

Dr Tiffany Lasky MHS, DO, FACOS, FACS

Texas Tech University of Health Sciences

Paul Foster School of Medicine

Professor of Surgery



# Pediatric Trauma Update

# Disclosures

- Nothing to disclose

# Objectives

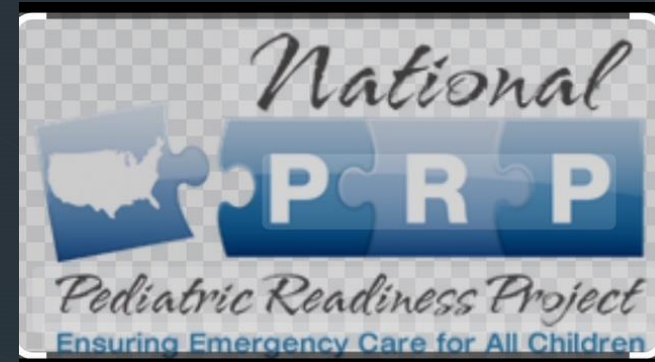
- Review *recent pertinent literature* in the field of Pediatric Trauma
- **Topics** involved are:
  - Emergency Readiness
  - Appropriate Imaging
  - Shock and Resuscitation

# Topic: Emergency Readiness

Association of Emergency Department Pediatric Readiness with Mortality to 1 Year Among Injured Children Treated at Trauma Centers. Newgard CD, Lin A, Goldhaber-Fiebert J, et al. *JAMA Surg.* 2022 Apr 1;157(4):e217419

Recognizing the need for improved pediatric care, the National Pediatric Readiness Program (NPRP) developed ER quality measures in areas of:

- Personnel
- Quality improvement plan
- Patient safety
- Policies and procedures
- Equipment and supplies



Pediatric readiness can be quantified with a weighted Pediatric Readiness Score (wPRS), higher signifying improved readiness.

# Emergency Readiness

- Retrospective cohort study of trauma patients <18 years among 983 EDs with wPRS from the prior 2013 assessment. Hospitals were divided into quartiles based on their wPRS (0-58, 59-72, 73-87, 88-100). Of the over 90,000 injured children treated at one of 592 EDs in the study, 1820 (2%) died during the index hospitalization including 1032 in the ED.

The adjusted **odds of dying in a hospital were 60% lower for children treated at a high-readiness ED** (wPRS quartile 4 vs 1, aOR, 0.4; 95% CI, 0.25-0.60).

- The authors estimated that *288 lives could have been saved* if injured children were treated in highest quartile of readiness EDs versus lower.
- Looking at injured children with 1-year outcomes, the **risks of death to 1 year was lowest in those treated in high-readiness EDs** (aOR, 0.34; 95% CI 0.25-0.45).



# National Pediatric Readiness Improves Child Injury Mortality

*Majority of children are initially seen at non-pediatric trauma centers. This data highlights that it is imperative that all trauma centers be 'Peds Ready'.*

Pediatric trauma patients improve if their initial trauma care is delivered at a high-readiness ED.

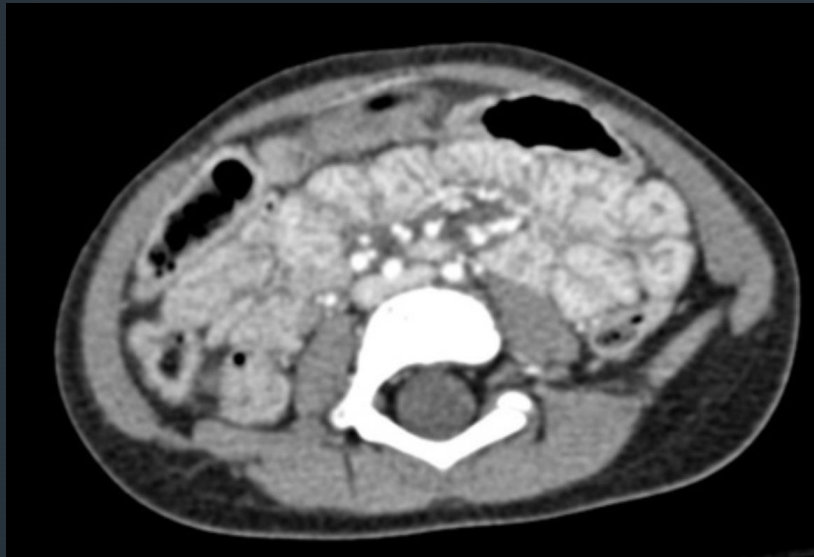
American College of Surgeons Committee on Trauma included this in the 2022 Resources for Optimal Care of the Injured Patient.

Each trauma center should participate in the NPRP assessment and use the findings of their results to improve their readiness for pediatric patients.

UMC Level one Trauma Center participates in the NPRP

# Topic: Pediatric Imaging

- Appropriate imaging
- Abdominal decision rule
- PECARN study



# Appropriate Imaging

- External validation of a pediatric decision rule for blunt abdominal trauma. Siagal AP, Deaner T, Woods S, et al. *J Am Coll Emerg Physicians Open.* 2022 Jan 15;3(1):e12623.
- The Pediatric Emergency Care Applied Research Network (PECARN) clinical decision making rules *CDR for abdominal trauma relies on 7 clinical criteria to rule out the need for CT imaging:*
  - Evidence of abdominal wall trauma/seat belt sign
  - Abdominal tenderness
  - Complaints of abdominal pain
  - Vomiting
  - Glasgow Coma Scale (GCS) of 13 or less
  - Evidence of thoracic wall trauma
  - Decreased breath sounds



# Pediatric Imaging

- The presence of any one of these criteria is considered “PECARN positive”, while the absence of all 7 is considered “PECARN negative”, which should effectively rule out the need for CT imaging.
  - This CDR was first prospectively evaluated by the PECARN network of pediatric emergency departments (ED) with good results (sensitivity of 97.0%, negative predictive value (NPV) of 99.9%)
  - It was subsequently retrospectively evaluated by a pediatric emergency department at a tertiary care center with ACS level 1 designation with similar findings.

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# Pediatric Imaging

- Study goal was to retrospectively apply the CDR in a community non-pediatric-specific emergency department with ACS level 1 verification who saw a fairly large volume of pediatric patients (~20% overall, 6.6% of all trauma activations).

7 year study period 1,953 traumatically injured pediatric patients identified 1,006 reviewed

Excluded penetrating injuries, isolated head injuries, and isolated extremity injuries with low likelihood of abdominal injury

212 patients (21%) had incomplete data to assess whether they were PECARN positive or negative, leaving 794 for analysis

Of those 794 remaining, 373 were PECARN positive, while 491 were PECARN negative. **PECARN negative patients' charts were then reviewed for potential missed intraabdominal injuries** requiring intervention (IAI-I), defined as undergoing therapeutic laparotomy, angiographic embolization due to intraabdominal injury, blood transfusion due to hemorrhage, IV fluids for 2 or more nights due to pancreatic or gastrointestinal injury, or death. This was identified by reviewing CT scans that were obtained at index assessment (since this was a retrospective review) or, if no CTs were obtained, by reviewing the chart for any subsequent ED visits.

Of these 421 PECARN negative patients, 2 had injuries necessitating intervention—one that required transfusion with a pelvic fracture that required orthopedic surgery, and another that required transfusion with a grade 2 liver injury and concomitant penetrating extremity wound with active bleeding that necessitated operative control. **The results in this study were roughly similar to prior studies, with a sensitivity of 91.3% and NPV of 99.5%.**

# Pediatric Imaging

- This study is limited by its retrospective nature and large number of patients with missing variables.
- Excluded patients were primarily low energy mechanisms, with falls as the mechanism for over half of all patients with missing variables.
- If a patient did not re-present to a particular ED within a week they could have visited a different ED for a missed injury, but this was the best way to assess in a retrospective analysis.
- *Being PECARN positive may not mandate CT imaging, but can be used as a two-step process in conjunction with other CDRs, such as:*
  - presence of abnormal chest x-ray
  - hypotension
  - abnormal exam
  - elevated liver or pancreatic enzymes
  - decreased hematocrit, or microhematuria
- Overall, this study validates PECARN CDR for assessment in community EDs that do not specialize in pediatric care but meet these standards.



# Topic: Prehospital Pediatric Transfusion and Mortality

- Association of Prehospital Transfusion With Mortality in Pediatric Trauma. Morgan KM, Abou-Khalil E, Strotmeyer S, Richardson WM, Gaines BA, Leeper CM. *JAMA Pediatr.* 2023 Jul 1;177(7):693-699.

Retrospective cohort study using the Pennsylvania Trauma Systems Foundation dataset (2009–2019) to determine if prehospital transfusion was associated with survival among bleeding children.

The study population were children aged 0 to 17 years old. The exposure was blood product transfusion in the prehospital setting (PHT) compared to the emergency department. The primary outcome was 24-hour mortality.



# Prehospital Pediatric Transfusion Mortality

- 559 children included in the final analysis, 70 received PHT (13%) over the 11-year study period.
- Children that received PHT were more likely to manifest shock (55% vs. 44%) due to blunt trauma (81% vs. 57%) and had longer prehospital time intervals. After 3:1 matching, the propensity score matched cohort included 207 children. After further risk-adjustment using logistic regression, PHT was associated with significantly lower odds of 24-hour mortality (OR 0.46; 95%CI 0.23-0.91). The NNT to reduce 24-hour mortality was estimated to be 6 children. The E-value, the effect size that a potential unmeasured confounder would need to have to explain these findings, was estimated to be 3.80.
- Important limitations to these findings stem mainly from the small sample size of children receiving PHT. This limited the ability to perform matching or risk-adjustment to account for the full array of variables that might confound the association between PHT and survival.

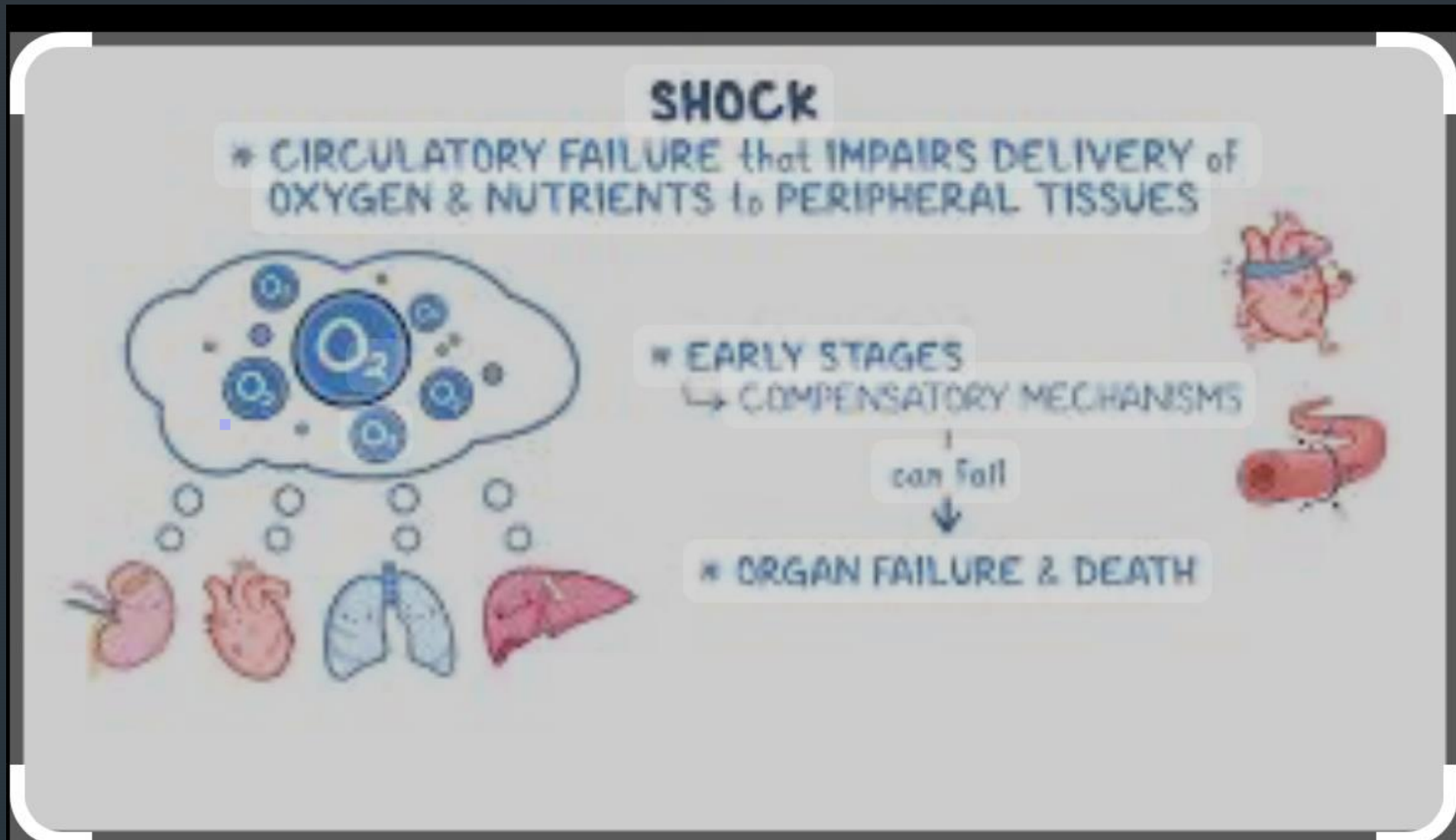


# ➤ Prehospital Pediatric Transfusion Mortality

## Conclusions:

- Other data pertaining to resuscitation such as crystalloid volumes, tranexamic acid use, or other hemostatic adjuncts could not be accounted for.
- It is also possible that injured children might have received treatment at facilities not contributing to the state-wide trauma registry
- Among children with bleeding due to trauma, early transfusion in the prehospital environment will be lifesaving. For this reason, there is need for a well-designed prospective multicenter study to evaluate prehospital transfusion as an intervention for injured kids.

# Topic: Pediatric Shock



# Pediatric Shock Consensus Conference

- Pediatric traumatic hemorrhagic shock consensus conference recommendations. Russell RT, Bembea MM, Borgman MA, Burd RS, Gaines BA, Jafri M, Josephson CD, Leeper CM, Leonard JC, Muszynski JA, Nicol KK, Nishijima DK, Stricker PA, Vogel AM, Wong TE, Spinella PC. *J Trauma Acute Care Surg*. 2023 Jan 1;94(1S Suppl 1):S2-S10.

16 interdisciplinary experts analyzed the literature in six domains, conducted a consensus meeting, and proposed 21 statements based on evidence, expert opinion, and good practice. Despite the paucity of pediatric-specific literature, the consensus panel's expertise and the synthesis of available data offer valuable insights.

The 6 domains covered: (1) use of tourniquets, (2) prehospital intubation and blood pressure management, (3) resuscitation and use of hemostatic monitoring, (4) blood products and fluid resuscitation for hemostatic resuscitation, (5) prehospital blood product use, and (6) use of tranexamic acid and other hemostatic adjuncts.

# Pediatric Shock Consensus

- Trained Individuals should use commercially available tourniquets for exsanguinating extremity hemorrhage. These children should be transported stat to an appropriate facility.
- Avoid permissive hypotension. The resuscitation goals should focus on optimal end-organ perfusion and oxygen delivery.
- Employ an initial empiric resuscitation with massive transfusion protocols and balanced blood product administration.
- Utilize a goal-directed resuscitation strategy to optimize hemostasis and correct coagulopathy post-initial resuscitation.
- When available, incorporate viscoelastic monitoring (VEM) as an adjunct tool.



# Pediatric Shock Consensus

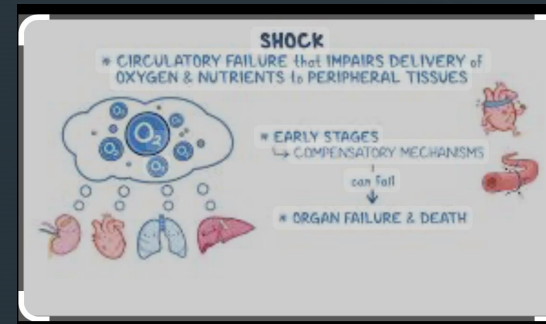
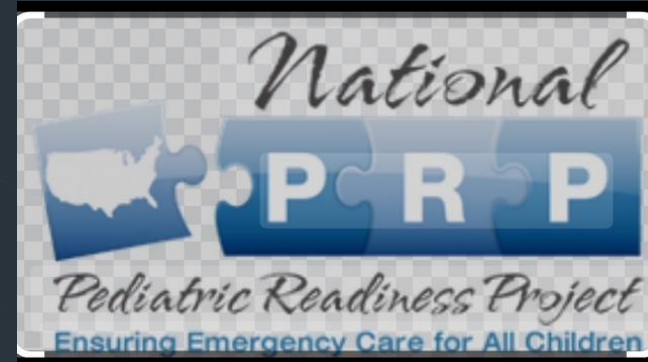
- Prioritize the use of blood products over crystalloids.
- Use low-titer (<200 immunoglobulin G) group O *whole blood* over individual blood components (RBC, plasma, platelets).
- Target high plasma/red blood cell ratios (1:1) to minimize the plasma deficit.
- Target high platelet-to-RBC weight-based-ratios (1:1) to minimize platelet deficit.
- Consider prehospital transfusion by out-of-hospital emergency medical service (EMS) based on product availability and clinical judgment.
- Consider *tranexamic acid* (TXA) empirically within 3 hours of injury.
- Consider TXA over aminocaproic acid as an antifibrinolytic agent.
- Limited evidence supports the empirical use of prothrombin complex concentrate, fibrinogen supplementation, or VEM) for antifibrinolytic therapy. Treat hypo-fibrinogenemia with fibrinogen replacement.



# Recap and Summary



- Review recent pertinent literature in the field of Pediatric Trauma
- Topics involved are:
  - Emergency Readiness
  - Appropriate Imaging
  - Shock and Resuscitation



# References

- EAST monthly literature review Sept 2023 'Pediatric Trauma' prepared by EAST Manuscript and Literature Committee Members Brian Yorkgitis, DO, FACS, Caleb Butts, MD, EAST Research - Scholarship Committee Member James Byrne, MD, PhD and EAST Member Ramitha Eshan Ruwanpathirana, MBBS
- [Pediatrictraumasociety.org](https://www.pediatrictraumasociety.org)
- JAMA
- JTACS



Questions?

