ISSUES IN THE MANAGEMENT OF PEDIATRIC TRAUMA

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GOALS

• Illustrate challenges and approaches to the initial management of pediatric trauma, especially in an environment not specifically focused on children.
• Describe a composite case from Harborview as an example.
• Discuss the role of the trauma system for pediatric patients and Harborview’s place in that system.

CASE

• 6 yo male, riding a bicycle un-helmeted.
• Crashed at unknown speed.
• Found by passer-by, confused but conscious and ambulating.
• Child vomited awaiting EMS.
CASE

- At Scene
  - HR 120  BP 100/-  RR 24  GCS 14
  - Abrasions R cheek, R flank. Slightly tender abdomen.
  - Backboard, c-collar.
  - 2 antecubital IVs with LR "wide open"

CASE

- In ED
  - T 36.9  HR 140  BP 95/42  RR 24  GCS 13
  - Sleepy but arousable – complains of abdominal pain and nausea.
  - Maintaining an airway.
  - Placed on oxygen by NRB.
  - Access is 2 antecubital IVs.

CASE

- In ED
  - T 36.9  HR 140  BP 95/42  RR 24  GCS 13
  - Physician calls for fluid bolus to address tachycardia.
  - Orders 20 cc/kg LR.
  - How much does this child weigh?
UNDERSTANDING SIZE IN PEDIATRIC CARE

• Most orders in children require accurate assessment of their size.
• Most trauma beds do not weigh critically ill patients.

CAN WE MAKE A GUESS?

-20 0 20 40

% variance

Actual vs. Estimated Weight
HMC Pediatric Admissions

COLOR CODED, LENGTH BASED RESCUITION SYSTEMS

• Recognize that length is a good proxy for size (for equipment) and weight (for resuscitation meds).
• But is it valid given the increasing prevalence of obesity?
COLOR CODED, LENGTH BASED RESUSCITATION SYSTEMS

- Estimated weights accurate (±10%) in 70% of children.
- Much more likely to underestimate than to overestimate size.
- But...
  - Ideal equipment size is not influenced by obesity.
  - Most resuscitation meds are ideally dosed on lean body mass.
  - Pattern in a resuscitation is: intervene - reassess - respond
  - Latest tapes updated with new NHANES data

COLOR CODED, LENGTH BASED RESUSCITATION SYSTEMS

- Not just a better way to estimate weight
- System removes reliance on weight estimation altogether
- Math-free algorithms:
  - Vitals
  - Dosing
  - Equipment
  - Allows critical thinking
  - Promotes transparency
  - Reduces error

CASE

- In ED
  - T 36.9  HR 140  BP 95/42  RR 24  GCS 13
  - Physician calls for fluid bolus to address tachycardia.
  - Orders 20 cc/kg LR.
  - Child is COLOR ZONE BLUE
  - Fluid bolus is 400 mL
CASE

- **In ED**
  - T 36.9 HR 140 BP 105/42 RR 24 GCS 13

- **Labs**
  - Hct 31%
  - INR 1.7
  - AST 445 ALT 357
  - UA ~

- What about imaging?

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CASE

- In ED

- Does he need a CT?
  - Of his head?
  - Of his abdomen?

CANCER RISK IN 680,000 PEOPLE EXPOSED TO COMPUTED TOMOGRAPHY SCANS IN CHILDHOOD OR ADOLESCENCE: DATA LINKAGE STUDY OF 11 MILLION AUSTRALIANS

- Minimize radiation dose by using pediatric specific protocols.
- Use clinical judgment to avoid unneeded scans.
- Minimize repeat scanning.
Mean number of CT examinations per patient per year at HMC

Abdomen

Chest

Roudsari B et al. Radiology 2013;267:479-486

CLINICAL DECISION RULES

• Balance the immediate need for clinically relevant information against the long term goal to reduce exposure to cancer-causing radiation.
• Developed and validated on large populations of children similar to those treated at our institution.
CASE

• In ED
  • T34.9  HR 150  BP 100/42  RR 24  GCS 13
  • Fluid boluses repeated x 2
  • Decision to defer head CT until hemodynamically stable.
  • Sent to CT scanner for abdominal imaging.

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CASE

- In ED
- T34.9  HR 150  BP 100/42  RR 24  GCS 13
- Fluid blouses repeated x 3
- Decision to defer head CT until hemodynamically stable.
- Sent to CT scanner for abdominal imaging.

HEMODYNAMIC RESPONSE TO HEMORRHAGIC SHOCK

% blood volume lost vs HR and SBP

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FAST IN CHILDREN

- Should this child have focused abdominal sonography in trauma (FAST)?

Pediatric FAST is very specific for hemoperitoneum (83% to 98.3%), but sensitivity is generally poor.
- For example, if pre-test probability is 6% and FAST is positive, the posttest probability rises to 48%. A negative FAST lowers the probability to 3%.
- A positive FAST scan suggests hemoperitoneum and abdominal injury, while a negative FAST scan aids little in decision-making.
Case: To CT Scanner
- T: 34.9  HR: 155  BP: 100/42  RR: 24  GCS: 13
- IV dislodges during imaging.
  - Resulting images are essentially without contrast.
  - BP drops without continued fluid infusion.

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Case: To OR
- T: 34.9  HR: 170  BP: 65/42  RR: 24  GCS: 13
- New labs:
  - Hct: 24%
  - INR: 2.5
  - Base Deficit: 8.5
- What is this child’s risk of mortality now?

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RISK OF TRAUMA MORTALITY: PEDIATRIC BIG SCORE

CASE

• To OR
• T 34.9 HR 170 BP 65/42 RR 24 GCS 13
• What about more fluids?

MANAGEMENT OF UNSTABLE PATIENTS WITH UNCONTROLLED HEMORRHAGE

• This child has already had 60 mL/kg crystalloid plus ~20 mL/kg in pre-hospital setting.
• Blood volume is a child this size is ~70 mL/kg.
• Blood products are ordered and a pediatric massive transfusion protocol activated.
Meticulous Fluid Management

- Account for all fluids given.
- Convert to mL/kg for interpretation.
- Another use for length based color coding to ease calculations.

Harborview Medical Center
Pediatric Massive Transfusion Protocol

* UNCONTROLLED & UNDIAGNOSED HEMORRHAGE *

Stable Tachycardia Hemodynamic Instability

Estimated Blood Loss

- < 20 mL/kg
- 20 mL/kg
- 40 mL/kg
- 80 mL/kg
- Each additional 80 mL/kg

Crystalloid

Blood Products

- PRBC 30 mL/kg
- FFP 30 mL/kg
- PLTs 5 mL/kg
- Cryo 4 mL/kg

Massive Transfusion Pack

- 6 PRBC
- 4 FFP
- 1 apheresis PLT
- 1 cryoprecipitate

To activate pediatric massive transfusion protocol: call 744.3088

Obtain labs (EHP, K+, Ca2+, ABG, lactate) q 20 mins

Aim for 1:1 (PRBC:plasma) ratio

Platelets to keep PLT >100K; Cryoprecipitate to keep fibrinogen >150 mg/dL

Aggressively manage: body temperature, serum Ca, K, and pH.

Pediatric patient > 40 kg: treat as adult. Transfuse 1:1:1

Deactivate protocol if hemorrhage controlled AND hemodynamically stable.


Reduce crystalloid to maintenance (D5). NS may activate MTP before crystalloid.
CASE

To OR

• T 34.9  HR 145  BP 105/75  RR 24  GCS 13

• New labs:
  • Hct 24 %
  • INR 2.5
  • Base Deficit 8.5

• Why is the INR so high?

COAGULOPATHY IN TRAUMA

• “Dilution”- difficult to demonstrate in the lab
• Hypothermia
• Consumption

• Acute Coagulopathy of Trauma
  • Hypoperfusion of tissue beds
  • Local consumption of clotting factors
  • Hyperfibrinolysis

TRANEXAMIC ACID IN PEDIATRIC TRAUMA

• Tranexamic acid (TXA) is an antifibrinolytic agent.
• CRASH-2 trial showed that administering TXA within 3 hours of trauma reduces the risk of death in bleeding adult trauma patients.

• No data for use in pediatric trauma.
TRANEXAMIC ACID IN PEDIATRIC TRAUMA

- However, experience suggests TXA yields significant reductions in total blood loss and total blood or blood product transfusion volume
  - In pediatric cardiac surgery
  - In surgical correction of craniosynostosis in children
- Good safety profile in these circumstances.
- Expect pediatric trauma protocols to emerge.

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CASE - CONCLUSION

- In OR
  - Shattered R lobe of liver.
  - Damage control resuscitation.
  - Liver packed; abdomen left open.
  - To angiography for embolization of bleeding hepatic arteries.
  - Aggressive resuscitation in the PICU
  - Multiple returns to the OR.

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TAKE HOME POINTS FOR NON-SURGEONS

- Use length based resuscitation aids to increase safety and efficiency of pediatric care.
- Image thoughtfully – use clinical decision rules to help.
- FAST is useful when it is positive.
- Understand the pediatric response to exsanguinating hemorrhage.
- Track fluids from all settings, and move early to blood product administration in uncontrolled bleeding.

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JUST ONE CASE …

• Why do kids come to Harborview at all?
• And does it make sense to have a pediatric and adult trauma center co-located?

TRAUMA SYSTEMS SAVE LIVES

• Integrated trauma systems have been demonstrated repeatedly to be effective.
• One of the most important advances in the care of the injured patient over the last 30 years.
• Most benefit seen for patients who are younger and more severely injured.
• Premise underlying regionalization of care is that larger volumes of trauma patients cared for in fewer institutions will lead to improved outcomes.

Relative odds of death, by trauma center volume, compared to lowest volume centers:

Patients with coma -

Patients with shock -

Washington's Pediatric Trauma System

Level 1
- Harborview Medical Center

Level 2
- Mary Bridge Children's Hospital
- Sacred Heart Children's Hospital

Level 3
- St. Joseph Regional
- Providence Regional Medical Center
- Central Washington Hospital
- Kennewick General Hospital
- Providence St. Mary Medical Center
- Yakima Valley Trauma Service

Pediatric Rehab
- Seattle Children's Hospital Seattle

SITE OF DEFINITIVE CARE: MAJOR (ISS 16+) PEDS TRAUMA PATIENTS
(DOH CRITERIA, ADMITTED PATIENTS ONLY)

Injury Severity Score
HMC Pediatric Burn & Trauma 2012

Only about 150/year with ISS > 16
Given the established relationship between trauma volumes & outcome ....

Threshold for benefit ~ 650 cases annually

... there is not enough major pediatric trauma in the state to reach this threshold.

Children need to be accommodated at the adult trauma center to benefit from our volume and experience.
THANK YOU!

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