massive hemorrhage in a hard to control area

Loss of 50% of blood volume in 4 hours
Loss of 1 blood volume in 24 hours (70 ml/kg in children and adolescents, 85 ml/kg in infants)

Shock index (HR/SBP) >2

Persistent hemodynamic instability due to hemorrhage

Active bleeding requiring operation, angio-embolization, endoscopy, or other invasive procedure to control

EMS Report of a patient enroute to the Emergency Department (ED) with hemodynamic
instability or cardiac arrest by EMS report, due to blood loss

Typical Component Volumes
Red cells: adult 350 mL
FFP: adult 245 mL
Platelets: adult 270 mL

Transfusion Guidelines *
-PRBC: 10-15 ml/kg should increase Hg by 2-3 g/dL
-FFP: 10-20 ml/kg should increase factor levels by 15-20%
-Pits: 10-15 ml/kg should increase platelets by 50,000-100,000/uL

*Massive bleeding with either shock or abnormal coagulopathy

Ensure delivery of type and screen specimen to blood bank if not already completed

SMALL	MEDIUM	LARGE
0-10 Kg	11-20 Kg	21-40 Kg

Confirm weight or give best weight

Call Blood Bank (1- 2731) to Activate Pediatric Massive Transfusion Protocol.

REQUEST, DELIVER AND TRANFUSE AS BELOW:

CALL OUT THE DOSE FOR BLOOD

Transfuse 10mL/kg per product per dose*	Transfuse 10-15 mL/kg per product per dose*	Transfuse 10-15 mL/kg per product per dose*
COOLER 1 1 adult RBC 1 adult FFP 1 platelet	COOLER 1 2 adult RBC 2 adult FFP	COOLER 1 3 adult RBC 3 adult FFP
Pull doses from the products in the cooler		
Dose 1: RBC, FFP	COOLER 2 1 adult platelet 2 adult RBC 2 adult FFP	COOLER 2 1 adult platelet 3 adult RBC 3 adult FFP
Dose 2: Platelet, RBC, FFP	Alternate Cooler 1 & Cooler 2	COOLER 3 3 adult RBC 3 adult FFP
Dose 3: RBC, FFP		
Beware of K+	Beware of K+	Beware of K+

Address abnormal labs urgently

Laboratory Studies- POC when available

Prior to first cooler
Type/Screen ABG/VBG Hgb/ Hct Ionized Calcium BMP + Magnesium PT/PTT/INR Platelet Count Fibrinogen TEG (where available)
Repeat Every 1 hour
Hgb/ Hct Platelet Count PT/PTT/INR Fibrinogen
After each cooler as POC
ABG/VBG Ionized Calcium BMP (Chem 7) with magnesium

Send indicated labs as each dose/cooler empties

Medication Considerations:
Tranexamix Acid (TXA)
Do not run in same line as blood products.
Loading dose: 15mg/kg with max dose 1000mg in in 25mL NS IV over 10 minutes ONCE. (Max rate 100mg/min)
Consider maintenance infusion: 2mg/kg/hr with max 1000mg dose in NS IV over 8 hours (12.5mL/hr x 8 hours).
Desmopressin
0.4 mcg/kg in 50 mL NS IV over 10 minutes ONCE.
Conjugated Estrogens (only >10 years)
0.6mg/kg/day in 50 mL NS IV over 15 minutes for 5 days.

Hypothermia Prevention
Administer products via warmer or Level 1 infuser
Initiate patient level interventions such as: heated vent circuits, warmed blankets, heating lamps, head covering, forced air warmers (such as Bair huggers), mattress/ underbody warmers.

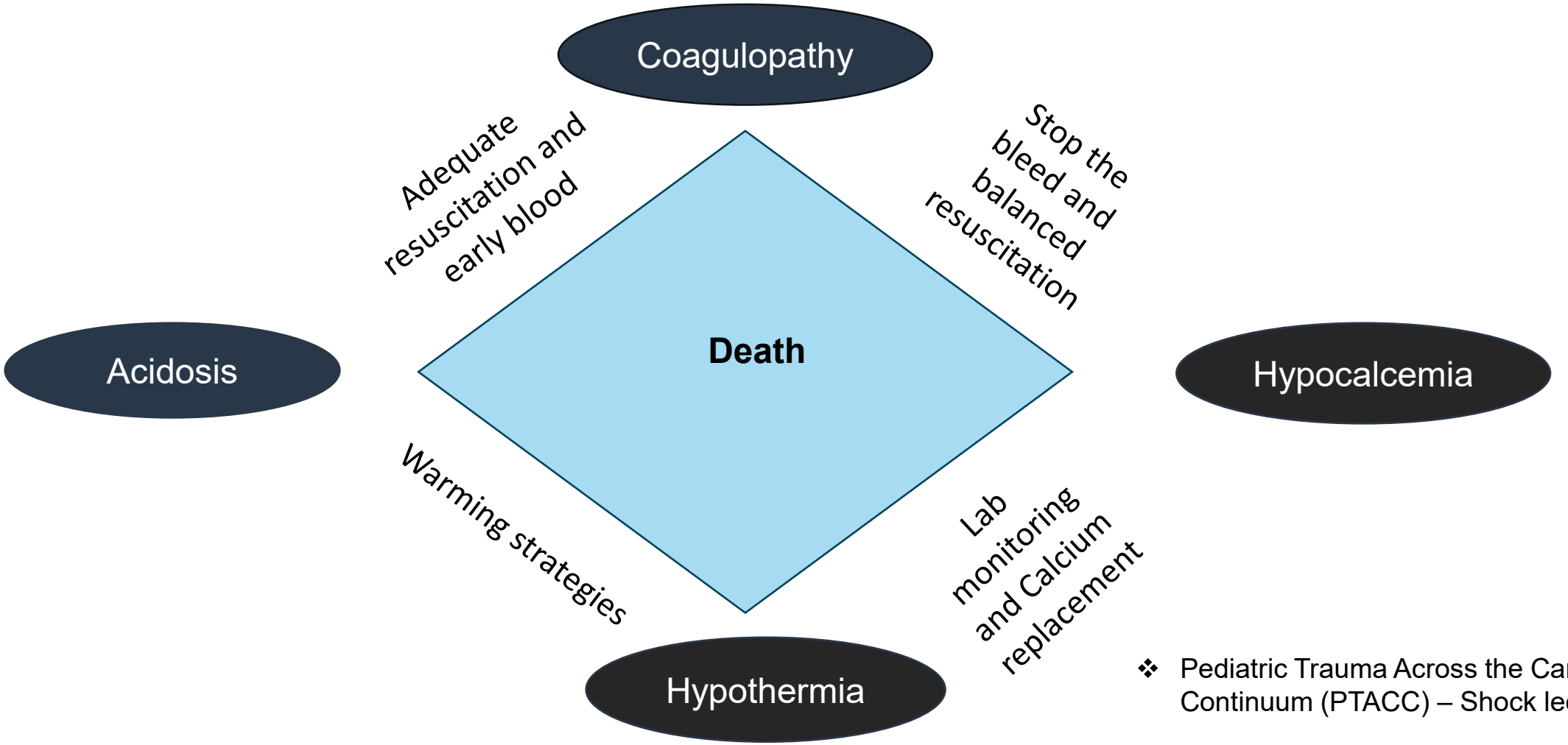
Hyperkalemia Tx:
Ca+ chloride 20mg/kg IV (max 1g) or Ca+ gluconate 60 mg/kg IV (max 3g) (dilute/ no IV push) do not infuse in same line as blood products
Dextrose 0.5 g/kg and insulin 0.1 unit/kg IV. Max 25g dextrose (=50mL of D50) and 10 units insulin.
Dextrose 10% (central): 1-2mL/kg
Dextrose 10% (peripheral): 5mL/kg
Sodium bicarbonate 1-2 mEq/kg IV (max 50mEq)
Albuterol <25kg: 2.5mg nebulized over 10 minutes
>/=25kg: 5mg nebulized over 10 minutes
Hyperventilation
Furosemide 1mg/kg IV (max 40mg)

Additional component consideration:
cryoprecipitate 0.2 units/kg (i.e. 1 unit/5kg) for fibrinogen < 100 mg/dL

- Crystalloid – up to 20 mL/kg
- Blood
  - Massive Transfusion - goal is balanced resuscitation → 1:1:1
  - Whole Blood

Wellstar

Trauma Diamond of Death



- Pediatric Trauma Across the Care Continuum (PTACC) – Shock lecture

Hematology: Low Titer O Blood (LTOWB)-WHOLE BLOOD (WB)

- Whole blood has been administered to pediatric patients in recent war conflicts, but has not been rigorously studied.
- No known contraindications, but no firmly established clinical criteria exist for transfusion of WB

- Four recent studies in Peds civilian population concluding :
- LTOWB allowed for quicker time to transfusion and has less ventilator days (may be related to less volume infused)
- WB recipients had faster time to resolution of base deficit, INR was increased in the component therapy only group
- No difference in time to transfusion; no difference in mortality, functional disability, LOS, ICU LOS, or ventilator days

Recommendations include:

- For patients < 40 kg, WB should be delivered in unit doses of 10-15 ml/kg.
- Physiologic variables should be interpreted by age.
- WB must be tested for all required infectious disease markers, and the ABO type must be confirmed by forward and back typing & undergo standard testing for the Rh type and RBC antibody screen.

Pediatric Trauma Society
A Voice for the Injured Child
pediatrictraumasociety.org

Infographic Author : Karen Macauley

Pediatric Trauma Society Guidelines Hub – Whole Blood Infographic

Summary

- Shock is a serious threat to the pediatric trauma patient.
- Treatment priorities for the trauma patient have evolved slightly to include XABCDE, but the goal remains to systematically evaluate and treat immediate threats to life.
- Early recognition improves pt outcomes.
- Blood replacement remains key for the trauma patient in shock – with the goal of replacing circulating volume, restoring end-organ perfusion and cellular oxygen delivery without worsening the Trauma Diamond of Death.

References

- American College of Surgeons. (2025). Advanced Trauma Life Support (ATLS): Standardized Trauma Care when Seconds Count. Chicago.
- Bjorklund, A. R. (2023). Pediatric Shock Review. Pediatr Rev, 551-565. doi.org/10.1542/pir.2022-005630
- Gupta, S. S. (2023). Advances in Shock Management and Fluid Resuscitation in Children. Indian J Pediatr, 280-288. doi:doi.org/10.1007/s12098-022-04434-3
- Macauley. (n.d.). Hematology: Low Titer O Blood (LTOWB) - Whole Blood. Retrieved October 1, 2025, from Pediatric Trauma Society - Resources - Guidelines: https://pediatrictraumasociety.org/multimedia/files/guidelines/Whole-Blood-Visual-Abstract.pdf
- Russell, R. E. (2022). Pediatric Traumatic hemorrhagic Shock Consensus Conference Recommendations. J Trauma Acute Care Surg, S2-S10. doi.org/10.1097/TA.0000000000003805
- Society of Trauma Nurses. (2020). Pediatric Trauma Across the Care Continuum (PTACC).
- Society of Trauma Nurses (2019). Advanced Trauma Care for Nurses (ATCN).

Kyndra Holm, MSN, RN, CEN, TCRN
Kyndra.holm@wellstar.org
Kyndra@holmgrown.com
410-960-1271