Monitoring, Common Problems & Possible Solutions

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- No disclosures to declare

Problem
What are we Monitoring?

Assimilate what's happening around us

- The patient
- Equipment
- Monitors
- Medication
- Surgery
- Bleeding
- Operating Room…sights, sounds, smells

Specific Challenges in Pediatric Monitoring

Clinical judgment of utmost importance
Cannot always rely on devices

- Wide range of equipment sizes required for safe, high-quality anaesthesia, often absent / lacking
- Hemodynamic and respiratory monitors routinely used
- Brain function is most vulnerable and least monitored

Solution to Monitoring

- Super Human, Competent, Experienced Pediatric Anesthesiologist

- The Perfect Ultimate Ideal Monitor
- Easy to set up
- Provide continuous, noninvasive, accurate, reproducible real-time measurements
- Display end organ function

So far, this monitor not yet been available!

Know your monitors and their limitations/problems

Noninvasive Monitoring Equipment

Oxygen monitor
Electrocardiograph
Blood pressure devices
Pulse oximetry
Precordial stethoscope
Capnography, anesthetic gas concentrations
Temperature, neuromuscular

Oxygen Monitor

Keep an eye on it!
We may not pay much attention to this!

Should be calibrated & alarm limits set before induction

Pulse Oximeter

- Malfunctioning probe
- Improper placement

Toe too big for probe!
Light inadequately detected
Compromised circulation
Damage to probe

Correct use of Pulse Oximeters

- Emitter & detectors must be opposite each other
- Light must reach the detector only through tissue
- Insert digit fully into probe

Too tight: Constricts finger
Pressure necrosis

Too loose: May fall off
Let ambient light in

Ear lobe vasoconstriction

- Cold
- Hypovolemia

Gently rub ear lobe & reapply

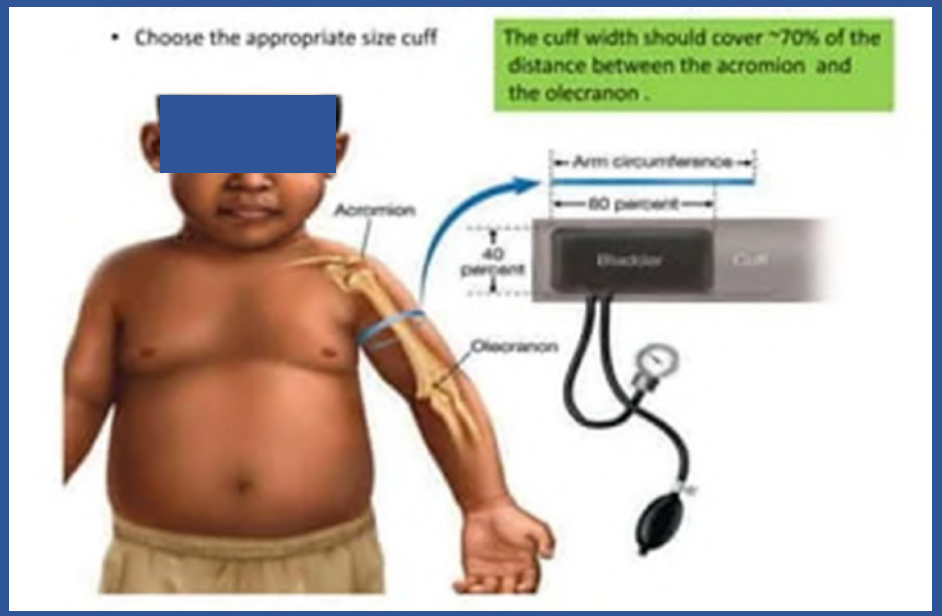
Pulse Oximeter Trouble Shooting

- Nail polish / dirty skin / dirty probe: clean with alcohol swab
- Maligned probe: reposition

Malfunction

- Cold extremity, poor perfusion, motion artifact: use alternative site
- Electrocautery, BP cuff inflation: Place probe on your own finger
- Flickering or bright ambient light: shield probe with covering
- Arrhythmias or injected dye
- Extensive burns : can apply to tongue

Blood Pressure Devices



Appropriate size BP cuff
Cover 2/3 upper arm / thigh length

Too small:
Incompletely occludes artery
Premature return of flow
False high BP recording

Too wide: false low recordings

Proper application: Bladder cuff should rest over the artery

Automated BP Devices Precautions

- Inflation not more that 2-3 minute intervals

Adequate deflation time imperative:

Problem:

  - Venous stasis
  - Petechiae
  - Nerve compression damage

- Match cuff size with appropriate tubing for that size

*Inaccurate measurements with cuff around the calf

Problems with Automated BP Monitoring

- Underestimates BP if HR outside normal ranges

  e.g., Atrial fibrillation*

*Zhao X, et al. Hypertens Res. 2022; 45(7):1183-1192. doi: 10.1038/s41440-022-00897-1.

- Inaccurate readings: movement, noise, vibrations
- Less reliable:

  Higher doses of norepinephrine

  Lower MAP value

  Higher BMI

*

BP Cuff Location & Deviations of NIBP

- Leg NIBP lower than arm measurements in children

Soft, compliant arteries

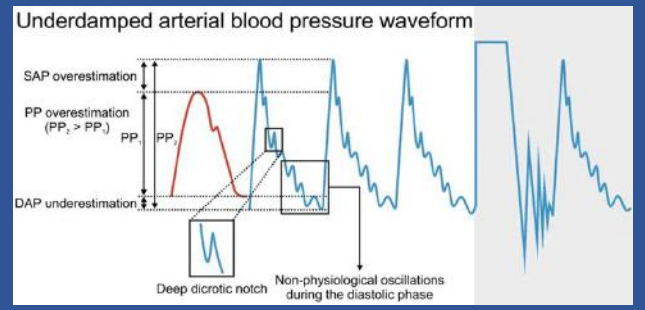
- ↓ sympathetic tone
- ↓ blood volume in lower limbs of small children may play a role
-

Invasive Arterial, Central Venous Monitoring

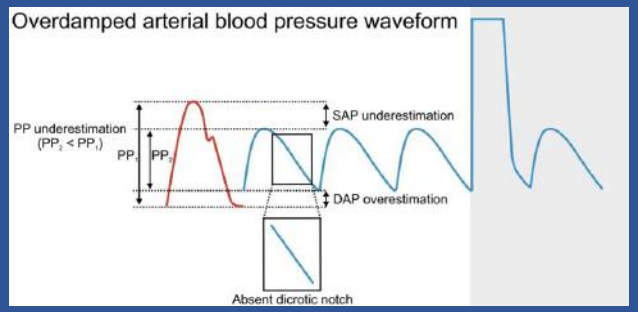
- Pressure transducer level of child’s right atrium
- Intracranial procedures: level of external auditory canal
- ABG: adequate sample aspiration, proper flushing (considerable extension length)

Invasive Arterial Pressure Monitoring: Problems

Inaccurate readings
- Dangerous treatment decisions
- Table repositioned: ? transducer level



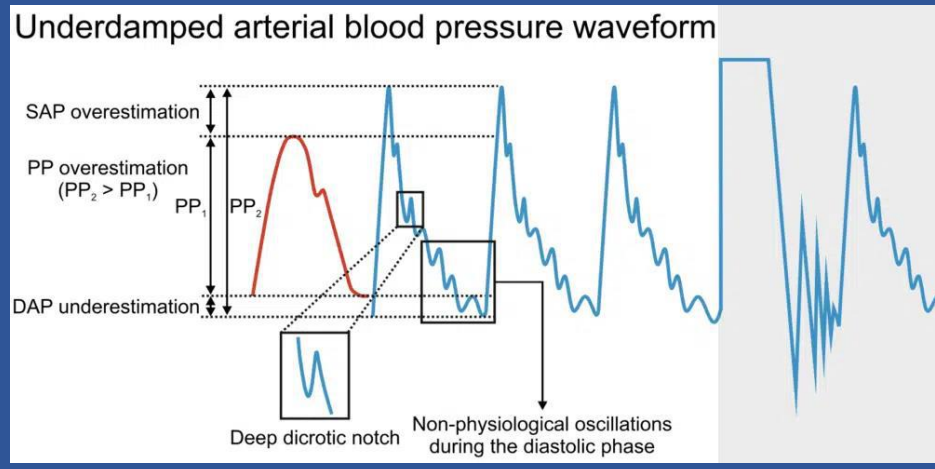
- System not zeroed to atmospheric pressure
- Wrong transducer position
  - Too high: BP readings low
  - Too low: BP readings high



- Damping (check wave forms)
- Inadequate damping: falsely high SBP, low DBP
- Overdamped: falsely low SBP, accurate DBP (catheter tip clot, fibrin)

Solution: Flush

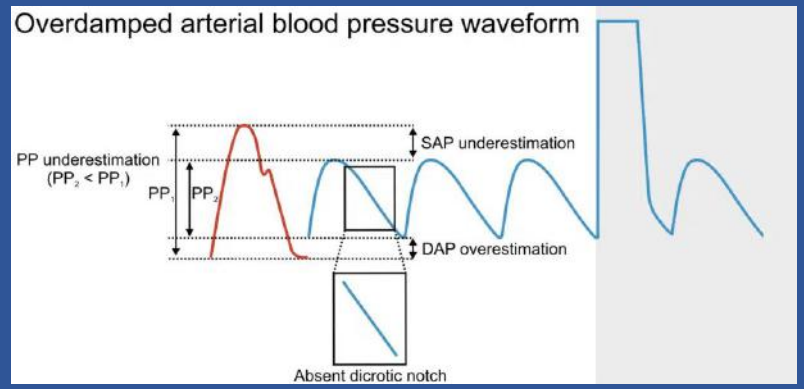
IAPB Problems: Underdamping



Potential causes

- Artifact from catheter (catheter whip)
- Tachydysrhythmias
- Overestimation systolic blood pressure
- Underestimated diastolic blood pressure
- Wider pulse pressure

I AP: Overdamping



Waveform appears unnaturally smooth

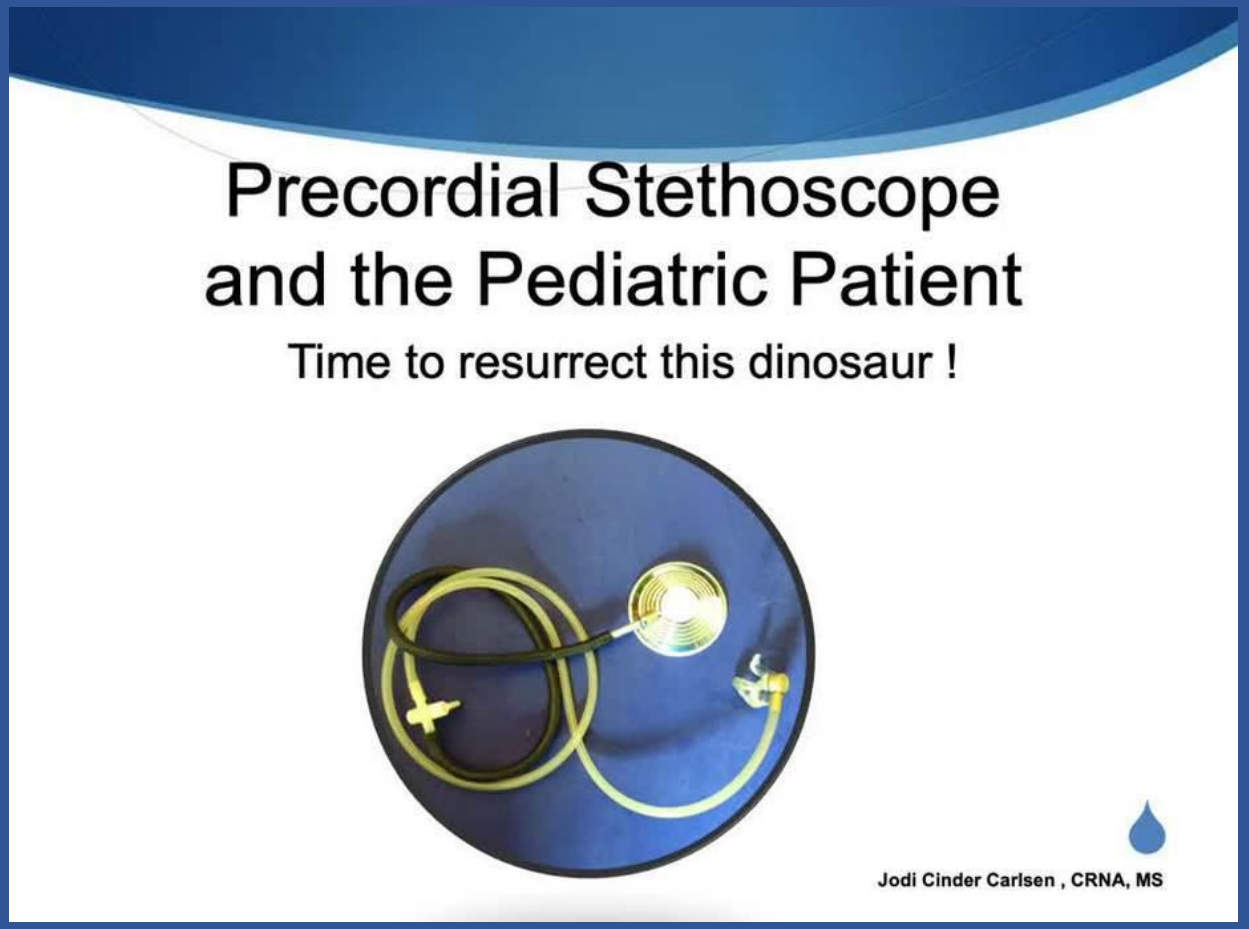
- Diminished or absent dicrotic notch

Potential causes

- Air column or air bubbles in tubing
- Kinks
- Clots

- Underestimated systolic blood pressure
- Overestimated diastolic blood pressure
- Narrowed pulse pressure

Precordial Stethoscope



Precordial Stethoscope

- Can detect
  - Arrhythmias
  - Assess CO
  - Airway obstruction, laryngospasm

Strong heart beat tones are heard, reassuring when monitor fails

- If heart tones weak, then serious problem!
- Early indication of

Major Drawback

Can only detect if connected to the anesthesiologist

Uncomfortable, custom made ear pieces help

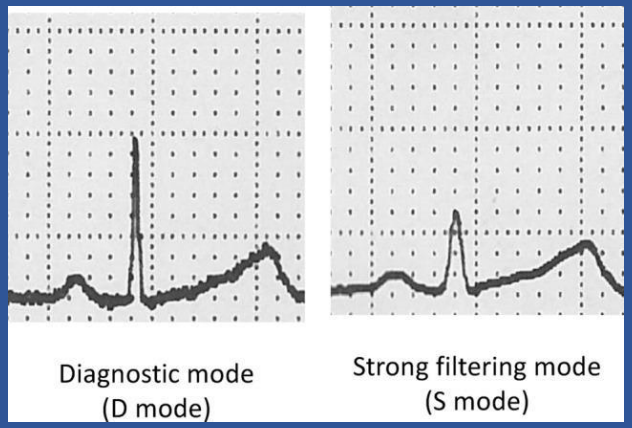
ECG Monitoring

L Arm, R Arm reversal: reversed P wave, QRS complex, T wave in leads I and aVL

Appropriate application:

- Clean skin: Remove lotions, powders, oils (can impede electrical conduction)
- Good electrode attachment (tincture benzoin for adhesive)
- Wet leads with preparation solutions
- Isolate from cautery electrode to avoid electrical burns
- Special ECG leads & monitors required for MRI

ECG



- Decrease R wave height
- Impression of relative high T waves (esp with tachycardias)
- Misinterpret T wave height , when no actual change
- Incorrect diagnoses of suspected

  ischemia, hyperkalemia

Jun Hirokawa J et al. Sci Rep. 2022; 12: 13279. doi: 10.1038/s41598-022-17680-4

ECG Monitoring- Problems

- Muscle movement: creates artifact, difficult to correctly identify alarms
- Electrical discontinuity: cable or lead wire unplugged / broken
- Electrodes: Fresh electrodes, good skin contact (clean , dry skin)
- Interference from electrical sources: power cords, infusion pumps, ventilators
- Monitor settings: impact trace quality, alarm accuracy.

Carbon Dioxide Monitors ($EtCO_2$) Problems

Side stream $EtCO_2$

- Obstructed: water, secretions
- Errors with large dead space ventilation

Main stream $EtCO_2$:

- Heavy, can kink, pull out ETT
- Not accurate in children with pulmonary problems (difference between arterial and $EtCO_2$)
- Accuracy > ETT > LMA > face mask

Nasal / Face Mask $EtCO_2$ Monitoring

- Connecting port:
  - Dislodgement
  - Occludes against tissues
  - Too far from nares

- Expired air may be shunted through the oral cavity

Solutions to $EtCO_2$ Problems

- Replace sampling tube
- Liquid in tubes cause corrosion, forms residues
  - Position sampling tube upwards away from patient (↓chances of liquid in tube)
- Place filters at either end of the sampling tube

Look for signs of poor sampling / artifact

Helps to differentiate real *vs.* inaccurate

Transcutaneous O_2 / CO_2 Monitors

O_2 Monitor (Probe heats skin to 42-44°C)

Affected by:

- Hypotension
- Hypothermia
- Vasoconstricting drugs

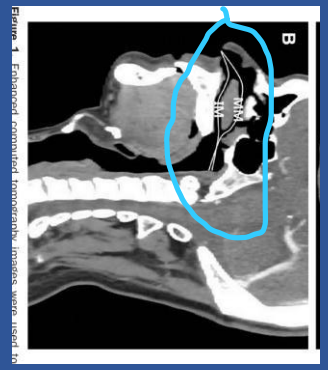
Transcutaneous CO may have a role in children with severe pulmonary disease, inaccurate $EtCO_2$

Problems with Temperature Monitoring

Improper application or insertion

Axillary: Over axillary artery, arm adducted

Nasal:



Esophageal: Placed 2/3 length of esophagus, near the heart
Rectal: Inaccurate in urological & major abdominal surgery
Beware of perforation injury
Forehead: not accurate in cold OT

Problems with Anesthetic Agent Analyzers

- Inaccurate if wrong agent in wrong vaporizer
- Accumulation of methane can cause inaccuracy of agent analysis with closed circuit systems
- Requires periodic flushing of the system

Neuromuscular Transmission Monitoring Problems

- Improper electrode contact (clean the skin)
- Injury caused by prolonged repeated electric current
  Put power off between monitoring
- Needle electrodes: can cause bleeding, infection, burns, nerve injury
- Facial nerve stimulation: false positive results

Conclusion

- We need to understand the operation and limitations of each monitoring device we use
- NEVER rely too heavily on the monitoring equipment
- ENSURE direct, close, personal observation of each child during anesthesia & surgery

Believe the monitor
and
then ……
disprove it

Thank you