Pediatric Perioperative Life Support

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Pediatric CPA outcome

<table>
<thead>
<tr>
<th>Out of hospital arrest</th>
<th>In-hospital arrest</th>
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<tbody>
<tr>
<td>-overall survival: 6%</td>
<td>-Overall survival: 27%</td>
</tr>
<tr>
<td>-most have poor neurological outcome</td>
<td>-most have favorable neurological outcome</td>
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• No flow →Low flow→ROSC
• Minimizing these intervals provide best chance of resuscitation and recovery.
Difference from PALS

- end-tidal CO2
- Arterial line
- Central line
- Prone CPR and defibrillation
- Open chest CPR
- Extra-corporeal life support (ECLS)
- Intra-operative events
Intraoperative events

- Hypovolemia
- Hyperkalemia
- Laryngospasm
- Anesthetic overdose
- Regional blocks and local anesthetic toxicity
- Anaphylaxis
- Venous air embolism
- Arrest with malfunctioning VP shunt
Respiratory failure

- Upper airway
- Lower airway
- Parenchymal disease
- Disorder of control
- Others
Airway-upper & lower

- Difficult intubation- small mouth, big tongue, floppy epiglottis, blood
- Obstruction- tonsil, foreign body, epiglottitis
- Laryngospasm- URI, GERD
- Laryngeal swelling- post extubation croup
- Equipment problems- machine, circuit, ETT
- Bronchospasm- reactive airway disease
- Compression- mediastinal mass
Parenchymal disease

- BPD
- Pulmonary edema-cardiac, fluid overload, leaky capillary, negative pressure
- Pneumonia- aspiration, infection
Disordered control

• Prematurity (45wk-60wk post-conception age)
• Central hypoventilation
• Opioid respiratory depression
• Ventilator failure
Chest compliance

- Narcotic induced chest rigidity
- Changing compliance during surgery (aspiration)
- Pneumothorax
Circulatory failure

- Intravascular volume status
- Myocardial contractility
- Vascular resistance
- Rate/ Rhythm
Intravascular volume status

• Low preload
  – Inaccurate assessment of loss
  – Inability to keep up with hemorrhage
  – Inadequate i.v. access

• Volume redistribution-

• Obstructed venous return- tamponade, pneumothorax, venous air embolism
Heart contractility

• Dysfunction
  – Anesthetic overdose
  – Hypoxia
  – Metabolic
  – Sepsis

• Myopathy
  ➢ Infectious
  ➢ Chemotherapy( daunorubicin, doxorubicin)
  ➢ idiopathic
Vascular resistance

• Low
  – Anaphylaxis
  – Anesthetic overdose
  – Hypoxia
  – Sepsis
  – neurogenic

• High
  – Catecholamine excess
  – Pulmonary hypertension
Rate/rhythm

- Congenital
- Mechanical-CVL
- Pharmacological- succinylcholine, neostigmine
- Hypoxia
- Ischemia- Supravalvular aortic stenosis
- Pacemaker failure-device, hypoxia, acidosis
Rate/rhythm contd...

• Metabolic
  – Malignant hyperthermia
  – hyperkalemia
    • Transfusion
    • Renal
    • Iatrogenic, TPN
  – Hypocalcaemia
    • Transfusion
    • Renal
    • DiGeorge syndrome
What is Normal

- **Upper limit** of heart rate and respiratory rate

<table>
<thead>
<tr>
<th>Age</th>
<th>R/R</th>
<th>HR</th>
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<tbody>
<tr>
<td>Newborn</td>
<td>60</td>
<td>160</td>
</tr>
<tr>
<td>Infant</td>
<td>40</td>
<td>150</td>
</tr>
<tr>
<td>Toddler</td>
<td>34</td>
<td>140</td>
</tr>
<tr>
<td>School age</td>
<td>30</td>
<td>120</td>
</tr>
<tr>
<td>Teenage</td>
<td>16</td>
<td>100</td>
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- **Lower limit** of systolic blood pressure
  - Newborn 60 mm Hg
  - Infant 70 mm Hg
  - 1-10 years 70 mm Hg+ (2. age in years)
Impedance Threshold Device

- Ventilation Port
- Ventilation Timing Assist Lights: provide guidance to the rescuer on proper ventilation rate to optimize cardiac output and oxygenation.
- Atmospheric Pressure Sensor System: augments blood flow to the heart when intrathoracic pressures are < 0 ATM.
- Ventilation Guidance Switch: slide for use of the ventilation timing assist lights.
- Single Use Only
- Patient Port: allows fast and easy connection to an endotracheal tube or other airway adjuncts.
Code team
CODE TEAM

- **LEADER** (anesthesiologist most familiar with patient and intra-operative course)
- **AIRWAY** (anesthesiologist) - airway & gastric intubation
- **COMPRESSORS** - (scrub/surgeon if sterility needed)
- **ACCESS** - i.o or i.v.; medication/fluids (anesthesiologist/surgeon)
- **MONITOR** - defibrillator, pulse check (sterility?)
- **RECORIDER** (circulator) - compares efforts to goals, reviews as needed.
- Gofer, security, parental advocate.
Obstruction/poor compliance

Kinked ETT

? Too deep (endobronchial)
? Mucous plug/secretion (Suction ETT)
? Bronchospasm

No improvement with treatment

- Remove airway device
- Establish bag-mask ventilation
- Call for help & Resecure airway
Circuit leak

Check for disconnect (patient to machine)
Soda-lime canister for leak
?NGT in trachea
Cuff not sealing trachea
ETT not in trachea
Broken cuff/ pilot balloon

Switch to self-inflating bag and call for help
No signs of obstruction or leak

- Check gas analyzer connections and power (\textit{on})
- CO2 line fitting (\textit{tight})

Wheezing/rhonchi
Therapeutic Hypothermia

-several multicenter RCT trials of induced hypothermia (33.5-34.5 °C) in newborn >36 weeks with hypoxic-ischemic encephalopathy showed improvement in neurodevelopment disability at 18 month follow-up.

-induce within 6 hours continue for 72 hours and slow rewarming over at least 4 hours.
Treatment of specific situations

- Arrest during inhalation induction
- Arrest in a child with malfunctioning VP shunt
- Posterior spinal fusion and craniofacial reconstruction surgery.
- Transfusion related hyperkalemia
- Local anesthetic toxicity
- Anaphylaxis
Loss of ETCO2/hypoxia in OR

- Give 100% O2
- Switch to hand bag ventilation
- Obstruction or leak present
- Ensure O2 delivery from wall to patient
- If patient hypoxic declare emergency
Determine airway patency
- Obstruction or leak present?
- Kinked or disconnected airway device?

Clinical obstruction or leak:
- Wheeze breath sounds
- Distant, rhonchi
- Other connections and leaks: are on.
- Settings are tight
- Blood, SaO2 all normal

Obstruction or poor compliance
- Check for kinked airway device or tubing
- Check for ETT depth: endobronchial intubation
- Suction ETT (or pharynx if no ETT)
- Examine for signs of lower airway obstruction (wheeze, distant breath sounds)
- No improvement with treatment

Circuit leak, bag leak
- Check for disconnected patient to machine
- Check soda lime canister
- NG tube in trachea?
- ETT/LMA cuff not sealed in trachea?
- ETT not in trachea?
- Damaged ETT or LMA?

Switch to self-inflating ventilation bag use
in emergencies and calls

- Remove airway device
- Establish bag-mask ventilation
Initiate CPR
Assign roles
Attach defibrillator

Assess rhythm
Treat possible causes
• Hypoxemia
• Hypovolemia
• Hyper/hypokalemia
• Hypothermia
• Tamponade
• Tension pneumothorax
• Thromboembolism
• Toxins/medication-LA
• Surgical stimulus

Intubate ASAP
Monitor ETCO2
Goal ETCO2>10

FiO2 to 100%
Stop inhalational agent
Stop potential medication/infusion/exposure
• Opioids
• Penicillin, Nondepolarizing MB
• Local anesthetics
• Blood transfusion/TPN
• Vasodilators
• Protamine, dextran
• Latex

Help

Stop surgery
VTach/VFib

1. Shock 2-4 J/kg
2. Resume CPR* immediately without rhythm check –
   - Possible Causes:
     - Hypoxemia
     - Hypovolemia
     - Hyper/hypokalemia
     - Hypothermia
     - Tamponade
     - Tension pneumothorax
     - Thromboembolism
     - Toxins/medications
     - Local anesthetic toxicity
     - Surgical stimulus

   Consider:
   - Hyperkalemia
   - Local anesthetic (LA) toxicity

2 minutes CPR

Check Rhythm: Shockable?

YES

Resume CPR* while defib is charging
1 shock, 4 J/kg
Resume CPR* immediately

Epinephrine
- 1 µg/kg IV/IO
- 100 µg/kg ETT
Repeat dose every 3-5 minutes

2 minutes CPR

Check Rhythm: Shockable?

NO

PEA/Asystole

Resume CPR* immediately
Give Epinephrine
- 10 µg/kg IV/IO
- 100 µg/kg ETT
Repeat dose every 3-5 minutes

Check rhythm every 2 minutes
If electrical activity, check pulse
If shockable, go to VTach/VFib pathway

*During CPR
- Continuous compressions hard and fast 100/minute
- Use full chest recoil technique

*During CPR
Pre-resuscitation preparation

• Common etiologies
• Categorization of risk and causes
• Familiarization with algorithms, skills & equipment
• Familiarization with team, roles, communication
Pre-resuscitation....

- Age
- ASA (ASA-5 is not even included in such studies)
- Volume status (NPO, shock? etc.)
- Labs (CBC, Chemistry, PT/PTT)
- Adequate i.v. access (central line)
- Hotline, level-1
- Ensuring blood products availability
Pre-resuscitation...

- Crash-carts
- AHA-PALS algorithms
- Pediatric Critical Event Checklists (App store)
- I.O. access (less than 33% providers had in OR)
- After hands on practice, trainee were able to defibrillate 87% faster.
- Peri-operative arrest record cognitive aid. (2min-4min-6min)
Pediatric Critical Event Checklist
The Children's...
Hyperkalemia

- Second leading cause of intra-operative cardiac arrests.
- In non-cardiac surgeries responsible for 19% pediatric cardiac arrest.
- Rapid transfusion of PRBC stored>2wks, irradiated
- Renal failure
- Undiagnosed myopathies and release of K from rhabdmyolysis
- Reperfusion of ischemic organs or limbs
Peri-operative resuscitation...

- Inform surgeon & team
- Stop surgery
- Trendelenberg & wide open i.v.
- Compressions
- Call for help
- Stop possible offenders (gas, propofol infusion, blood, TPN, latex, antibiotic, dextran, NDNMB, protamine)
- Apply bag of ice to the child’s head
- Role assignment
Perioperative Resuscitation

- Recognizing the need.
- Airway management
- Circulation
- Medication administration
- Cardioversion & defibrillation
- Monitoring the effectiveness of CPR
- Open chest CPR
- ECLS
- Role assignment
Peri-Operative Resuscitation...

- Cuffed ETT is better, will work with changing compliance.
- Keep fiO2 100% during CPR, later on during post-resuscitation management fiO2 can be decreased to maintain SpO2 94-99%
- Overzealous ventilation causes alkalosis decreasing cerebral blood flow and increases intra-thoracic pressure decreasing venous return.
- Compression 100/min; hard, fast, full recoil; use of resQpod improves venous return
Peri-Operative resuscitation...

- C-A-B than A-B-C
- Push hard, push fast, minimize interruptions and use a ratio 100 compressions: 10 ventilations without interposition.
- Compressor change and pulse check @ 2 minutes
- Single biphasic shock than shock-shock-shock-shock
- ROSC is revealed by sudden increase in the ETCO2 level.
Figure 3. A. Prone chest compressions with a midline posterior incision. B. Prone chest compressions with no midline incision.
Peri-operative resuscitation...

- i.o./peripheral i.v./ central lines with tip below diaphragm.
- Use of flush 0.25ml/kg (5cc for infant; 10cc for child & 20cc for adult)
- Epinephrine is the most effective medication.
- ETT route dose is 10 times the i.v./i.o.
  why??(poor absorption & vasodilator effect of low dose epinephrine)
Peri-operative resuscitation....

• ETCO2 confirms
  – airway placement
  – Pulmonary blood flow
  – Effectiveness of CPR( keep ETCO2>10)
  – Compressor fatigue
• Arterial line (keep diastolic >35mm Hg in adults); also volume.
• Central line for CVP; venous saturation (keep>30%)
Figure 4. Tracing of end-tidal CO₂ (ETCO₂) during chest compressions, showing decreasing ETCO₂ levels as rescuer fatigues (arrows 1–8) and sudden increase in ETCO₂ during compression when spontaneous circulation returns (9). Adapted from Kalenda.³³
<table>
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<th>Action</th>
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<tbody>
<tr>
<td>Incision</td>
<td>100% O2</td>
<td>Wound lower than heart</td>
<td>Consider head cont.</td>
</tr>
<tr>
<td></td>
<td>Inhalational agents off</td>
<td>Flood field if above heart</td>
<td>Call 5-5260 for EMT</td>
</tr>
<tr>
<td></td>
<td>Anesthetic infusions off</td>
<td>PCA, TPN stopped</td>
<td>Call 3-8594 for CTR</td>
</tr>
<tr>
<td>pt</td>
<td>Open IV fluids</td>
<td>Catheters out of heart</td>
<td>Consider chest X-ray</td>
</tr>
<tr>
<td>Add to pt</td>
<td>Check ETT</td>
<td></td>
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Recording Data: ____________________________

Name of Arrest Leader: ______________________
Peri-operative resuscitation....

- Paddles or AED?
- Open chest CPR?
- ECLS?
Act in time
Post-resuscitation Management

- Maintain Normotension
- Temperature maintenance
- Oxygen saturation maintenance
- Avoid hyperventilation
- Maintain Normoglycemia
- Breaking bad news to family
- Team debriefing