RESUSCITATION IN PEDIATRICS AFTER TRAUMA AND BURN INJURY

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Ukraine/ Mayo Webinars

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OBJECTIVES

Initial Resuscitation and Management

- Describe anatomic, physiologic, and treatment strategies for pediatric patients with trauma
- Recognize and apply the ABCDE approach
- Define management of the injured or burned pediatric patient after the initial resuscitation.
- Recognize child-, family-, and society-specific risk factors associated with pediatric trauma
OBJECTIVES

Describe anatomic, physiologic, and treatment strategies for pediatric patients with trauma
STEP 1
Make sure the scene is safe.
Check to see if the person is awake and breathing normally.

STEP 2
Shout for help.
If you’re alone
- With a cell phone, phone 9-1-1, perform CPR (30 compressions and then 2 breaths) for 5 cycles, and then get an AED
- Without a cell phone, perform CPR (30 compressions and then 2 breaths) for 5 cycles, and then phone 9-1-1 and get an AED

If help is available, phone 9-1-1. Start CPR while you send someone to get an AED.

STEP 3
Repeat cycles of 30 compressions and then 2 breaths.
- Child CPR
  Push in the middle of the chest at least one third the chest depth or approximately 2 inches with 1 or 2 hands.

- Infant CPR
  Push in the middle of the chest at least one third the chest depth or approximately 1½ inches with 2 fingers.

Use the AED as soon as it arrives.
Continue CPR until EMS arrives.
Pediatric Basic Life Support

Single rescuer

- Check for responsiveness.
- Shout for nearby help.
- Activate the emergency response system via mobile device (if appropriate).

Look for no breathing or only gasping and check pulse (simultaneously). Is pulse definitely felt within 10 seconds?

- Normal breathing, pulse felt.
  - Monitor until emergency responders arrive.

- No normal breathing, no pulse felt.
  - Check for gasping.

Braden score of less than 15 with signs of poor perfusion?

- Yes
  - Provide rescue breathing, 1 breath every 2-3 seconds, or about 20-30 breaths/min.
  - Assess pulse rate for no more than 10 seconds.

- No
  - Continue rescue breathing, check pulse every 2 minutes.
  - If no pulse, start CPR.

Witnessed sudden collapse?

- Yes
  - Activate emergency response system (if not already done), and retrieve AED/defibrillator.

- No

Start CPR:
  - 1 rescuer: Performs cycles of 30 compressions and 2 breaths.
  - When second rescuer arrives, perform cycles of 15 compressions and 2 breaths.
  - Use AED as soon as it is available.

After about 2 minutes, if still alone, activate emergency response system and retrieve AED (if not already done).

Check rhythm. Shockable rhythm?

- Yes, shockable
  - Give 1 shock. Resume CPR immediately for 2 minutes (or until prompted by AED) to allow rhythm check.
  - Continue until ALS provider takes over or the child starts to move.

- No, nonshockable
  - Resume CPR immediately for 2 minutes (until prompted by AED to allow rhythm check).
  - Continue until ALS provider takes over or the child starts to move.

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### Components of Post-Cardiac Arrest Care

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oxygenation and ventilation</strong></td>
<td>Measure oxygenation and target normoxemia 94%-96% (or child's normal/appropriate oxygen saturation).</td>
</tr>
<tr>
<td></td>
<td>Measure and target Paco, appropriate to the patient's underlying condition and limit exposure to severe hypercapnia or hypopcapnia.</td>
</tr>
<tr>
<td><strong>Hemodynamic monitoring</strong></td>
<td>Set specific hemodynamic goals during post-cardiac arrest care and review daily.</td>
</tr>
<tr>
<td></td>
<td>Monitor with cardiac telemetry.</td>
</tr>
<tr>
<td></td>
<td>Monitor arterial blood pressure.</td>
</tr>
<tr>
<td></td>
<td>Monitor serum lactate, urine output, and central venous oxygen saturation to help guide therapies.</td>
</tr>
<tr>
<td></td>
<td>Use parenteral fluid bolus with or without inotropes or vasopressors to maintain a systolic blood pressure greater than the fifth percentile for age and sex.</td>
</tr>
<tr>
<td><strong>Targeted temperature management (TTM)</strong></td>
<td>Measure and continuously monitor core temperature.</td>
</tr>
<tr>
<td></td>
<td>Prevent and treat fever immediately after arrest and during rewarming.</td>
</tr>
<tr>
<td></td>
<td>If patient is comatose apply TTM (32°C-34°C) followed by (36°C-37.5°C) or only TTM (36°C-37.5°C).</td>
</tr>
<tr>
<td></td>
<td>Prevent shivering.</td>
</tr>
<tr>
<td></td>
<td>Monitor blood pressure and treat hypotension during rewarming.</td>
</tr>
<tr>
<td><strong>Neuromonitoring</strong></td>
<td>If patient has encephalopathy and resources are available, monitor with continuous electroencephalogram.</td>
</tr>
<tr>
<td></td>
<td>Treat seizures.</td>
</tr>
<tr>
<td></td>
<td>Consider early brain imaging to diagnose treatable causes of cardiac arrest.</td>
</tr>
<tr>
<td><strong>Electrolytes and glucose</strong></td>
<td>Measure blood glucose and avoid hypoglycemia.</td>
</tr>
<tr>
<td></td>
<td>Maintain electrolytes within normal ranges to avoid possible life-threatening arrhythmias.</td>
</tr>
<tr>
<td><strong>Sedation</strong></td>
<td>Treat with sedatives and anxiolytics.</td>
</tr>
<tr>
<td><strong>Prognosis</strong></td>
<td>Always consider multiple modalities (clinical and other) over any single predictive factor.</td>
</tr>
<tr>
<td></td>
<td>Remember that assessments may be modified by TTM or induced hypothermia.</td>
</tr>
<tr>
<td></td>
<td>Consider electroencephalogram in conjunction with other factors within the first 7 days after cardiac arrest.</td>
</tr>
<tr>
<td></td>
<td>Consider neuroimaging such as magnetic resonance imaging during the first 7 days.</td>
</tr>
</tbody>
</table>
Neonatal Resuscitation Algorithm

1 min

Antenatal counseling
Team briefing and equipment check

Birth

Term gestation? Good tone? Breathing or crying?
Yes

Infant stays with mother for routine care: warm and maintain normal temperature, position airway, clear secretions if needed, dry. Ongoing evaluation

No

Warm and maintain normal temperature, position airway, clear secretions if needed, dry. Ongoing evaluation

Aprea or gasping? HR below 100/min?
Yes

PPV SpO₂ monitor Consider ECG monitor

No

Apnea or gasping? HR below 100/min?

No

Labored breathing or persistent cyanosis?
Yes

Position and clear airway SpO₂ monitor Supplementary O₂ as needed Consider CPAP

No

Postresuscitation care Team debriefing

HR below 100/min?
Yes

Targeted Procedural SpO₂, After Birth

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>SpO₂ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 min</td>
<td>60%–65%</td>
</tr>
<tr>
<td>2 min</td>
<td>65%–70%</td>
</tr>
<tr>
<td>3 min</td>
<td>70%–75%</td>
</tr>
<tr>
<td>4 min</td>
<td>75%–80%</td>
</tr>
<tr>
<td>5 min</td>
<td>80%–85%</td>
</tr>
<tr>
<td>10 min</td>
<td>85%–95%</td>
</tr>
</tbody>
</table>

Check chest movement Ventilation corrective steps if needed ETT or laryngeal mask if needed

No

HR below 60/min?
Yes

Intubate if not already done Chest compressions Coordinated with PPV 100% O₂ ECG monitor Consider emergency UVC

No

HR below 60/min?

Yes

IV epinephrine If HR persistently below 60/min Consider hypovolemia Consider prematurity
OBJECTIVES

Recognize and apply the ABCDE approach
Trauma Activation Criteria: Level 1 or level 2
ACRONYMS

- **ABCDE**: Airway, Breathing, Circulation, Disability, Environment

- **MARCH**: Massive hemorrhage, Airway, Respirations, Circulation, Head injury/Hypothermia is an acronym used by TCCC-trained individuals to help remember the proper order of treatment.
  

- **PAWS**: Pain, Antibiotics, Wounds, Splinting is an acronym used by TCCC trained individuals to help remember additional casualty care issues
**Tactical Training**

### Tactical Field Care

- **Scene is secure, triage in the casualty collection point, disperse casualties with altered mental status**
  - **YES**: Apply deliberate CoTCCC-approved vented chest seal.
  - **NO**: Consider pneumothorax. Decompress at the mid-clavicular line.

- **Respirations**
  - **YES**: Torso trauma?
  - **NO**: Respiratory distress?

- **Massive Hemorrhage**
  - Untreated limb hemorrhage?
  - **YES**: Deliberate tourniquets are 2 to 3 inches above the wound on skin.
  - **NO**: Untreated junctional hemorrhage?
    - **YES**: Junctional areas are the axilla and groin.
    - **NO**: Uncontrolled abdominal or pelvic hemorrhage?
      - **YES**: Pack abdomen/pelvis with a hemostatic agent.
      - **NO**: Airway obstruction?

- **Airway**
  - **YES**: Surgical cricothyotomy?
  - **NO**: Endotracheal intubation?

- **Circulation**
  - **YES**: Blood transfusion anticipated?
  - **NO**: Fluid resuscitation required (preferred order).

- **Hemorrhagic shock**
  - **YES**: Hemorrhagic shock?
  - **NO**: Document Military Acute Concussion Evaluation (MACE) exam.
  - **NO**: Look/Feel for equal rise and fall of the chest wall.

- **Respiratory distress**
  - **YES**: Consider chest tube.
  - **NO**: Provide supplemental oxygen.

- **YES**: Vital traumatic brain injury or severe traumatic brain injury suspected?

- **YES**: Massive hemorrhage?

### Tactical Field Care (Continued)

- **RESPIRATIONS**
  - **YES**: Torso trauma?
  - **NO**: Respiratory distress?

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  - **NO**: Look/Feel for equal rise and fall of the chest wall.

### Care Under Fire

- Direct casualty to minor fire cover, return fire, and apply self-aid.
  - **YES**: Casualty conscious?
    - **YES**: Move casualty to cover.
    - **NO**: Move casualty to cover.
  - **NO**: Life-Threatening Bleeding:
    - Arterial bleed, spurring blood, complete or partial amputation, blood-soaking uniform.
      - **YES**: Apply CoTCCC-approved limb tourniquet.
      - **NO**: Continue mission.

- Massive Hemorrhage
  - **YES**: Tourniquet?
    - **YES**: Apply CoTCCC-approved hemostatic agent.
    - **NO**: Apply CoTCCC-approved pelvic splint.
  - **NO**: Apply CoTCCC-approved pelvic splint.

- Tactical Field Care

### Tactical Training

- CoTCCC-approved limb tourniquet "high and tight."

- Move casualty to casualty collection point for tactical field care.

- TCCC Medical Provider: Trained

- TCCC Medical Provider: Trained

- TCCC Medical Provider: Trained

- TCCC Medical Provider: Trained

- TCCC Medical Provider: Trained
MIST Report

- Mechanism
- Injuries
- Symptoms
- Treatment
<table>
<thead>
<tr>
<th>Primary Survey</th>
<th>Exam</th>
<th>Negative findings</th>
<th>Positive findings</th>
<th>Life-threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catastrophic Hemorrhage</td>
<td>Identify and control active exanguination. Mark GSW, call out each wound</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airway (w/ cervical immobilization)</td>
<td>Patency: Look, crying, hoarseness</td>
<td>Airway patent</td>
<td>Airway intubated</td>
<td>Critical &amp; difficult airway</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C-spine immobilized</td>
<td>Obstructed</td>
<td></td>
</tr>
<tr>
<td>Breathing</td>
<td>Inspect &amp; auscultate: bilateral breath sounds</td>
<td>Breath sounds equal</td>
<td>Breath sounds decreased on one side</td>
<td>Tension pneumothorax</td>
</tr>
<tr>
<td></td>
<td>Jugular distention</td>
<td>Trachea midline</td>
<td>Chest wall movement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Saturation</td>
<td></td>
<td>WOB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ETCO₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circulation</td>
<td>Inspect &amp; Palpate</td>
<td>Normal pulses</td>
<td>Fem pulses unequal</td>
<td>Hemorrhagic shock</td>
</tr>
<tr>
<td></td>
<td>Central pulses-femoral</td>
<td>Cap refill &lt; 2 sec</td>
<td>Tachycardia</td>
<td>Massive hemothorax</td>
</tr>
<tr>
<td></td>
<td>Heart rate, BP, rhythm</td>
<td>IV gauge: location or IO</td>
<td>Bradycardia</td>
<td>Cardiac tamponade</td>
</tr>
<tr>
<td></td>
<td>Active bleeding</td>
<td></td>
<td>Cap refill &gt; 3 sec</td>
<td>Blunt trauma</td>
</tr>
<tr>
<td></td>
<td>Hypoxia</td>
<td></td>
<td>Distal extremities cold/pale</td>
<td>Penetrating</td>
</tr>
<tr>
<td></td>
<td>Vascular access</td>
<td></td>
<td>No vascular access</td>
<td>Pelvic fracture</td>
</tr>
<tr>
<td>Disability</td>
<td>Glasgow</td>
<td>Alert</td>
<td>Depressed</td>
<td>Severe TBI</td>
</tr>
<tr>
<td></td>
<td>Pupillary size</td>
<td>GCS 15</td>
<td>GSC &lt; 15</td>
<td>Intracranial injury</td>
</tr>
<tr>
<td></td>
<td>Glucose</td>
<td>Pupils equal</td>
<td>Unequal pupils</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moves all 4 extremities</td>
<td>Pt not moving</td>
<td>Spinal shock</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ext weak</td>
<td></td>
</tr>
<tr>
<td>Exposure</td>
<td>Remove clothing</td>
<td>Normothermic</td>
<td>Deformities, no pulses</td>
<td>Hypothermia</td>
</tr>
<tr>
<td></td>
<td>Temperature</td>
<td></td>
<td></td>
<td>Toxins</td>
</tr>
<tr>
<td>Log roll</td>
<td>After Survey</td>
<td>No cervical tenderness</td>
<td>Midline tenderness</td>
<td>Spinal cord injury</td>
</tr>
<tr>
<td></td>
<td>Palpate spine</td>
<td></td>
<td>Urethral/penile, perineum</td>
<td></td>
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</tr>
</tbody>
</table>
## Secondary Survey

<table>
<thead>
<tr>
<th>History</th>
<th>Adjuncts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Allergies</td>
<td>C-spine, CXR, pelvis, CT scan as needed, lab Studies, OG/NG, Foley</td>
</tr>
<tr>
<td><strong>M</strong> Medication used</td>
<td></td>
</tr>
<tr>
<td><strong>P</strong> Past illness, pregnancy</td>
<td></td>
</tr>
<tr>
<td><strong>L</strong> Last meal</td>
<td></td>
</tr>
<tr>
<td><strong>E</strong> Events/Environment related to injury</td>
<td></td>
</tr>
</tbody>
</table>

### Exam
- **Negative/Normal**
- **Positive findings**

<table>
<thead>
<tr>
<th>Head, Maxillofacial, ENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head: wounds, skull tenderness</td>
</tr>
<tr>
<td>Eyes: hemorrhage, hyphema</td>
</tr>
<tr>
<td>Ears: Signs of basilar skull fx, Battle sign</td>
</tr>
<tr>
<td>CSF leak</td>
</tr>
<tr>
<td>Teeth</td>
</tr>
<tr>
<td>Maxilla/Mandible</td>
</tr>
<tr>
<td>No visible wounds, hematoma, step-off</td>
</tr>
<tr>
<td>No midface instability</td>
</tr>
<tr>
<td>Eyes w/o trauma</td>
</tr>
<tr>
<td>No hemotympanum</td>
</tr>
<tr>
<td>Nares clear</td>
</tr>
<tr>
<td>Oropharynx clear</td>
</tr>
<tr>
<td>Teeth not loose</td>
</tr>
<tr>
<td>Step-off, Midface instability, Unequal pupils</td>
</tr>
<tr>
<td>Hyphema</td>
</tr>
<tr>
<td>Periorbital contusion</td>
</tr>
<tr>
<td>Hemotympanum</td>
</tr>
<tr>
<td>CSF drainage</td>
</tr>
<tr>
<td>Trismus</td>
</tr>
<tr>
<td>Incisors loose</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C-spine &amp; neck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect and palpate</td>
</tr>
<tr>
<td>Subcutaneous emphysema</td>
</tr>
<tr>
<td>Neck supple, no pain</td>
</tr>
<tr>
<td>No step-offs or wounds</td>
</tr>
<tr>
<td>No subcutaneous emphysema</td>
</tr>
<tr>
<td>Trachea deviated</td>
</tr>
<tr>
<td>C-spine with tenderness</td>
</tr>
<tr>
<td>Distended neck veins, Pulsating hematomas</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect, auscultate, palpate</td>
</tr>
<tr>
<td>Chest wall: stable</td>
</tr>
<tr>
<td>Breath sounds equal</td>
</tr>
<tr>
<td>No tachypnea or labored breathing</td>
</tr>
<tr>
<td>Abrasions</td>
</tr>
<tr>
<td>Breath sounds decreased</td>
</tr>
<tr>
<td>Abn. Movement chest</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abdomen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect, auscultate, palpate</td>
</tr>
<tr>
<td>Abdomen soft</td>
</tr>
<tr>
<td>Normal bowel sounds</td>
</tr>
<tr>
<td>Abdomen rigid/firm, distended, tender</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pelvis Perineum, rectum, vagina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect and palpate</td>
</tr>
<tr>
<td>Digital rectal exam to evaluate tone</td>
</tr>
<tr>
<td>if spinal cord injury</td>
</tr>
<tr>
<td>Perineum clear</td>
</tr>
<tr>
<td>Pelvis stable</td>
</tr>
<tr>
<td>Unstable pelvis,</td>
</tr>
<tr>
<td>Tenderenss</td>
</tr>
<tr>
<td>Abrasion, puncture</td>
</tr>
<tr>
<td>Blood at</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Musculoskeletal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect and palpate</td>
</tr>
<tr>
<td>Upper/lower extremities without tenderness. Pulses</td>
</tr>
<tr>
<td>Deformities, Absent pulses</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neurologic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluate cranial nerves</td>
</tr>
<tr>
<td>Strength &amp; sensation</td>
</tr>
<tr>
<td>GCS 15</td>
</tr>
<tr>
<td>Cranial nerve normal</td>
</tr>
<tr>
<td>Altered mental status</td>
</tr>
<tr>
<td>GCS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>Abrasion/contusion</td>
</tr>
</tbody>
</table>
# Ongoing care & Disposition

<table>
<thead>
<tr>
<th><strong>Consults</strong></th>
<th>Neurosurgery, Orthopedics, Plastics, Oral and Maxillofacial Surgery, ENT, Vascular, Urology, Social Work</th>
</tr>
</thead>
</table>
| **Other Considerations** | • Continued attention to **ABCDEs**  
• Analgesia, temperature, antibiotics, tetanus  
• Review laboratory/radiology results |
| **Communication** | • CT, Blood Bank, OR, Anesthesia, PICU  
• Contact numbers to higher level of care |

**ALL SHOULD BE COMPLETED IN 20 MINUTES**
Primary and Secondary Surveys

- Primary survey and resuscitation, both in the field and emergency department (ED)
  - ABCDE
- Secondary survey (ED, radiology)
  - Injury recognition and treatment: SAMPLE history, head-to-toe examination, laboratory tests, imaging studies
- Tertiary survey (pediatric ICU)
  - Identify missed injuries
OBJECTIVES

Define management of the injured or burned pediatric patient after the initial resuscitation
Airway and Breathing

- Open and clear upper airway with bimanual cervical spine stabilization.
- Establish and maintain definitive airway via oropharyngeal airway ± endotracheal tube (ETT) ± needle cricothyroidotomy.
- Support ventilation via nonrebreather mask or bag-valve-mask (BVM) ± ETT, oxygenation via 100% O₂, goal \( \text{Spo}_2 \) 95%-99%.
- Assess for life threats and treat if found.
Common Life Threats

- Tension pneumothorax: needle decompression, then chest tube
- Open pneumothorax: 3-sided occlusive dressing, then chest tube
- Massive hemothorax: volume resuscitation and chest tube
Bleeding and Hemodynamics

- Stop the bleeding!
  - External: direct pressure ± tourniquet ± pelvic binder
  - Internal: immediate surgery (hypotensive)
- Volume resuscitation
  - Isotonic crystalloid: 20 mL/kg x 1-2, reassess
  - Packed s: 10-20 mL/kg, best 1:1:1, RBC + fresh frozen plasma + platelets
- Monitor urine output (urinary catheter)
- Central venous line rarely needed
- Follow laboratory values
Shock Etiologies in Trauma

- **Hemorrhagic**
  - Chest
  - Abdomen
  - Pelvis
  - Thighs
  - Open wound

- **Non-Hemorrhagic**
  - Obstructive: Tension pneumo, cardiac tamponade
  - Neurogenic: Spinal cord injury
  - Cardiogenic: Blunt injury
Airway Complications in the Pediatric Group

- A young patient’s < 2 YEARS of age has
  - increased parasympathetic tone
  - immature brain
  - underdeveloped respiratory center
  - behavioral responses that increase the risk for airway complications and respiratory failure

- Large Occiput
- Small oral opening
- Large tongue
- High Larynx and Narrow Subglottis
- Hypoxia
- Bradycardia
- Arrest
### Table 35-6 Glasgow Coma Scale Modified for Pediatric Patients*

<table>
<thead>
<tr>
<th>EYE OPENING RESPONSE</th>
<th>&gt;1 YR</th>
<th>&lt;1 YR</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCORE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Spontaneous</td>
<td>Spontaneous</td>
</tr>
<tr>
<td>3</td>
<td>To verbal command</td>
<td>To shout</td>
</tr>
<tr>
<td>2</td>
<td>To pain</td>
<td>To pain</td>
</tr>
<tr>
<td>1</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MOTOR RESPONSE</th>
<th>&gt;1 YR</th>
<th>&lt;1 YR</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCORE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Obey commands</td>
<td>Spontaneous</td>
</tr>
<tr>
<td>5</td>
<td>Localizes pain</td>
<td>Localizes pain</td>
</tr>
<tr>
<td>4</td>
<td>Withdraws to pain</td>
<td>Withdraws to pain</td>
</tr>
<tr>
<td>3</td>
<td>Abnormal flexion to pain (decorticate)</td>
<td>Abnormal flexion to pain (decorticate)</td>
</tr>
<tr>
<td>2</td>
<td>Abnormal extension to pain (decerebrate)</td>
<td>Abnormal extension to pain (decerebrate)</td>
</tr>
<tr>
<td>1</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VERBAL RESPONSE</th>
<th>&gt;5 YR</th>
<th>2-5 YR</th>
<th>0-2 YR</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCORE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Oriented and converses</td>
<td>Appropriate words and phrases</td>
<td>Babbles, coos appropriately</td>
</tr>
<tr>
<td>4</td>
<td>Confused conversation</td>
<td>Inappropriate words</td>
<td>Cries but is consolable</td>
</tr>
<tr>
<td>3</td>
<td>Inappropriate words</td>
<td>Persistent crying or screaming to pain</td>
<td>Persistent crying or screaming to pain</td>
</tr>
<tr>
<td>2</td>
<td>Incomprehensible sounds</td>
<td>Grunts or moans to pain</td>
<td>Grunts or moans to pain</td>
</tr>
<tr>
<td>1</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

*Total score key: severe <9; moderate 9-13; mild 14-15.

*Photo by Unknown Author is licensed under CC BY-SA-NC.
Thoracic Injuries

- Results from blunt or penetrating trauma
- Second leading cause of traumatic injury and death in children
- Case fatality rate 5% increases to 25% when accompanied by head and abdominal trauma
- Tension pneumothorax, open pneumothorax, and massive hemothorax are life threats
Thoracic Injuries

- Threatens ventilation and oxygenation
- Contributing anatomic/physiologic factors
  - Higher oxygen consumption, smaller functional residual capacity
  - Increased chest wall compliance
  - Horizontally aligned ribs, weak intercostal muscles lead to diaphragmatic breathing
- Signs predictive of thoracic injury
  - Hypotension, increased respiratory rate, abnormal chest wall exam, abnormal breath sounds, femur fracture, GCS score <15
Abdominal Trauma

- **Signs predictive of abdominal injury**
  - GCS score < 15, hypotension, tenderness, femur fracture, elevated liver enzymes, hematuria, hematocrit < 30%, ecchymosis

- **Low injury risk**
  - No ecchymosis, GCS score > 13, no tenderness, no chest wall trauma, no pain, normal breath sounds, no emesis
  - Hemodynamically stable
  - Continue assessment

- **Hemodynamically unstable**
  - Immediate laparotomy
Declaration of brain death in the pediatric population is governed by specific criteria and detailed physical examination. Brain death is a clinical diagnosis based on the absence of neurological function with a known irreversible cause of coma. Although there are no universal worldwide accepted guidelines for brain death determination, the majority of developed countries agree that brain death is medical and legal death.

Infographic Author: Melanie Stroud, RN, BSN, MBA

Pediatric Brain Death – Critical Care

Please review all relevant hospital and state policies and regulations when utilizing the Society of Critical Care Medicine guideline and toolkit in the assessment and declaration of brain death in children.

Guidelines for Brain Death in Children: Toolkit


http://pediatrics.aappublications.org/content/early/2011/08/24/peds.2011-1511

Guidelines for the determination of brain death in infants and children: an update of the 1987 task force recommendations —
Burns:

**Classification:**
- **Superficial:** red, dry, painful, intact skin
- **Partial Thickness:** moist, blistering or denuded skin; pain
  - **Superficial Partial:** pink, blanching when compressed,
  - **Deep Partial:** drier, whiter no blanching
- **Full Thickness:** dry, fully white, charred, no sensation,

**Estimating Size:**
- **Total Body Surface Area (TBSA),** only partial and full thickness count
- **Palmar surface of child’s hand** is about 1% TBSA
- **Lund Browder charts** for official calculation; need not be used immediately

https://www.researchgate.net/figure/Paediatric-Lund-and-Browder-Chart_fig1_319994658

References:
Pediatric Population

- Pain
- Agitation
- Neuromuscular Blockade
- Delirium
- Environment ICU and Family engagement
- Mobility

<table>
<thead>
<tr>
<th>ASSESSMENT</th>
<th>PAIN</th>
<th>SEDATION</th>
<th>DELIRIUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-report scales for those who can communicate</td>
<td>Arousal or Level of Consciousness LOC</td>
<td>Acute brain dysfunction with cardinal features of:</td>
<td></td>
</tr>
<tr>
<td>Visual Analog Scale</td>
<td>Consider monitoring at least every 2 hrs when on MV</td>
<td>• Inattention</td>
<td></td>
</tr>
<tr>
<td>Numeric Rating Scale</td>
<td>Comfort-B Scale</td>
<td>• Acute or fluctuating mental status</td>
<td></td>
</tr>
<tr>
<td>Oucher Scale</td>
<td>State Behavioral Scale (SBS)</td>
<td>At least twice daily screening</td>
<td></td>
</tr>
<tr>
<td>Wong-Baker FACES pain scale</td>
<td>Richmond Agitation-Sedation Scale (RASS)</td>
<td>• Preschool (psCAM-ICU): &lt; 5 years developmental age</td>
<td></td>
</tr>
<tr>
<td>Behavioral/Observational scales for those who cannot communicate</td>
<td></td>
<td>• Pediatric (pCAM-ICU): 5 years &amp; older</td>
<td></td>
</tr>
<tr>
<td>FLACC</td>
<td>TARGETED sedation: Set goal level of sedation using LOC scale and titrate sedation to maintain target</td>
<td>• Cornell Assessment of Pediatric Delirium (CAPD)</td>
<td></td>
</tr>
<tr>
<td>COMFORT-B</td>
<td>EEG based monitoring and/or VITAL SIGNS changes while utilizing NMBAs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute VITAL SIGN changes while utilizing NMBAs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Consider NMBA holiday</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RISK FACTORS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Barriers to Pain assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developmental delay</td>
<td></td>
<td>Predisposing and Precipitating Factors</td>
</tr>
<tr>
<td>Altered mental status</td>
<td>Developmental delay</td>
<td>• Younger Age</td>
</tr>
<tr>
<td>Mechanical ventilation (MV)</td>
<td>MV</td>
<td>• Cyanotic heart disease</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMPLICATIONS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Iatrogenic Withdrawal Syndrome (IWS)</td>
<td>Complications with over-sedation</td>
<td>Worse Outcomes</td>
</tr>
<tr>
<td></td>
<td>• Prolonged MV</td>
<td>• Longer ICU &amp; hospital stay</td>
</tr>
<tr>
<td></td>
<td>• Delirium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Prolonged PICU stay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• IWS</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MANAGEMENT</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocolized ANALGO-SEDATION may offer benefit</td>
<td>First-line: Treat medical disease (i.e., BRAIN MAPS)</td>
<td>First line: Treat medical disease</td>
</tr>
<tr>
<td>Mild/Moderate first-line:</td>
<td></td>
<td>• Hypoxia</td>
</tr>
<tr>
<td>• Acetaminophen and NSAIDs</td>
<td>• Over-sedation</td>
<td>• Hypotension</td>
</tr>
<tr>
<td>Moderate/Severe first-line: IV opioids</td>
<td>• Lack of sleep</td>
<td>• Hypotension</td>
</tr>
<tr>
<td>• Renal dysfunction: consider fentanyl</td>
<td></td>
<td>• Infection/sepsis</td>
</tr>
<tr>
<td>Second-line: Improved pain control and opioid sparing</td>
<td>Second line: Non-pharmacologic</td>
<td>• Early mobility</td>
</tr>
<tr>
<td>• Acetaminophen</td>
<td>• Improve sleep hygiene</td>
<td>• Family presence/involvement</td>
</tr>
<tr>
<td>• NSAIDs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Alpha-2-agonist</td>
<td>• Minimize sedation exposure</td>
<td>Third-line: Pharmacologic</td>
</tr>
<tr>
<td>• Consider regional/neuraxial in postop</td>
<td>• Transition off benzodiazepine</td>
<td>• Haloperidol or atypical antipsychotic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• May decrease manifestations of refractory delirium such as severe agitation (hyperactive) or being withdrawn/ability in mood (hypoactive)</td>
</tr>
<tr>
<td>Non-pharmacologic adjuncts</td>
<td>Peri-extubation strategies to decrease risk of inadvertent device removal</td>
<td></td>
</tr>
<tr>
<td>Neuromuscular Blockade (NMB)</td>
<td>Iatrogenic Withdrawal Syndrome (IWS)</td>
<td>PICU Environment &amp; Early Mobility</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td><strong>ASSESSMENT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train-of-four (TOF)</td>
<td>Assessment for IWS at least daily</td>
<td>Consider the status of the following:</td>
</tr>
<tr>
<td>monitoring to</td>
<td>Duration &gt; 5 days exposure</td>
<td>• Degree of parental involvement on ranges and patient care routines</td>
</tr>
<tr>
<td>monitor depth of NMB</td>
<td>Duration 3-5 days with high exposure</td>
<td>• Sleep hygiene</td>
</tr>
<tr>
<td>Drug holiday: discontinuation of NMB &amp; evaluation of time until movement</td>
<td>Opioid or benzodiazepine withdrawal</td>
<td>• Mobility</td>
</tr>
<tr>
<td>• If movement &gt; 60 min after discontinuation, systematically decrease infusion dose &amp; reassess</td>
<td>Withdrawal Assessment Tool (WAT-1)</td>
<td>• Age &lt; 6 years</td>
</tr>
<tr>
<td>PAIN assessment while on NMB</td>
<td>Sophia Observation Scale (SOS)</td>
<td>• Developmental delay</td>
</tr>
<tr>
<td>• Acute VITAL SIGN changes while utilizing NMBA</td>
<td>Alpha-2-agonist withdrawal</td>
<td>• Precipitating Factors</td>
</tr>
<tr>
<td>• Consider NMBA holiday</td>
<td>• Consider Wat-1 or SOS</td>
<td>• Mechanical ventilation</td>
</tr>
<tr>
<td>• Consider unique sxs; tachycardia, hypertension, sleeplessness</td>
<td>Consider unique sxs; tachycardia, hypertension, sleeplessness</td>
<td>• Sedation and other medication</td>
</tr>
<tr>
<td><strong>RISK FACTORS</strong></td>
<td><strong>COMPPLICATIONS</strong></td>
<td>• Inadequate pain management</td>
</tr>
<tr>
<td></td>
<td>Coma/le Abrasions</td>
<td>• Lack of schedule or routine</td>
</tr>
<tr>
<td></td>
<td>• Passive eyelid closure and lubrication</td>
<td>• Ambient noise</td>
</tr>
<tr>
<td><strong>COMPLICATIONS</strong></td>
<td></td>
<td>• Light</td>
</tr>
<tr>
<td></td>
<td>Coma/le Abrasions</td>
<td>• Poor sleep hygiene</td>
</tr>
<tr>
<td></td>
<td>• Passive eyelid closure and lubrication</td>
<td>• Increased metabolic demand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Altered adrenocortical function</td>
</tr>
<tr>
<td><strong>MANAGEMENT</strong></td>
<td>Protocolized approach for opioid and/or sedative wean</td>
<td>• Altered immunity</td>
</tr>
<tr>
<td>Consider lowest dose for bolus or continuous infusion administration</td>
<td></td>
<td>• Increased pain perception</td>
</tr>
<tr>
<td></td>
<td>Protocolized approach for opioid and/or sedative wean</td>
<td>• Delirium</td>
</tr>
<tr>
<td></td>
<td>Environmental Interventions</td>
<td>• Immobility</td>
</tr>
<tr>
<td></td>
<td>• Noise reduction strategies</td>
<td>• ICU-acquired weakness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Delirium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• IWS</td>
</tr>
</tbody>
</table>
Resources

- Pediatric Trauma Society - Guidelines Hub
- Algorithms | American Heart Association CPR & First Aid
- Trauma Resuscitation Clinical Pathway — Emergency Department | Children's Hospital of Philadelphia (chop.edu)
- OPEN Pediatrics - Bing video
- Online Medical Education | Openpediatrics
- OPENPediatrics (free, registration required)
- Pediatric Fundamental of Critical Care Support, 3rd Edition https://sccm.org/Home