PEDIATRIC RESUSCITATIONS AND ACLS

GOALS:

After reviewing this section, you should be able to

1. Classify patients by age according to the PEP Nomenclature.
2. Perform a "Rapid Cardiopulmonary Assessment" and decide whether a pediatric patient is in shock (and/or respiratory failure requiring intubation) or not, based on the exam findings.
3. Recall dosages of epinephrine and atropine for pediatric arrest
4. Figure out dosages of other ACLS drugs by using the adult drug doses.
5. Recall when atropine is first-line drug for any pediatric arrhythmia (hint: Never!)
6. Recall pediatric defibrillation doses for ACLS.
7. Run a pediatric arrest according to pediatric ACLS algorithms.
8. Explain the clinical importance and practical applications of the following PALS concepts:
    1. "Pediatric patients in shock are usually in compensated shock"
    2. "Most pediatric cardiac arrests are secondary to progressive respiratory failure"
    3. "Sepsis and hypovolemia frequently contribute to cardiovascular collapse (shock) and cardiac arrest in pediatric patients."
9. Recall appropriate ventilation rates and ventilation-to-compression rates for 1- rescuer and 2 – rescuer CPR in infants and children.
10. Recall indications for starting chest compressions in a pediatric patient with severe symptomatic bradycardia.
11. Recall indications for atropine in a pediatric patient with PEA. (Never!)
12. Recall indications for atropine in a patient with asystole (Never!)

I. PEP NOMENCLATURE

PEP classifies pediatric patients as neonate, infant, child, or adult as follows:

CLASS	AGE
Neonate	**< 1 mo**
Infant	**1mo-1 yr**
Child	**1-10 yr**
Adult	**≥ 10 yr**

Why is it important to memorize the PEP nomenclature?

Just by knowing the PEP nomenclature, you will automatically be able to rapidly determine the appropriate BVM size, ventilation rate, and compression**:**ventilation ratio.*

*** Knowing PEP Nomenclature = Knowing Appropriate CPR Parameters**

PALS Nomenclature	**ADULT** (≥10yo)	**CHILD** (1-10 yo)	**INFANT** (1mo- 1yr)	**NEONATE** (<1mo)
BVM size	Adult	Medium	Small	Neonate
Ventilation Rates (breaths/min)	10	20	30	40
CPR Compression**:**Ventilation Ratio	30:2	30:2 1- rescuer 15:2 2- rescuer	30:2 1-rescuer 15:2 2- rescuer	3:1

*** Note: Just by knowing the PEP nomenclature, you will automatically be able to rapidly determine appropriate BVM size, ventilation rate, & compression : vent ratio.**

II. AXIOMS OF PEDIATRIC RESCUSITATION

1. COMPENSATED SHOCK = SHOCK WITH NORMAL BP

2. UNLIKE ADULTS, PEDIATRIC PATIENTS IN SHOCK ARE USUALLY IN "COMPENSATED SHOCK"

In pediatric patients, hypotension may occur only as a premorbid event (followed by rapid progression to full cardiac arrest) when it may be already too late to salvage the patient.

Since salvageable patients in shock will have normal BP and may not appear as severely ill as they really are, you need to identify the unstable patient with pulmonary and/or circulatory failure and impending cardiopulmonary arrest by performing a "**Rapid Cardiopulmonary Assessment**" on any infant or child who appears ill. Based solely on a very focused physical exam, it rapidly identifies patients with inadequate ventilation (respiratory failure requiring intubation) and/or end-organ hypo-perfusion (compensated shock), and takes less than 30 seconds to complete:

3. RAPID CARDIOPULMONARY ASSESSMENT (Following ABC's)

A rapid clinical evaluation to assess both 1)breathing and 2) end-organ perfusion, in order to identify compensated shock and/or respiratory failure, OR any illness severity requiring immediate intervention:

THE RAPID CARDIOPULMONARY ASSESSMENT

A – airway

B – breathing

head bobbing, grunting (impending respiratory arrest!)
respiratory rate, aeration, retractions, breath sounds, I:E, O2 sat

C – circulation

brain – mental status, tone
skin – clammy, mottled, pale, cyanosis
pulses (feet), cap refill (toes)

INDICATIONS FOR THE RAPID CARDIOPULMONARY ASSESSMENT
Extremes of HR or RR or hemodynamically unstable.
Ill-appearing
Abnormal pulse pressure (wide or narrow)
Any signs of hypoperfusion
Very young infants

4. MOST PEDIATRIC CARDIAC ARRESTS ARE SECONDARY TO PROGRESSIVE RESPIRATORY FAILURE

If you are called emergently to the bedside of a pediatric patient who is bradycardic and appears to be in extremis or shock[1], it is likely the result of inadequate, ventilation or profound hypoxemia from respiratory failure (and **not** a primary arrhythmia of cardiac etiology). Grabbing the ambu bag (not the atropine! [2]) and rapid intervention to establish adequate ventilation (with 100% oxygen by BVM) is the most important initial step to correct it and prevent cardiac arrest[3]. Often such patients may respond immediately to BVM ventilation alone with a dramatic rise in heart rate toward normal.

However, if there is not a rapid response to BVM ventilation in a patient with signs of severe hemodynamic compromise (lethargy, hypotension, or extremis) and a pulse rate of < 60, chest compressions(3) should be initiated immediately.

5. SEPSIS AND HYPOVOLEMIA ALSO MAY FREQUENTLY CONTRIBUTE TO CARDIOVASCULAR COLLAPSE (SHOCK) AND CARDIAC ARREST IN PEDIATRIC PATIENTS:

Therefore, aggressive IV fluid boluses (20-100 cc/kg in the 1st hour of resuscitation) are often indicated in pediatric shock and cardiac arrest.

For instance, in the above patient scenario, if following BVM-assisted ventilation the patient's heart rate increases but a rapid reassessment (using the **"Rapid Cardiopulmonary Assessment"** outlined above in #3) reveals the patient is still in shock, IV fluid bolus (NS) of normal saline (20 cc/kg), given IVP by syringe at bedside as quickly as possible) would be a reasonable next strategy (especially in the setting of a respiratory or infectious illness preceding the event).

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[1] Infants and young children who become bradycardic will rapidly decompensate into shock, since they have a rate-dependent cardiac output due to a fixed stroke volume.

[2] Unlike adult ACLS, atropine is of no proven benefit for pediatric symptomatic bradycardia. 1st line intervention is ventilation; then if no response and HR < 60, initiate chest compressions even in patient with pulse (see below), followed by epinephrine 0.1 cc/kg (1:10,000) as the 1st line pharmacologic agent. (Atropine 0.02 mg/kg is 2nd line agent if no response to epinephrine)

[3] Bradycardia is usually a preterminal rhythm in pediatric patients, with cardiac arrest imminent. Therefore, if signs of severe hemodynamic compromise (hypotension, lethargy, extremis) and HR < 60, initiate compressions while patient still has a pulse.

III. MODIFICATIONS OF ACLS ALGORITHMS FOR PEDIATRICS

All the arrhythmia algorithms are EXACTLY the same in children and adults, except for the following modifications which you MUST KNOW COLD:

ALGORITHM	PEDIATRIC ACLS	ADULT ACLS
Asystole PEA	Epinephrine 1st line drug Atropine not indicated	Same as for Pediatric ACLS 2013 Revised AHA Guidelines : Atropine not indicated for adult PEA/asystole
Severe symptomatic bradycardia* ***(HR<60, poor perfusion)**	BVM ventilation Chest compressions Epinephrine 1st line drug *Atropine 2nd line drug*	100% O2 by NRB No chest compressions Atropine 1st line drug (0.5mg) Epinephrine not indicated
Defibrillation for pulseless VF/VT	SAME dosing for both monophasic & biphasic defibrillators: 1st shock: 2J/kg 2nd shock: 4J/kg Subsequent shocks: 4-10 J/kg	Biphasic : 200 J Monophasic : 360 J

IV. PEDIATRIC WEIGHT BASED ACLS DRUG DOSAGES

The 3 MUST KNOW drugs for pediatric ACLS:

DRUG	PEDS DOSE	MAX DOSE (adult dose)
Epinephrine 1:10,000 (IV; IO)	0.1 cc/kg	1AMP (10cc)
Sodium Bicarbonate	1meq/kg	1 AMP (50meq)
Atropine (2nd line drug for bradycardia)	0.02 mg/kg (min dose = 0.1 mg)	0.5mg

ALL OTHER ACLS DRUGS : (ADULT DOSE IS SAME MG/KG DOSE AS PEDS DOSE)

DRUG	ADULT DOSE* ***ALWAYS the max. Pediatric dose**	PEDIATRIC DOSE (MG/KG)
Lidocaine	70-100 mg **(1.0 – 1.5 mg/kg for 70 kg adult)**	1.0-1.5 mg/kg
Amiodarone	300 mg **(5 mg/kg for 60 kg adult)**	5 mg/kg
Adenosine	1st dose: 6 mg 2nd dose: 12 mg **(0.1 – 0.2 mg/kg for 60 kg adult)**	1st dose: 0.1mg/kg 2nd dose: 0.2mg/kg
Procainamide	1000 mg **(15mg/kg for 60 kg adult)**	15 mg/kg

NOTE: THE SAME PRINCIPAL APPLIES FOR INTUBATION DRUG DOSAGES:
(ie- ADULT DOSE IS SAME MG/KG DOSE AS PEDS DOSE)

DRUG	ADULT (MAX) DOSE	PEDIATRIC DOSE (MG/KG)
Etomidate	20 mg	0.3 mg/kg
Ketamine	100 mg	1.5 mg/kg
Thiopental	350 mg	3-5 mg/kg
Succinylcholine	100 mg	1.5 mg/kg
Rocuronium	84 mg	1.2 mg/kg
Pancuronium Vecuronium	10 mg	0.15 mg/kg (defasciculation = .015 mg/kg)

READ THIS:

If you forget the pediatric weight-based (mg/kg) drug dose, you can use the adult dose to help you remember it:

For instance: the cardiac arrest dose of amiodarone for a 60 kg adult is 300 mg. Dividing the adult dose of 300mg by the adult weight of 60kg would give you **5 mg/kg, the same as the pediatric dosage!** In other words, a 6 year old 20kg child who is 1/3 the weight of a 60kg adult would get 1/3 the adult (300mg) dose of amiodarone, namely 100mg (5mg/kg).

This method works for lidocaine, amiodarone, adenosine, and procainamide! It works for all the RSI/intubation drugs too! It does NOT work for epinephrine (or atropine or bicarb) and since epinephrine 1:10,000 is always the first-line drug pediatric pulseless arrests, you better memorize the dose: 0.1cc/kg!!

REMEMBER!!!

FOR ACLS & RSI DRUGS:

- Adult dose is always maximum dose
- Adult dose is the mg/kg dose for pediatric ACLS for lidocaine, amiodarone, procainamide, adenosine.
- Double-check your pediatric doses by considering patient's weight and dose as a percentage of the adult weight and dose.
- Epinephrine dose (1:10,000) for ACLS is always 0.1cc/kg!!
- Epinephrine 1:10,000 0.1cc/kg is always 1st line drug for all pediatric ACLS pulseless arrest and bradycardia algorithms!!

V. PEDIATRIC AIRWAY/RSI FORMULAS AND MNEMONICS

1. ETT FORMULAS:

A. ENDOTRACHEAL TUBE (ETT) SIZE:

If ≤ 1 yo:

FT Newborn	6 months	1 year
3.0-3.5	3.5 – 4.0	4.0-4.5

If > 1 yo: Use formula** $\frac{\text{age} + 16}{4}$ **(Maximum ETT size = 8.0)**

**** NOTE:**
1) Using this formula results in cuffed ETT sizes for children ≥8 years old and un-cuffed ETT size for children < 8 years old.
2) For children < 8 years old, subtract 0.5 from result to determine proper cuffed tube size.

B. ETT DEPTH OF INSERTION (TO ANTERIOR LIP LINE):

If **> 1 yo : Use formula: (ETT size) X 3**
(Maximum depth of insertion = 21 cm)

If **< 1 yo :**

FT newborn	6 mo	12 mo
9	12	12

2. LARYNGOSCOPE BLADE MNEMONIC:

MNEMONIC	EXPLANATION
"0 AT 0"	#0 blade in neonate < 1 mo
* "1 AT 1"	#1 blade at both 1mo & at 1 yo
"2 AT 2"	#2 blade at 'close to' 2 yo (ie- ≥ 1½ yo)
** "3 -CURVED ADULT"	#3 blade at ≥ 10 yo (adult)

*** Switch from straight blade, &begin using a curved blade when age is ≥ 6 months old**

**** A "3-CURVED" is an adult-sized blade, & in PEP nomenclature ≥ 10 yo is an "Adult". Hence the mnemonic "3-CURVED ADULT" for children ≥ 10 yo.**