Transport of the Pediatric Trauma Patient: The Essentials

Allan de Caen MD FRCP
Pediatric Critical Care Medicine
Stollery Children's Hospital
Edmonton, Canada
Faculty/Presenter Disclosure

● Faculty: Allan de Caen
  ■ Medical Director of Stollery PICU Transport Team
  ■ Co-Chair of CAPHC (National) Pediatric Inter-facility Transport Steering Committee

● Relationships with commercial interests:
  ■ None
Objectives

- Who should transport which pediatric trauma patient, and how do we decide?
- Disease specific issues in pediatric trauma transport
- Stabilization pre-transport
  - Airway Control in the traumatized child
  - Respiratory care in the transport setting
  - Transport management of Pediatric Traumatic Shock
Case Presentation

A 5 year old is extricated from a highway speed MVC. He has a GCS of 7 on scene. He remains unresponsive upon arrival in the rural ED, with vitals of HR 130, RR 20 (assisted with BVM), BP 80/50, O2 saturations of 92% and a T of 36°C.

Physical examination shows a boggy swelling over his left temperoparietal area, and a distended abdomen.

You start resuscitation, and call your pediatric trauma center to arrange transfer. Your hospital is located 250 km away from the pediatric trauma facility.
Who should transport the patient?

- **Pediatric critical care**
  - Best option for critically ill child (↓ mortality)
  - Limited resource
  - Prolonged time to patient bedside (av. 90-120 min)

- **ALS/ adult critical care flight team**
  - Predominantly adult-focused
  - Limited (non-trauma) pediatric experience

- **Referral hospital/ regional team (MD/ RN/ Medic)**
  - Removing local resources
  - Do they have setting specific cognitive / technical skills/ equipment?
How is the decision made as to what kind of team transports?

- Patient acuity (acuity scores vs. gut feeling)
- Age (<5 years age vs. adolescence)
- Distance to tertiary care center
- Specific team availability
- Disease specific
  - Expanding intracranial mass
  - Traumatic shock (fluid-refractory)
- Time to tertiary care (support more important than time to trauma center, OR NOT)

*Never accept a step-down in care for your patient*
Stay and Play vs. Stay and Stabilize?

High Acuity Trauma and Stollery Children's Hospital

<table>
<thead>
<tr>
<th>Year</th>
<th>Total ISS&gt;15</th>
<th>OR within 6 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>102</td>
<td>15</td>
</tr>
<tr>
<td>2011</td>
<td>95</td>
<td>24</td>
</tr>
<tr>
<td>2012</td>
<td>112</td>
<td>16</td>
</tr>
<tr>
<td>2013</td>
<td>91</td>
<td>11</td>
</tr>
<tr>
<td>2014</td>
<td>86</td>
<td>16</td>
</tr>
</tbody>
</table>
Case Presentation

Your initial assessment finds him having decerebrate posturing with an applied painful stimulus, and with a dilated and unresponsive left pupil.

You discuss the transport options with the trauma center.

*Local ALS air transport vs. PICU team?*

*Helicopter vs. ground vs. fixed wing?*
448 severe TBI (12 months, 2003-04)

20% underwent emergent Neurosurgery

- 37% of these had at least 1 non-reactive + dilated pupil

¼ children >1 hr to reach 1° hospital from scene

Once in referring ED, 41% took >4 hrs from injury to neurosurgeon

- 79% of transports by referring hospital:
  - tpt time 4.5 hrs
- Regional (3° care) center transports:
Take away messages from UK pediatric TBI transport experience

- Call trauma center early: transport specialist to coordinate patient movement

- Balancing act when deciding to use regional (PICU) tpt teams vs. local (ALS) teams
  - Longer tpt times with specialty teams
  - Less tpt-related morbidity/ mortality) with specialty teams *(Ramnarayan, Lancet, 2011)*

- Different patients have different transport needs
  - Tertiary care on-line support of referral region tpt teams?
Scene response

- Adult and pediatric data suggests morbidity/mortality benefit to use of rotary over ground EMS, but significant bias to literature \((\text{Missios, J Neurotrauma, 2014})\)
  - Observational data only
  - Patient selection/ confounders
  - Training/ experience of medics/ teams used

Interfacility transport

- Limited data available
- Many geographic locales (eg. Canada), rotary not a feasible option for many centers
Case Presentation

Considering the patient’s condition and the transport time involved, you decide to intubate.

*What are the patient and pharmacologic issues that need to be taken into consideration?*
Before the patient is transported…

Does the airway need to be secured?

- General (subjective) indications:
  - altered LOC, respiratory distress / decreased effort/ shock (not just an ABG/ 02 sat)
- Patient age/ size
- What is the trend in patient condition?
- Patient co-morbidities (acute or chronic)?
- Transport distance
- Transport Mode
  - Intubating in a ground ambulance vs. cramped helicopter
Respiratory compromise during trauma transport or reasons to intubate pre-transport!

- Abdominal distention in the infant (swallowed air, intra-abdominal bleeding, ileus)
  - Gastric decompression vs. post-pyloric air
- Sedative/ analgesic needs (eg. pediatric burns)
- Increase in gas volume at altitude in unpressurized aircraft (pleural/ gastric), especially with use of positive pressure ventilation
  - Drain the small Pneumothorax vs. pressurize the plane
Atropine and Rapid Sequence Intubation (RSI)

Atropine as an anti-sialogue
● Need 15-30 minutes prior to laryngoscopy

Bradycardia with intubation can occur due to:
● Hypoxia or ischemia
● Drug-related (eg. Fentanyl or succinylcholine)
● Vagal reflexes with laryngoscopy (even if baseline tachycardic)
● Positive pressure ventilation (PPV) in infants

Suggestion that atropine creates survival advantage in emergent pediatric intubation (even with underlying tachycardia)

Shepherd, Circulation, 1981
What drugs for Pediatric Trauma RSI?

- Propofol/ benzodiazepines
  - Vasodilation combined with occult hypovolemia !!

- Fentanyl
  - good analgesic but poor anesthetic/ sedative

- Ketamine
  - Maintains BP (*usually*) and *lowers* ICP if C02 ‘N’
  - Repeated boluses of 0.5 mg/ kg better than a large (2 mg/ kg) dose

- Always use a paralytic agent
Hypotension Surrounding Intubation

- **Hemodynamic preparation pre-RSI**
  - Treat hypotension/ tachycardia prior to starting RSI (start with volume)
  - Reduce anesthetic/ sedative doses, or withhold in setting of refractory severe hypotension

- **Hypotension post-RSI (even minutes post) is common but is usually fluid responsive**
  - PPV reduces venous return to heart (slower IMV!)
  - RSI drugs vasodilate and reduce preload
  - PPV (pre-atropine) can reduce HR in small infants due to CNS reflexes
Case Presentation

The patient is successfully intubated. EtCO2 is 47. ETT sounds appropriately placed (CXR is pending).

How much and how should the child be ventilated?

What airway/ventilation issues need to be addressed prior to transport?
Ventilating the Small Child During Transport

- **Suction post-intubation**
  - Small airway and thick secretions
  - Humidification

- **Once the ETT is in, ventilate (sub-physiologic rate)**
  - 3 months: 30 BPM
  - 2 yrs. age: 20 BPM
  - 10 yrs. Age: 12 BPM

- Tidal volume 5-7 cc/ kg or PiP<30/ move the chest

- PEEP 5

- Titrate FiO2 to 02 sat>94%

- Baseline (ABG) and trend (EtCO2 30-35mm Hg)
Hyperventilation and the Cardiovascular System
The Hemorrhagic shock victim

Pepe et al, J Trauma, 2003

- Reduced preload due to increased intrathoracic pressure and reduced venous return

<table>
<thead>
<tr>
<th>Table 1 Mean Values (n = 8) for Cardiopulmonary Variables Using Various Rates of PPV in a Swine Model of Moderate, Controlled Hemorrhage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>RA (mm Hg)*</td>
</tr>
<tr>
<td>ITP (mm Hg)</td>
</tr>
<tr>
<td>Ao Syst (mm Hg)*</td>
</tr>
<tr>
<td>Ao Diast (mm Hg)</td>
</tr>
<tr>
<td>PacO₂ (mm Hg)</td>
</tr>
<tr>
<td>PacO₂ (mm Hg)</td>
</tr>
<tr>
<td>pH (arterial)</td>
</tr>
<tr>
<td>CPP (mm Hg)</td>
</tr>
<tr>
<td>QR (L/min)</td>
</tr>
</tbody>
</table>

* Measured at end-expiration.
Respiratory Care in the Transport Setting

Ability (or not) to clinically assess the patient

- Ambient lighting: Patient blue/ pink/ white/ grey?
- Noise: stethoscope = useless (in flight or not)
  - Baseline CXR (ETT position/ pneumothorax) and continuous ETCO2 monitoring
- Motion artifact (BP cuff, 02 saturation monitor)

Monitored ETT cuff pressure vs. saline filled

- Patient series commonly document dangerous cuffed ETTs cuff pressures (>30 cm H2O)
  2/3 of patients >30 cm H2O (median 40 cm H2O)

Case Presentation

Reassessment of the 5 yr old prior to transport yields the following vital signs:

- HR 130
- RR 28 (IMV)
- O2 saturation 95%
- T 36° C
- BP 78/55

Next steps?
Pediatric Traumatic Shock Resuscitation: What kind of fluid to give?

**SAFE Study, NEJM, 2004**

- Multi-center double-blinded RCT comparing crystalloid (Normal saline, NS) to colloid (4% albumin) in fluid resuscitation of adults upon admission to ICU (n= 6997)
- No difference noted in morbidity or mortality

Subset of SAFE patient population with traumatic brain injury

- Increased mortality rate with the use of albumin when compared to NS
  - 41.8% mortality vs. 22.2% mortality (P<0.001)

*Don’t use dextrans/ starches/ hypertonic saline for shock!*
Pediatric Traumatic Fluid Resuscitation

**NS for fluid resuscitation**

- Efficacious for survival and cost
- Risks?
  - Hyperchloremic metabolic acidosis: following the BE as marker of success
  - Hyperchloremia: possible association with need for CCRT (adult literature)
- Alternatives:
  - Ringers lactate (hyponatremic)
  - Plasmalyte (expense)
- Bottom Line:
  
  *NS is still the standard of care for the first 40cc/kg*
Has enough resuscitation fluid been given?

Systolic Wave Variation/ Pulse Pressure Variability: check your pulse oximetry tracing (audio or visual)
Persistent shock in pediatric trauma

- On-going bleeding
- Hypoglycemia in the small child
- Hypocalcemia if transfusing blood
- Cardiorespiratory effects (IMV/ PiP)
- Other causes of shock (Pericardial tamp/ PTX)
Hypotension and Severe Pediatric Head Injury

- Adult literature has shown that early correction of hypotension in the traumatic brain injury improves outcome
  Bouma, 1990

- A single episode of hypotension (BPs<90) in children with traumatic brain injury is associated with a *fourfold decreased survival rate*
  Pigula, 1993

**Bottom Line: Avoid Hypotension (BP 70 + (ageX2))**
Once the ETT is in, keeping it in…

- Avoid benzodiazepines/ propofol due to vasodilatory effects

- Serial dosing of analgesic agents
  - Fentanyl: 1-2 mcg/ kg q30-60 min
  - Ketamine 0.5-1 mg/ kg q1hr
  - Morphine 0.05-0.1 mg/ kg q1-2hr

- The patient with residual paralysis
  - Titrate sedative/ analgesic dosing to jumps in HR/ BP
  - Even these agents have vasodilator effects…

- Rocuronium 1 mg/ kg q30-60 min with patient movement
Temperature Management of the Pediatric Patient on Transport

- Small children lose significant heat (radiant/ evaporative/ conductive losses)
- Hypothermia increases myocardial stress
- The importance of temperature (fever) control is disease specific
  - Cardiac arrest: Avoid fever; don’t cool
  - TBI: Avoid fever; don’t cool (harmful)
- The earlier fever is managed, the better for the patient (window of dose effect starts early)
Tex Kissoon’s Golden Rules of Transport

- Plan ahead
- Transports are palliative, not curative
- No form of transport is ideal for every patient
- Any hospital is a better hospital than an airplane or ambulance
- If it is possible for a sick person to become sicker, he probably will
- Big problems are simply small problems you have not anticipated
- Nothing lasts forever (eg. Air, O2, battery, etc)
Thanks for your attention.

Questions?
Strategies to Enable Visualization of the Pediatric Trauma Airway

- Time for laryngoscopy/ good view: pre-oxygenation
- Anteriorly opened C-spine collar
- ETT with stylet
- Straight laryngoscope blade
  - Don’t laryngoscope the esophagus: start at base of tongue
- Pre-endoscopy suctioning
- Gentle anterior laryngeal pressure
  - *Not cricoid pressure: worsens view!*
- Failed intubation?: BVM and OPA; laryngeal mask
- *Don’t depend upon fancy airway adjuncts (especially if you don’t routinely use them)*
ICU transport teams take longer to stabilize…

**Significant difference in stabilization times comparing kinds of transport teams**

<table>
<thead>
<tr>
<th>Transport Team</th>
<th>Stabilization Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALS</td>
<td>0.44 +/- 0.15 hr</td>
</tr>
<tr>
<td>ALS (peds)</td>
<td>0.98 +/- 0.21 hr</td>
</tr>
<tr>
<td>PICU</td>
<td>1.24 +/- 0.34 hr</td>
</tr>
</tbody>
</table>

*McNabb, J Trauma, 1991*
Transport stabilization times for neonatal and pediatric patients prior to interfacility transfer
Whitfield, Children’s Emergency Transport Service, Denver, 1993

Pediatric Stabilization Times 1988-1990

All transports (n = 1106)
55 (10-419)

Ventilated (n = 157)
88 (18-419)

Ventilated with Inotropes (n = 13)
156 (55-419)
Summary of PICU tpt data

- Sick patients get sicker on transport
- Longer transports, sicker patients
- Sicker patients take longer to stabilize, and that is usually OK