PEDIATRIC TRAUMA CARE
A clinical reference for physicians and nurses caring for the acutely injured child
VOLUME III

An Updated Guide to Meeting Yearly Pediatric Trauma CME/CNE Requirements

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This activity has been approved for 17.5 nursing contact hours using a 60-minute contact hour.

ACTIVITY OBJECTIVES
After reading Pediatric Trauma Care: A Clinical Reference for Physicians and Nurses Caring for the Acutely Injured Child, Volume III, the participant will be able to:

1. Discuss conditions that should increase suspicion for traumatic injuries in pediatric patients.
2. Describe the various modalities used to identify different traumatic conditions.
3. Cite methods of quickly stabilizing and managing pediatric patients.
4. Identify possible complications that may occur with traumatic injuries in children.

Physicians and nurses participate in this CME/CNE activity by reading the articles, using the provided references for further research, and studying the relevant questions at the end of the book. Participants will then be directed to a website, where they will complete an online assessment to show what they’ve learned. They must score 100 on the assessment in order to complete the activity, but they are allowed to answer the questions multiple times if needed. After they have successfully completed the assessment, they will be directed to an online activity evaluation form. Once that is submitted, they will receive their credit letter.

TARGET AUDIENCE
This activity is intended for trauma physicians, trauma nurses, emergency department physicians, and emergency department nurses.

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PHYSICIAN EDITOR
Ann Dietrich, MD, FAAP, FACEP
Associate Professor of Primary Care-Lead
Ohio University Heritage College of Medicine, Athens, OH
Associate Pediatric Medical Director, MedFlight
Medical Director of Education, Ohio Chapter ACEP, Columbus
PHYSICIAN PEER REVIEWER
Taryn Taylor, MD, FAAP, FACEP
Assistant Professor of Pediatrics and Emergency Medicine
Emory University School of Medicine, Atlanta, Georgia

NURSE PLANNER
Lee Ann Wurster, RN, MS, CPNP
Patient Care Manager/Trauma Nurse Leader
Emergency Department, Nationwide Children’s Hospital, Columbus, Ohio

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Authors
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Module 2: Pediatric Advances and Controversies with Pediatric Major Trauma (2.5 credit hours)
**BATIC Score**

The Blunt Abdominal Trauma in Children (BATIC) score uses readily available lab values, Doppler ultrasound results, and physical exam findings to assess trauma patients without the use of imaging requiring radiation. The score combines the results of abdominal Doppler ultrasound with three physical exam findings (abdominal pain, peritoneal irritation, and hemodynamic instability) and six laboratory values (AST, ALT, WBC, LDH, lipase, and creatinine).[^57]

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### Table 6. Duodenum Injury Scale

<table>
<thead>
<tr>
<th>Grade*</th>
<th>Injury Type</th>
<th>Description of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma</td>
<td>Involving single portion of duodenum</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Partial thickness, no perforation</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>Involving more than one portion</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Disruption &lt; 50% of circumference</td>
</tr>
<tr>
<td>III</td>
<td>Laceration</td>
<td>Disruption 50%-75% of circumference of D2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disruption 50%-100% of circumference of D1, D3, D4</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Disruption &gt; 75% of circumference of D2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Involving ampulla or distal common bile duct</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Massive disruption of duodenopancreatic complex</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Devascularization of duodenum</td>
</tr>
</tbody>
</table>

*Advance one grade for multiple injuries up to grade III. D1-first position of duodenum; D2-second portion of duodenum; D3-third portion of duodenum; D4-fourth portion of duodenum


### Table 7. Pancreas Injury Scale

<table>
<thead>
<tr>
<th>Grade*</th>
<th>Injury Type</th>
<th>Description of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma</td>
<td>Minor contusion without duct injury</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Superficial laceration without duct injury</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>Major contusion without duct injury or tissue loss</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Major laceration without duct injury or tissue loss</td>
</tr>
<tr>
<td>III</td>
<td>Laceration</td>
<td>Distal transection or parenchymal injury with duct injury</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Proximal** transection or parenchymal injury involving ampulla</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Massive disruption of pancreatic head</td>
</tr>
</tbody>
</table>

*Advance one grade for multiple injuries up to grade III.

**Proximal pancreas is to the patients’ right of the superior mesenteric vein.


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The Blunt Abdominal Trauma in Children (BATIC) score assigns points as follows:

- 4 points for an abnormal Doppler evaluation of the renal arteries on abdominal ultrasound
- 2 points each for abdominal pain, signs of peritoneal irritation on physical exam, hemodynamic instability, AST > 60 IU/L, and ALT > 25 IU/L
- 1 point each for peripheral white blood cell count > 9.5 g/L, lactate dehydrogenase > 330 IU/L, lipase > 30 IU/L, and creatinine > 50 µg/L

A BATIC score cutoff of > 6 (out of a possible...
score of 18) resulted in a sensitivity of 100% and specificity of 87% for IAI. A cutoff of 7 resulted in a sensitivity of 89% and a specificity of 94%. Using cutoffs of 6 and 7 could have avoided 47% and 56%, respectively, of the 34 CT scans performed.

Willem-Jan et al studied the validity of the BATiC score on 216 trauma patients minus Doppler ultrasound and found that it had a 99% negative predictive value, and, therefore, could be used to reliably rule out IAI. They did suggest that a positive score should lead to subsequent CT scan. The use of the BATiC score could help reduce the amount of unnecessary CT scans, reducing radiation exposure as well as cost.

Focused Assessment with Sonography in Trauma (FAST) remains an item of contention in pediatric trauma. Some authors advocate not to use it at all. In part, this likely stems from its inability to identify abdominal parenchymal injury when used in its simplest B-mode implementation. However, the addition of Doppler ultrasound — preferably power Doppler, which is more sensitive for any flow, vs color Doppler, whose directionality is unneeded under investigation and termed c-FAST (for color), vs the more accurate but socially unacceptable alternative acronym for using recommended power Doppler (p-FAST) — will permit identification of solid organ injuries not visualized by B-mode and not accompanied by free fluid. Power Doppler highlights parenchymal injuries via deformation of vascular arcades by relatively isoechoic intraparenchymal hematomas, absence of typical regional parenchymal vascularity (ultrasonographic Westermark sign), and linear truncation of parenchymal vascular arcades — with administration of ultrasound contrast likely to improve sensitivity even further. (See Figures 1, 2, and 3.) There are two commercially available ultrasound agents in the United States and three in Europe. Their usable half-life is about 5 minutes and they can only be re-dosed once, hence limiting patient re-evaluation, but they do facilitate parenchymal injury detection. Power Doppler viewing is best utilized by obtaining a “hilar” long axis view of the organ in question and fanning through the organ.
using a single window when feasible. Given the confounding problem of aerophagia in children, low intercostal views are preferred vs abdominal views when scanning intra-abdominal organs. The liver is more complex to scan given its size, lack of a simple hilum, and “non-bean” morphology. By identifying vascular structures in the liver, such as hepatic veins’ origination from inferior vena cava and/or portal vein and tracing branches out to the periphery, the entire territory of the liver can be covered in an organized fashion and the power Doppler utility fully leveraged. The reliability of these techniques in children by nonradiologists vs CT scan has yet to be established. Neither Karam nor Willem-Jan indicated that they looked for free air, highly diagnostic for perforated hollow viscus, or that they detected it in perforated hollow viscus cases, implying that it was not screened for. Intra-abdominal free air is easily detected on ultrasound with suprahepatic-subdiaphragmatic free air (the most common location) easily seen when viewing Morison’s pouch. As such, ultrasound offers the ability to screen for free air long before the onset of peritonitis. Visualization of the pancreas is problematic given the prevalence of pediatric aerophagia and lack of suitability of intercostal windows.

CONCLUSION

With the advent of child safety devices and practices, the incidence of serious pediatric trauma, in the youngest, most difficult to treat age groups, has declined. In addition, Broselow tapes and advances in airway and vascular access have improved the ability of providers to stabilize a child’s vital functions rapidly and effectively.

Nonoperative management for BAT remains dominant, with even fewer operative procedures necessary with advancements in interventional radiological procedures. Reserving the utilization of CT scanning for those in whom the risk-benefit ratio exceeds future cancer risk is critical. Advances in ultrasound may enable clinicians to further decrease CT scanning rates, while maintaining diagnostic accuracy.

REFERENCES

11. Ho AMH, Aun CST, Karmakar MK. The margin of safety associated with the use of cuffed pediatric tracheal tubes.

Figure 3. Patient Showing No Obvious Splenic Fracture

Patient from Figure 1 showing no obvious splenic fracture. However, medial aspect of spleen is devascularized suggesting presence of fracture seen on CT.
CME Questions

MODULE 2: PEDIATRIC ADVANCES AND CONTROVERSIES WITH PEDIATRIC MAJOR TRAUMA

1. Which of the following can lead to a dangerous loss of perfusion in a pediatric trauma patient?
   A. Supine positioning
   B. Medications that lower heart rate
   C. Endotracheal intubation
   D. IV fluids

2. What is the most commonly injured organ after blunt abdominal trauma?
   A. Liver
   B. Spleen
   C. Kidney
   D. Bowel

3. How do you determine hypotension in a pediatric patient?
   A. It is the same as an adult
   B. SBP < 70 mmHg
   C. SBP < 70 mmHg + 2 times the age in years
   D. Evidence of end organ dysfunction

4. In which of the following scenarios is surgery absolutely required?
   A. Grade V liver laceration
   B. Positive seat belt sign and heart rate of 120
   C. Evidence of intestinal perforation
   D. Tibia fracture

5. The ultrasound feature best suited for detecting blood flow is:
   A. M-mode.
   B. B-mode.
   C. Com-mode.
   D. Power Doppler.

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