

Pediatric Cardiac Arrest

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Patient 1

- 3 month old female, previously healthy
- Dropped off at in-home daycare at 0700
- Estimated weight 5 kg
- Found unresponsive in crib
- 911 called with CPR in progress

Patient 1

- EMS arrival – infant lying on floor, CPR not in progress
- Initially paramedic thought pulse present
- Moved quickly to unit where no pulse noted
- CPR started, IO attempted without success
- CPR/BMV to Children's ED in full arrest
- Monitor shows asystole throughout

- What do you think?

Patient 1

- Other Information from EMS record
 - Oral airway placed at the scene
 - Towel placed under shoulders
 - No medications given

Patient 1

- What do you all think?
 - EMS response reasonable?
 - Therapy reasonable?
 - Feel ready for this today?

Patient 1

- ED Therapy
 - 10:55 - CPR/BMV continued
 - 11:00 - Intubated with 3.5 uncuffed ETT (2nd attempt)
 - 11:00 - IO Placed
 - Next 30 min
 - 6 doses of 1:10,000 epinephrine
 - 3 doses sodium bicarbonate (1 initially, 2 more later)
 - 1 dose atropine for bradycardia
 - 1 fluid bolus 100 ml of NS
 - Epinephrine drip started after pulses returned

Patient 1

- Initial Lab Values:
 - pH 6.68, pCO₂ 55, PO₂ 113, BD >30
 - Na 143, K 8.5, Cr 0.82, Glucose 273
 - AST 1798, ALT 1434, Lipase 848

Patient 1

- PICU Therapy
 - Pt arrives significantly acidotic
 - Continued inotropic support
 - Improved ventilation – to normal/low PCO₂
 - Need IV access
 - Pt sedated & paralyzed
 - Central/arterial lines placed
 - CT/MRI
 - Severe hypoxic brain injury
 - Withdrawal of support about 48 hours after admission

Review

- Infant found pulseless and apenic
 - Possible etiologies?

Review

- Most common causes of post-neonatal deaths (28 days to 1 year)
 - SIDS (22%)
 - Congenital malformations (17%)
 - Accidents, unintentional injuries (11%)
 - Cardiac disease (4%)
 - GI disease (3%)
 - Homicide (3%)
 - Septicemia (3%)
 - Influenza/pneumonia (2.5%)

SIDS

- The sudden death of an infant under one year of age which remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene, and review of the clinical history.

Review

- Is CPR effective for out-of-hospital cardiac arrest in children?
 - Yes!
 - Compressions and rescue breathing is best
 - Rescue breathing or compressions better than nothing
 - When is it effective?

Review

- Houston study on drowning
 - 72% of children with ROSC *prior* to EMS arrival following bystander CPR survived to hospital discharge with good neurologic outcomes
 - All had signs of significant hypoxia upon arrival to the ED so likely were in real arrest
 - < 5% of children who remained pulseless/apenic upon EMS arrival survived and no survivors were neurologically intact

Patient 2

- 13 year old female playing soccer at school
- Feels faint, then collapses
- Trainer quickly at her side begins CPR
- Previously healthy

- What do you suspect?

- Next steps?

Patient 2

- Teammate's dad sheriff's officer
- Has AED in trunk of patrol car
- AED applied and delivers 3 shocks within 3 minutes of the patient collapsing
- Fire crew arrives 8 minutes following call
- EMS (with ALS crew) arrives 3 minutes later

Patient 2

- Pulses present when fire arrives
 - EMS crew starts IV
 - Patient awakening
 - Taken to Children's
 - Discharged home 4 days later following internal defibrillator placement
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- Take home message – AED's work for children also!
 - Final diagnosis?

Cardiopulmonary Resuscitation

- Two phases important for EMS
 - Cardiac Arrest (no-flow)
 - Cardiopulmonary resuscitation (low-flow)
- Priorities?
 - Airway
 - Breathing
 - Circulation

Cardiopulmonary Resuscitation

- Most common cause of cardiac arrest in kids?
 - Respiratory arrest
 - How about trauma?
 - Still respiratory arrest
- Therefore A & B receive priority
 - Why can a respiratory arrest be worse than a sudden cardiac arrest?

Cardiopulmonary Resuscitation

- Airway/Breathing
 - Secure the airway
 - Clearing
 - Positioning
 - “Sniffing” position
 - Provide ventilation
 - Bag Mask Ventilation remains the cornerstone of providing effective ventilation
 - Studies show no difference in outcomes between BMV and ETT insertion with ventilation

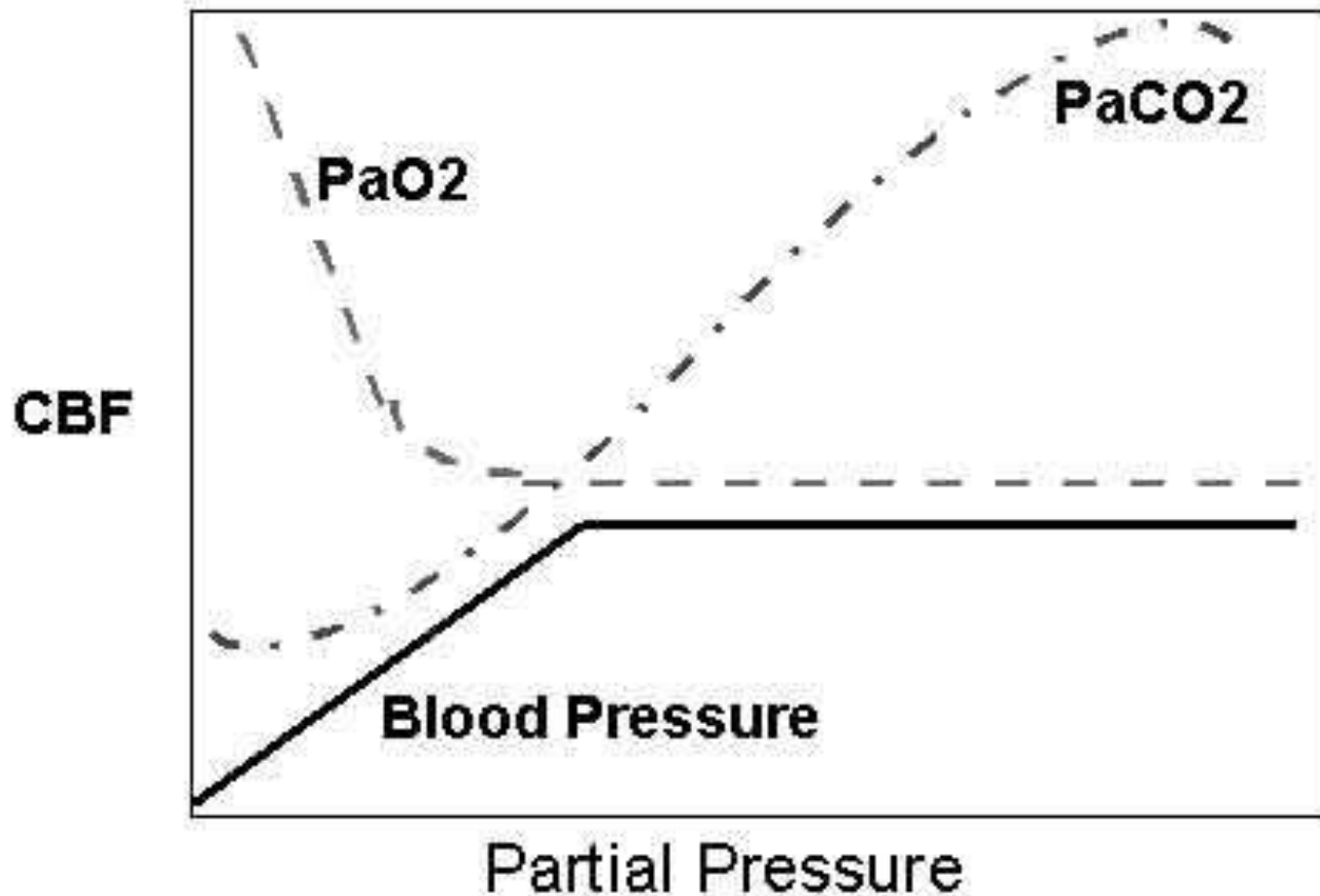
Ventilation

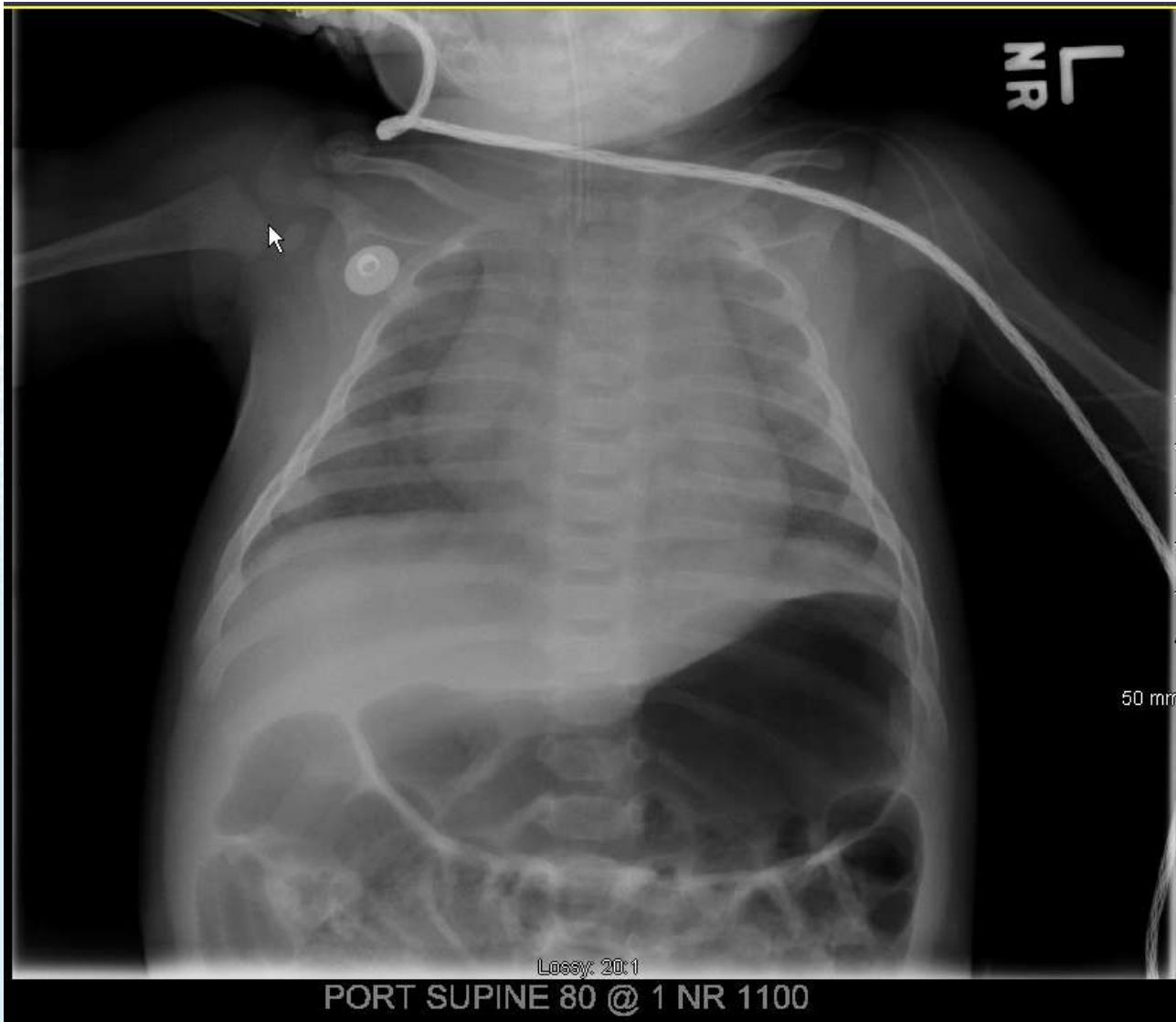
- Problems with ventilation
 - What commonly happens when, during a stressful event, we start bagging a patient?
 - Hyperventilation

Ventilation

- What problems can over-ventilation cause?
 - Pneumothorax
 - Abdominal distention
 - Increased intrathoracic pressure
 - What does this do?
 - Profoundly decreases $p\text{CO}_2$
 - What does this cause?

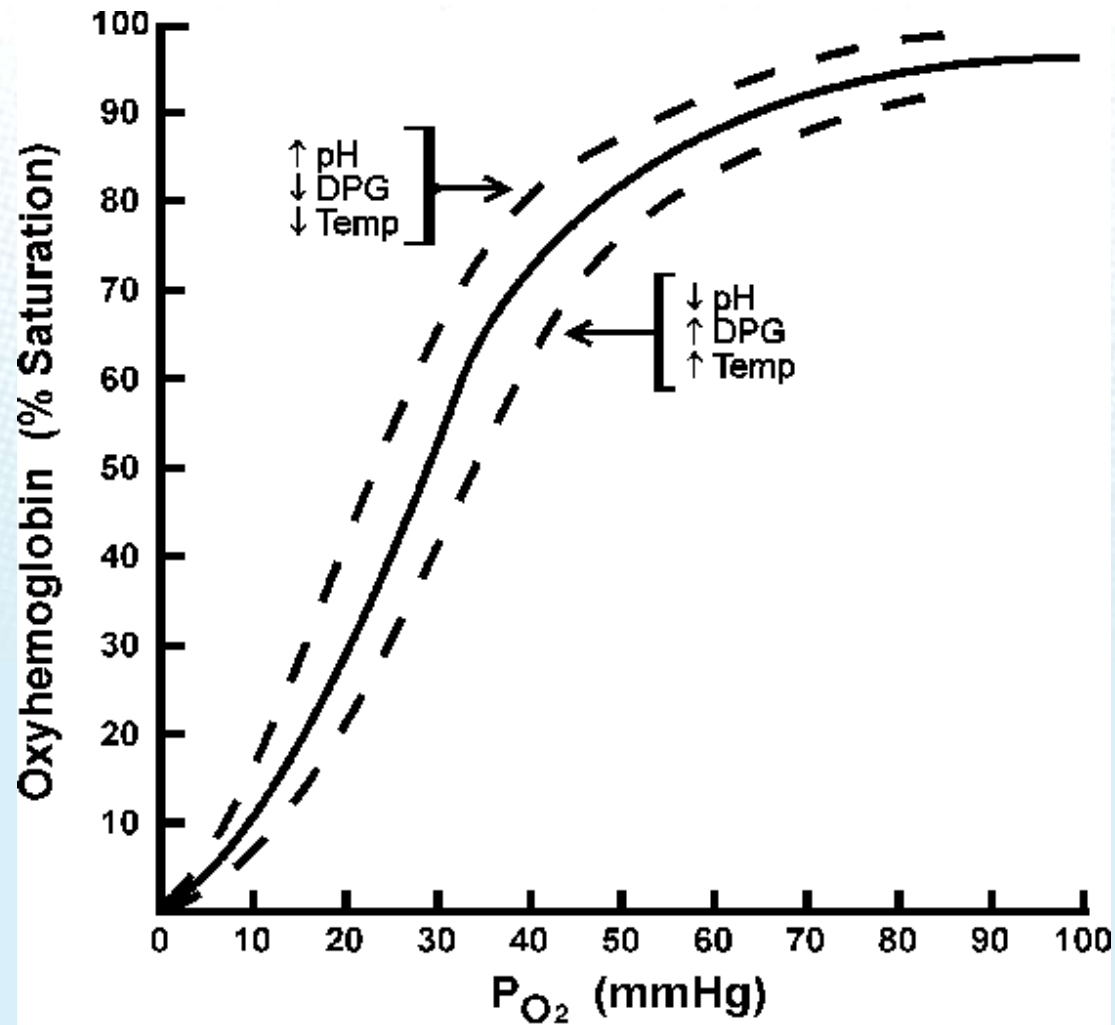
Effect of Blood Gases on Cerebral Perfusion





Circulation

- Push hard and push fast
 - Remember no flow occurs without compressions
 - Need to fill the heart between compressions so full recoil needed
 - Circumferential compressions “two thumb” is more effective if possible
 - **Minimal** interruptions



Glucose

- What does hyperglycemia do to outcomes following brain injury?
- Glucose for a neonate is reasonable, otherwise only if hypoglycemia is present
- NS/LR are perfectly fine for initial resuscitation
 - Glucose is frequently > 200 upon arrival
 - Stress causes glucose to rise so generally hypoglycemia is not an issue

Patient 3

- 6 month old male found apneic in car seat by father
- Calls 911, starts CPR
- Previously healthy

- Thoughts?

Patient 3

- EMS/fire arrive, continue CPR/intubate
- Patient transported to Children's, pulse eventually returns
- Thoughts?
- What if we add the anterior fontanelle is full and the left pupil is blown?

Patient 3

- Large subdural hematoma with severe hypoxic injury
 - 7 other scattered fractures
 - Bilateral retinal hemorrhages/detachments
 - Patient proceeds to brain death
-
- Thoughts now?

Other Thoughts

- “Sedation/paralysis limits neurological exams”
 - Treat the patient, not the future
 - Ask for pain meds if needed
 - Sedation/paralysis if needed to support ABC’s
 - Breathing abnormalities common, may have to sedate/paralyze

Other Thoughts

- “Getting to the hospital faster is always better”
 - What did we do that EMS couldn't?
 - CPR
 - Intubation
 - Placed IO
 - 6 doses of 1:10,000 epinephrine
 - 3 doses sodium bicarbonate
 - 1 dose atropine for bradycardia
 - 1 fluid bolus 100 ml of NS
 - ***Epinephrine infusion started after pulses returned***

Other Thoughts

- Rushing or “Freaking out” generally does not help in any situation
- Systematic approach (Safety, ABC’s)
 - Remember minimal interruptions
 - One extra minute of effective CPR in controlled fashion is better than many interruptions while rushing to depart/arrive
- Focus should be on delivering oxygen

Other Thoughts

- In fact, *each* and *every* action you undertake should be with the specific intention of delivering oxygen

Airway

- Intubation
 - What are your protocols?
 - Is the anatomy different in kids making it easier or harder?
 - Why can't I see the cords?
 - Wow, this kid is anterior!
 - Is there a reason my ETCO_2 detector is not changing color?
 - Maximize the possibility of success
 - Hold CPR
 - Plan the procedure, take your time, find the landmarks

Airway

- Intubation

- What size tube should I use?

- Sizes (uncuffed)

- Newborn = 3.5

- 6 m.o. = 4.0

- > 1 yr: $\text{Age (y)} / 4 + 4$

- Example 1 yr old = $\frac{1}{4} = 0.25 + 4 = 4.25 = 4.0$ or 4.5

- Size of pinky finger

Airway

- What about these cuffs?
- Purpose?
- Do I need to adjust the size
 - Yes, $\frac{1}{2}$ size smaller

Airway

- Intubation – How deep?
 - Depth
 - > 1 yr: $\text{Age (y)} / 2 + 12$
 - Watch lines go through cords
 - Watch/listen to chest

Airway

- Adjunct devices
 - Oral/Nasal airway
 - LMA
 - King
 - Fiberoptic
 - Others?

Airway

- The difficult airway
 - What do you do?
 - BMV with oral airway?
 - Cricoid pressure?
 - Two person insertion?
 - Tactile/blind intubation?
 - Bring clean underwear?

Airway

- Which patients are known to have a difficult airway?
 - Trisomy 21 (Down's Syndrome)
 - Pierre Robin
 - Treacher Collins

We know children.



We know children.



Access

- IO Access
 - In an arrest, just place an IO?
 - Maybe in non-arrest also
 - Is there an advantage for IV vs IO?
 - No
 - Maximize the possibility of success
 - Have everything prepared
 - Hold CPR – good time to check for pulse
 - Secure well

Overall

- Prepare for success (and increase your chances!)
 - Plan/prepare (play what-ifs)
 - Stop everything else and focus on current job
 - Take your time
 - Work systematically
 - Never rush
 - Trust your training/instincts

Overall

- Practice!!!
- Call Children's ED or PICU and ask for the department manager
- Come see sick kids for a day or at least a few hours