DON'T BE SHOCKED BY SHOCK: COMPLICATIONS AND PITFALLS OF MULTI-ORGAN SYSTEM FAILURE

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Children are not small adults; they have special needs and are more susceptible to injury.
CHALLENGES OF THE PEDIATRIC POPULATION

- You can not talk to or reason with them
- They always fight when you try to help
- Parents try to tell you what to do
- You need special size equipment
MOTHER'S LAP
[ The safest place on earth ]
SHOCK

- Acute, progressive, complex state of circulatory dysfunction
- Inadequate tissue perfusion leading to cellular oxygen deficiency
- May be associated with a reduced arterial blood pressure— but not always
- The final common pathway to multiple organ system failure and death
Oxygen Delivery $\neq$ Oxygen Demand
SHOCK: PHASES

• **Compensated**
  - Vital organ function maintained by compensatory mechanisms

• **Uncompensated**
  - Failing intrinsic regulatory mechanisms leads to compromised cardiovascular function

• **Irreversible**
  - Even with return of cardiovascular homeostasis, irreparable organ system damage has occurred
CLASSIFICATION OF SHOCK STATES

- **Hypovolemic**: sudden ↓ volume = “FLUID”

- **Distributive**: loss of vasomotor tone (↑ capacity) = “PIPES”
  - Septic, Anaphylactic, Neurogenic, Adrenal

- **Cardiogenic**: pump failure = “PUMP”

- **Obstructive** = “CLOG”
  - Tamponade, pulmonary embolism
RECOGNIZING SHOCK

- Mental Status
  - Lethargic, sleepy
RECOGNIZING SHOCK

- Airway: if inadequate intervene with airway maneuvers
  - Positioning, suctioning, BMV, supplemental oxygen: 100%
**RECOGNIZING SHOCK**

- **Circulation**
  - palpate pulses comparing peripheral to central
  - Rate, quality

*Vitals help to distinguish early and late shock (**NEED to KNOW NORMAL VITALS FOR PEDIATRIC PATIENTS**)*

Systolic BP: $70 + 2 \times \text{age (yrs)}$
MANAGEMENT

- Rapid stabilization and transport to a center with pediatric capabilities is essential for a good outcome.

  - Airway maneuvers and OXYGEN

  - Support circulatory system
    - Vascular access- DON'T DELAY
    - IVF
      - 20mls/kg NS or LR
**STEP 1:** Make sure the pump is full (volume depletion)

**STEP 2:** Make the train is on a fast track (vascular tone)

**STEP 3:** See if supply is keeping up with demand
MANAGEMENT

- Special Considerations
  - Anaphylaxis $\rightarrow$ epinephrine
  - Cardiogenic Shock $\rightarrow$ minimize fluids because of pulmonary edema
CONCLUSION

- Shock is a pathological state in which the supply of oxygen is insufficient to meet the body’s needs.

- Early recognition is key to preventing decompensation and irreversible organ damage.

- Management requires good assessment skills and knowledge of normal vital signs in the pediatric population.

- Remember your ABCs: give oxygen, control bleeding and give fluids.
Keep your chin up.
No one expected you
to save the world,
otherwise you would
have been born wearing
a cape and tights.

Just do
the best you can.
Recognize decreased mental status and perfusion. Begin high flow O₂. Establish IV/IO access.

**Initial resuscitation:** Push boluses of 20 cc/kg isotonic saline or colloid up to & over 60 cc/kg until perfusion improves or unless rales or hepatomegaly develop. Correct hypoglycemia & hypocalcemia. Begin antibiotics.

**shock not reversed?**

**Fluid refractory shock:** Begin inotrope IV/IO. Use atropine/ketamine IV/IO/IM to obtain central access & airway if needed. Reverse cold shock by titrating central dopamine or, if resistant, titrate central epinephrine. Reverse warm shock by titrating central norepinephrine.

**shock not reversed?**

**Catecholamine resistant shock:** Begin hydrocortisone if at risk for absolute adrenal insufficiency.

Monitor CVP in PICU, attain normal MAP, CVP & ScvO₂ > 70%.

**Cold shock with normal blood pressure:**
1. Titrate fluid & epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL.
2. If ScvO₂ still < 70%
   Add vasodilator with volume loading (nitrovasodilators, milrinone, imipramine, & others)
   Consider levosimendan

**Cold shock with low blood pressure:**
1. Titrate fluid & epinephrine, ScvO₂ > 70%, Hgb > 10 g/dL.
2. If still hypotensive, consider norepinephrine
3. If ScvO₂ still < 70%
   Consider Dobutamine, milrinone, enoximone or levosimendan

**Warm shock with low blood pressure:**
1. Titrate fluid & norepinephrine, ScvO₂ > 70%.
2. If still hypotensive, consider vasopressin, terlipressin or angiotensin
3. If ScvO₂ still < 70%
   Consider low dose epinephrine

**shock not reversed?**

**Persistent catecholamine resistant shock:** Rule out and correct pericardial effusion, pneumothorax, & intra-abdominal pressure >12 mmHg.
Consider pulmonary artery, PICCO, or FATD catheter, &/or doppler ultrasound to guide fluid, inotrope, vasopressor, vasodilator and hormonal therapies.
Goal CI > 3.3 & < 6.0 L/min/m²

**shock not reversed?**

**Refractory shock:** ECMO
SEPSIS AND MORTALITY

- Globally, mortality rates from sepsis are about 1.56M/yr, accounting for 60-80% of all deaths.

- About 6M infants and children die/yr globally with mortality rates 40-50%.

- In the developed world, 5M/yr and rates have risen 8-13%/yr over the past decade though mortality rates are lower, around...