PEDIATRIC RESUSCITATION

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Out of hospital cardiac arrest

- Not witnessed (long time without CPR)
- No preexisting conditions
- Etiology: Respiratory
- Bystander CPR late and less effective

In hospital cardiac arrest

- Witnessed
- Preexisting pathology
- Etiology: Cardiac
- Immediate high quality CPR
Pediatric Resuscitation = PREVENTION

- Respiratory failure
- Shock
- Effective and early CPR
Prearrest care- In hospital

• Medical rapid response teams
  • May prevent cardiac and respiratory arrest

• Pediatric early warning scores (PEWS)
  • May be used, but effectiveness not established
BLS
Respiratory failure- anticipate

• Increased respiratory rate
• Signs of respiratory distress
  • Nasal flaring
  • Retractions
  • Seesaw breathing
  • Grunting
• Diminished breath sounds
• Gasping
• Cyanosis
Pediatric Anatomy & Physiology

Young infants
- obligate nose breathers, obstruction of nasal passages causes distress

Young children
- less reserve, deteriorate quickly

Children
- more flexible chest walls, less developed chest muscles, diaphragm more prone to fatigue
RESPIRATORY FAILURE OCCURS MORE COMMONLY IN CHILDREN

- NOSE BREATHERS
- LARGE TONGUE
- SMALL AIRWAY
- MUSCLE FATIGUE EASIER
- FREQUENT VIRAL RESPIRATORY INFECTIONS

INFANTS
Anticipate
Pediatric airways of concern

• Altered sensorium
  • Upper airway relaxes

• Extra soft airway tissue (Laryngomalacia)
  • Obstruction with viral illnesses

• Malformations of the tongue and mandible
  • Down syndrome

• Child with noisy breathing
  • Croup, tracheitis, retropharyngeal abscess, burns, allergic reactions

• Cervical spine immobilization
Failproof interventions for respiratory distress

• Position of comfort: in mom’s arms, sitting up
  • Stridor: Croup, tracheitis

• Nasal suctioning
  • Infants with bronchiolitis

• Oxygen
  • Nasal canula: infants with bronchiolitis
  • Blow by: older children
  • Face mask held by mom in front of the face
BLS
Shock- recognize

Compensated
• Tachycardia
• Cool pale extremities
• Prolonged cap refill
• Weak peripheral pulses
• Normal blood pressure

Decompensated
• Depressed mental status
• Decreased urinary output
• Tachycardia
• Weak central pulse
• Deterioration in color (mottling)

*No single sign confirms the diagnosis- integrate symptoms and signs
BLS
Hypotension: systolic blood pressure values

• Neonates <60 mm Hg
• Infants (1mo-1 year) <70 mm Hg
• Children (1-10 years) <70 + 2(age) mmHg (years)
• Adolescents (>10 years) <90 mm Hg
Prearrest care
Septic shock

• Previous recommendation: early and rapid administration of IVF

• Current recommendations:
  • Administration of 20 ml/kg bolus is reasonable
  • Reassess after each bolus
  • Either crystalloids or colloids are effective

• Why the recommendations changed
  • One large study in a limited resource area showed increased mortality with 20-40 ml/kg fluid boluses when compared with maintenance fluid alone
  • Thus, in areas with no intensive care support (mechanical ventilation, pressors) gentle approach to intravenous fluids is recommended
Prearrest care

Hypovolemic shock

• Use crystalloids: lactated Ringer’s or normal saline as the initial bolus
• Treat shock with 20 mL/Kg bolus even if blood pressure is normal
  • Compensated shock
Prearrest care
Myocarditis

• Avert cardiac arrest
• Consider pre-cardiac arrest extracorporeal membrane oxygenation (ECMO) use
Pediatric cardiac arrest

• Respiratory
• Respiratory
• Respiratory
• Cardiac
Pediatric CPR

VENTILATIONS ARE IMPORTANT

RATE FOR 2 RESCUERS
15:2
When do we use adult guidelines in children?

- At Puberty
  - physical characteristics are easier to identify than specific ages
- Puberty:
  - Girls: Breast development
  - Boys: Axillary hair
BLS
Simultaneous actions

• Chest compressions- one rescuer
• Ventilations- another rescuer
• Monitor, defibrilator, iv, prepare medication- third rescuer

*ventilations are important in pediatrics: asphyxial cardiac arrests
BLS
Assure GOOD Quality of Compressions

• Push hard
  • 1/3 the AP diameter of the chest
  • 1 ½ in in infants= 4 cm
  • 2 in in children= 5 cm
• Push fast
  • 100 compressions/min
    • Rotate compressors every 2 minutes
• Allow full recoil
• Minimize interruptions
• Firm surface

*Don’t hyperventilate
BLS
Compressions

• Is there a need to assist circulation
  • assure adequate oxygen & ventilation
  • HR < 60 with poor perfusion

• Chest compressions
  • 1 rescuer 30:2
  • 2 rescuer 15:2
  • 1/3 depth of chest
Two thumb-encircling hands chest compression in infant (2 rescuers).
Two-finger chest compression technique in infant (1 rescuer)
BLS
Compressions in monitored patients

• Use end tidal CO₂ to guide chest compressions
BLS
Oropharyngeal and nasopharyngeal airways

• Oropharyngeal
  • Absent gag reflex
  • Use correct size
    • small may push tongue back
    • large may obstruct airway

• Nasopharyngeal
  • Gag reflex present
  • Use correct size
    • short is not effective
    • long may obstruct airway
  • Suction as needed: may become obstructed with secretions
BLS
Laryngeal Mask Airway (LMA)

• Acceptable to be used by experienced providers when:
  • Bag Valve Mask is ineffective
  • Endotracheal intubation is not possible
BLS Oxygen

• Reasonable to ventilate with 100% oxygen during CPR

• After return of spontaneous circulation, wean to $O_2$ Sat 94-99%

Why:
* there is insufficient information on the optimal oxygen concentration
* use enough oxygen to oxygenate but avoid hyperoxia
BLS
Pulse oximetry

• If the patient has a perfusing rhythm, monitor $O_2$ saturation with pulse oximeter
BLS
Bag-mask ventilation

Bag-mask ventilation might be safer than endotracheal intubation for
• Short periods
• During out-of-hospital resuscitation

*use proper mask
*provide tight seal
*assess effectiveness of ventilations- chest rise
BLS
Bag-mask ventilation

*use only the force and tidal volume to make the chest rise visibly
  - avoid gastric inflation
*inspiratory time 1 sec
  - Squeeze-release-release
*if the child is intubated or LMA:
  - 1 breath every 6 seconds (10 breaths per minute)
*if perfusing rhythm
  - 1 breath every 3-5 sec (12-20 breaths per minute)
BLS
Bag-mask ventilation

Two person BVM
  - better seal

Cricoid pressure in the unresponsive victim (may require a 3rd person)
  - reduces gastric inflation
  - avoid excessive cricoid pressure (may obstruct trachea)
*may need to discontinue during intubation (if view is distorted)
BLS
Ventilation with tracheostomy

• Ventilate through tracheostomy
• If ineffective: suction tracheostomy tube
• If suctioning ineffective:
  • replace tracheostomy tube
  • place endotracheal tube
• If nothing works
  • Mouth to stoma or mask to stoma ventilations
  • Occlude stoma and perform bag-mask ventilations
BLS

Endotracheal intubation

• Only if experienced
• Both cuffed and uncuffed tubes are ok
• Cuffed tubes may decrease risk of aspiration:
  • Cuff inflation pressure 20-25 mmHg
  • Formula:

  • Uncuffed  \(4 + \frac{\text{age}}{4}\)
  • Cuffed  \(0.5\) mm smaller

*think this way: start at 4 (uncuffed) in infants
BLS
Verify endotracheal tube position

• Bilateral chest movement
• Equal breath sounds
• End tidal monitor- color change or tracing
• Pulse oximeter read (if perfusing rhythm)
• Direct laryngoscopy (if uncertain)
• Chest x ray (in hospital)

*if end tidal CO₂ is not detected in CA, confirm tube position with direct laryngoscopy
*low pulmonary blood flow may cause absence of exhaled CO₂
Atropine for pre-medication during intubation

• Previous recommendations:
  • Use atropine
    • To prevent bradycardia (hypoxia, vagal reflex laryngoscopy)

• Current recommendations:
  • May be reasonable to use atropine
  • 0.02 mg/kg
BLS
Newborns CPR rates

• 15:2 if resuscitated in the prehospital, ED, PICU

*newborn CPR is 3:1 in NICU or delivery room
*for ease of training, 15:2 is recommended
ACLS
Pulseless arrest - Asystole

CPR 2 min
- IO/IV access
- Epinephrine every 3-5 min
- Consider advanced airway

Rhythm shockable?
Yes

Drug Therapy
- Epinephrine IO/IV dose: 0.01 mg/kg (0.1 mL/kg of 1:10 000 concentration). Repeat every 3-5 minutes.
  If no IO/IV access, may give endotracheal dose: 0.1 mg/kg (0.1 mL/kg of 1:1000 concentration).

Reversible Causes
- Hypovolemia
- Hypoxia
- Hydrogen ion (acidosis)
- Hypoglycemia
- Hypo-/hyperkalemia
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis, pulmonary
- Thrombosis, coronary

No

CPR 2 min
- Treat reversible causes

No

Rhythm shockable?
Yes
ACLS
Ventricular fibrillation

**Shock Energy for Defibrillation**
First shock 2 J/kg, second shock 4 J/kg, subsequent shocks ≥4 J/kg, maximum 10 J/kg or adult dose

**Drug Therapy**
- **Epinephrine** IO/IV dose: 0.01 mg/kg (0.1 mL/kg of 1:10000 concentration). Repeat every 3-5 minutes.
  If no IO/IV access, may give endotracheal dose: 0.1 mg/kg (0.1 mL/kg of 1:1000 concentration).
- **Amiodarone** IO/IV dose: 5 mg/kg bolus during cardiac arrest. May repeat up to 2 times for refractory VF/pulseless VT.
- **Lidocaine** IO/IV dose: Initial: 1 mg/kg loading dose. Maintenance: 20-50 mcg/kg per minute infusion (repeat bolus dose if infusion initiated >15 minutes after initial bolus therapy).
ACLs Bradycardia

Pediatric Bradycardia With a Pulse and Poor Perfusion Algorithm

1. Identify and treat underlying cause
   - Maintain patent airway; assist breathing as necessary
   - Oxygen
   - Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
   - IO/IV access
   - 12-Lead ECG if available; don’t delay therapy

2. Cardiopulmonary compromise?
   - Hypotension
   - Acutely altered mental status
   - Signs of shock

3. CPR if HR <60/min with poor perfusion despite oxygenation and ventilation

4a. Support ABCs
   - Give oxygen
   - Observe
   - Consider expert consultation

4. Bradycardia persists?
   - No
   - Yes

5. Doses/Details
   - Epinephrine IO/IV dose: 0.01 mg/kg (0.1 mL/kg of 1:10,000 concentration). Repeat every 3-5 minutes. If IO/IV access not available but endotracheal (ET) tube in place, may give ET dose: 0.1 mg/kg (0.1 mL/kg of 1:1000).
   - Atropine IO/IV dose: 0.02 mg/kg. May repeat once. Minimum dose 0.1 mg and maximum single dose 0.5 mg.

6. If pulseless arrest develops, go to Cardiac Arrest Algorithm
ACLS
Tachycardia with a pulse
ACLS
Special situations

• Trauma: do not hyperventilate
• Past history of cardiac condition: consider ECMO initiation
  • EMS: notify hospital to prepare
• Family presence should be encouraged whenever possible
• Termination of resuscitation efforts: no reliable predictors of outcome
to guide termination of resuscitation efforts
  • Bystander CPR, short interval form collapse to CPR, witnessed collapse
  increase chances of successful resuscitation
Post resuscitation care

• Target normoxia
• Target normal end tidal CO$_2$
• Remove IO after other intravenous access is available
• Maintain blood pressure at > 5$^{th}$ percentile for age
  • Fluids, inotropic agents
• Temperature management
  • Avoid hyperthermia
  • 5 days of normothermia (36-37.5 C) \textit{OR}
  • 2 days of hypothermia (32-34 C) + 3 days of normothermia (36-37.5 C)
• SIDS: refer families for screening of arrhythmia