MANAGING THE PEDIATRIC PATIENT WITH SEVERE TRAUMATIC BRAIN INJURY & INCREASED INTRACRANIAL PRESSURE THROUGH THE USE OF BASIC PATHWAYS

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Speaker Introduction

• Michelle Buontempo is a pediatric APN in a tertiary Level I adult, Level II pediatric trauma hospital providing direct care to critically ill pediatric patients in the pediatric trauma program. Michelle obtained her MSN and BSN from Seton Hall University, magna cum laude. She is certified as a pediatric nurse practitioner and in pediatric critical care.

Disclosures

I have no relevant financial disclosures.

These pathways were developed by myself and the pediatric trauma team at BMSCH- Robert Wood Johnson University Hospital for our patient population

Learning Objectives

• Analyze and apply the Severe Traumatic Brain Injury Pathway tool created to guide the management of severely injured pediatric patients
• Analyze and apply the Increased Intracranial Pressure Management pathway created to guide the management of pediatric patients with elevated intracranial pressure
• Understand the current evidence-based practices that apply to caring for pediatric patients with severe traumatic brain injury and elevated intracranial pressure
• Apply the concepts presented in the pathway tools while accounting for differences in presenting symptoms and mechanisms

Identification of a Problem

In the setting of a Children's Hospital within an adult focused system, we noticed great variability in how pediatric patients with severe TBI are treated. We set out to create a pathway to assist providers who may not be familiar with pediatrics and those who care for them frequently to standardize this practice and thereby improve outcomes.

Where is the evidence?

• Due to the nature of pediatric trauma, class I evidence is limited
• Most programs utilize The American College of Surgeon's TQIP recommendations and the Brain Trauma Foundation's Guidelines which has a separate Pediatric TBI section with analysis of the evidence for each recommendation
• Our pathways utilized the current ACS and Brain Trauma Foundation recommendations, as well as expert input from pediatric critical care, trauma surgery, and pediatric neurosurgery to create practical and evidence based pathways
### Pediatric Pathway for Severe TBI in the ED

- **Initial Workup of TBI**
  - Primary survey: ABCDE, or MARCH
  - Stabilize life threats, +/- intubate if GCS < 8
  - If apparent neuro-trauma, consult neurosurgery ASAP per hospital protocol
  - Imaging
  - Immediate treatment vs. observation

- **Mechanisms and TBI**
  - Leading cause of death and long-term injury in children
  - Blood loss from neuro-trauma can lead to hemorrhagic shock in children, even with a “small” amount
  - 0-4 yrs: falls, abusive head trauma
  - Children: falls, MVA’s, bicycle accidents
  - Adolescents: MVA’s, transportation related accidents
  - Does the mechanism match the injury?

- **ED Management**
  - Prioritize CT scans for neuro-trauma patients with the understanding that patients in extremis can and often go from CT to OR for immediate surgical intervention while being actively resuscitated

- **Radiologic Findings**
  - CT head without contrast remains standard
  - A positive CT can have, but is not limited to: new or expanding lesion, mass effect, fracture
  - Understand that not all injuries are immediately seen on CT. The presence of neurological signs and symptoms supersedes the findings on CT scan (e.g., patients with severe DAI may have no findings on CT but require intervention based on clinical assessment

- **Continued ED Management Decision Making**
  - Generally, patient disposition decision making is made after review of the presenting exam, radiology, and current exam/status
  - Patients will generally fall into three categories of disposition: to OR, to PICU with aggressive medical management, or admit and observe
  - All patients should be ACTIVELY resuscitated before/while receiving definitive care
  - Refer to ICP management pathway to aggressively manage ICP
Patients with severe TBI are more likely to have multi-system trauma affecting their homeostasis. Utilize a systematic patient survey method—ACS or MARCH so you do not miss injuries and life-threats.

Strong Grade I evidence exists that arterial hypotension and hypoxemia pre-hospital and in the first 24 hours of injury are associated with increased mortality as well as a poorer neurological outcome at six months.

Hospital resuscitation guidelines should include aggressive measures to resuscitate those patients with evidence of shock (usually hemorrhagic) and hypoxemia.

New evidence suggests whole blood improves the mortality risk of adults with hemorrhagic shock related to trauma. This data is currently being extrapolated to pediatrics in many centers.

There is no contraindication to utilizing massive transfusion protocols in TBI patients (be sure to use a warmer for age appropriate patients).

Permissive hypercapnea is no longer recommended by ACS.

Neurogenic shock is a distributive type of shock associated with spinal cord injury.

ALL SHOCK IS TO BE TREATED AS HEMORRHAGIC IN THE SETTING OF TRAUMA UNTIL PROVEN OTHERWISE.

Abnormal head CT with an unreliable exam (patient is pharmacologically sedated, intubated, paralyzed or under the influence).

Normal head CT with unexplained hypotension or abnormal posturing with poor neurologic exam.

GCS < 8 with no other obvious explanation (e.g., DAI patients).

Questions:
What part of the infant's neurological exam is concerning to you?
Do you think the infant is in hemorrhagic shock that requires resuscitation?
Would this child activate the severe TBI protocol?
What is your priority for this infant?

At any point in the pathway if ICP is uncontrolled or the exam is deteriorating, a repeat head CT may be considered.
**GOALS DURING PICU ADMISSION**

- Normal, normal, normal!
- ICP < 20
- Normocarbia
- CPP - 40-50 based on the age of the patient. 40 should be used as the absolute minimum value (CPP = MAP – ICP)
- Normotension
- Normothermia
- Avoid hypo/hyperglycemia
- Interventions for treating elevated ICP- use of the tiered approach
- De-escalate invasive monitoring when:
  - Normal ICP maintained for 48h without interventions completed
  - EEG monitoring for 48 hours or as per neurology with seizure prophylaxis & management

**TIER ONE**

- HOB should be to 30 degrees for all patients unless contraindicated in spinal trauma, when trendelenberg should be utilized. Neck should be midline, ensure proper fit of a c-collar if present
- Manage airway pressures as elevated airway pressures can alter brain perfusion and therefore ICP
- Evaluate for other sources of agitation (e.g. urinary retention, infiltrated IV’s, noise, antibiotic reactions etc.)
- Address analgesia and agitation. Adequate analgesia should always be provided and reassess needs regularly. Avoid hypo-perfusion

**TIER TWO**

- If NO resolution after 5 minutes, call Neurosurgery. Consider EVD if not already in place
- Consider 3% saline bolus 2-5 ml/kg (max 10ml/kg or 500 cc/dose) Repeat PRN
- Consider starting continuous IV infusion of hypertonic saline at 2-5ml/kg/hr., assess CPP and auto regulation, if necessary decrease MAP goal
- EVD may be placed at the bedside but ideally in the OR. EVD can be used to measure as well as treat increased ICP through the drainage of CSF
- 3% saline is preferred in the management of increased ICP over Mannitol EXCEPT in the setting of impending herniation
- 3% saline infusions are infused through a central line (preferred, in an emergency may be given through a peripheral) and aggressive fluid and electrolyte management
- Avoid hypovolemia and hypotension while using 3%
- Re-evaluate the CPP and compensation of hemodynamics. It may be prudent to manage the MAP to maintain an adequate CPP

**TIER THREE**

- If NO Resolution after 10 minutes, call Neurosurgery. Hyperventilation with end tidal CO-2 goal of 33-38. Consider Neuromuscular blockade trial, continuous EEG, Repeat head CT.
- Consider decompressive hemi-cranietomy vs. starting pentobarbital drip if thinking of hyperventilation or for burst suppression.
- Pentobarbital 3-5 mg/kg IV, continuous infusion 1-4 mg/kg/hr.
- Start Levophed and/or Vasopressin
- When ICP remains elevated, pediatric neurosurgery should be notified immediately to assist with management, appropriate radiology and to consider surgical intervention

**Tier Three Continued**

- Neuromuscular blockade trial- trial of intravenous dose of paralytic (with adequate sedation and analgesia already on board) to assess the effect on the increased ICP. If successful, consider infusion
- Continuous EEG may alert the team to subclinical seizures or bursts that may be causing increased ICP, treat as appropriate
- Consider decompressive hemi-cranietomy- will be decided between PICU and pediatric neurosurgery based on clinical presentation and assessed potential benefit to the patient
- Burst suppression is usually attained with utilizing Pentobarbital which may affect hemodynamics. Monitor patient per Pentobarbital coma protocol, and aggressively maintain hemodynamic status to support CPP.
CASE STUDY

Alexa is a 17yF who was an unrestrained driver in a high speed MVA yesterday. She arrived in the ER with a GCS of 6. She was managed in the ED with the severe TBI protocol, her CT scan revealed a small subdural bleed, a small subarachnoid hemorrhage and no other abnormality. An EVD was placed for intracranial monitoring. Her EVD is now reading 25-26 mmH2O consistently.

• Based on the tiered approach to ICP management, what are your initial interventions?
• What interventions can you anticipate?
• Bonus question- what is the likely underlying pathology? What type of scan is needed to confirm this?

NURSING CARE AND CONTINUED CARE OF THE PATIENT

Commonly identified missed goals:
- Failure to initiate nutrition within 48-72h
- Failure to maintain normo-thermia (more frequent in the initial resuscitation and post operative periods)
- No early evaluation with PT/OT/ rehab medicine to begin the process of post injury therapies/ transition to inpatient rehab
- Pressure ulcers related to collar care
- Failure to call appropriate consults- usually neurology to help co-manage seizures or seizure prophylaxis, as well as co-managing basilar skull fractures with ENT
METRICS TO BE COLLECTED

- Time from arrival to CT scan
- Time from arrival to OR (for patients who go directly to OR for intervention)
- Number of abnormal head CT’s with GCS ≤ 8 that received an ICP monitor (bolt or EVD)

THE ART OF PEDIATRIC NEUROSURGERY

- Why is this a pathway and not a protocol?
- Why can’t you create a protocol for ICP monitors?
- Why doesn’t every patient go to the OR for decompressive craniectomy if it is definitive care?
- What are the barriers to this working at your institution?

SPECIAL THANKS

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