

26th Annual General Pediatric Review & Self-Assessment

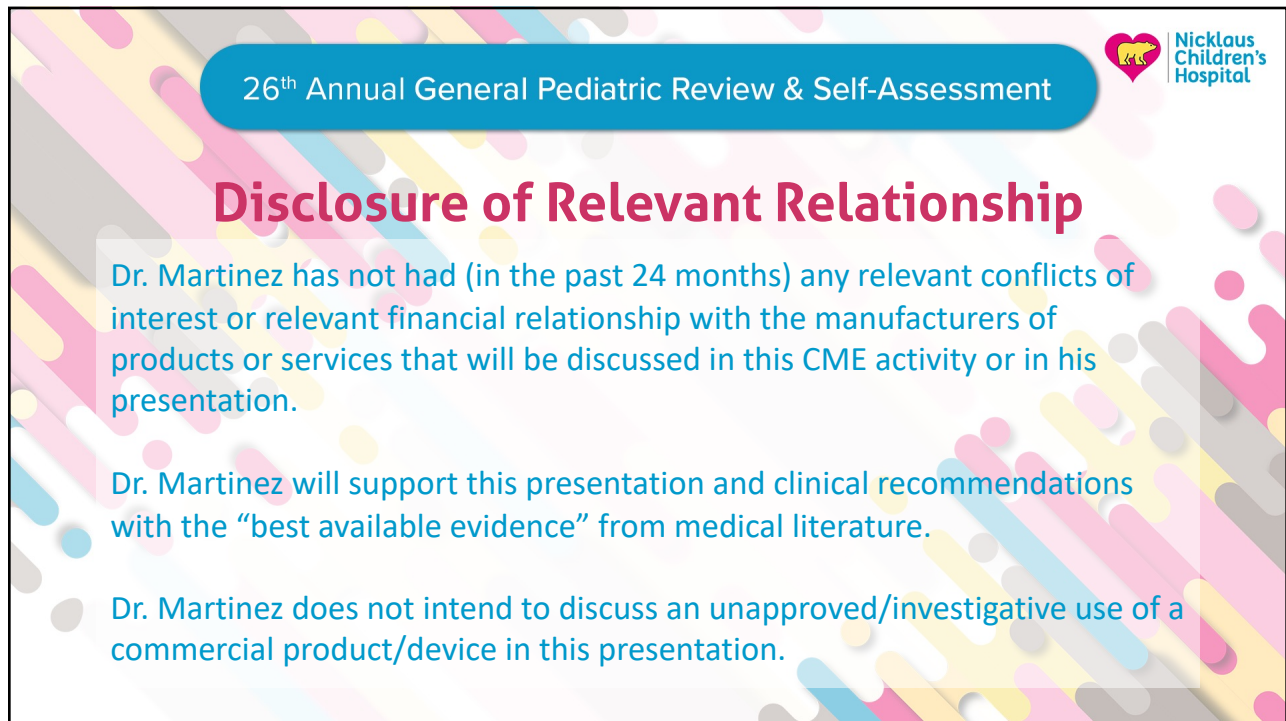
CRITICAL CARE

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Nicklaus Children's Hospital logo

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26th Annual General Pediatric Review & Self-Assessment

Disclosure of Relevant Relationship

Dr. Martinez has not had (in the past 24 months) any relevant conflicts of interest or relevant financial relationship with the manufacturers of products or services that will be discussed in this CME activity or in his presentation.

Dr. Martinez will support this presentation and clinical recommendations with the “best available evidence” from medical literature.

Dr. Martinez does not intend to discuss an unapproved/investigative use of a commercial product/device in this presentation.

Nicklaus Children's Hospital logo

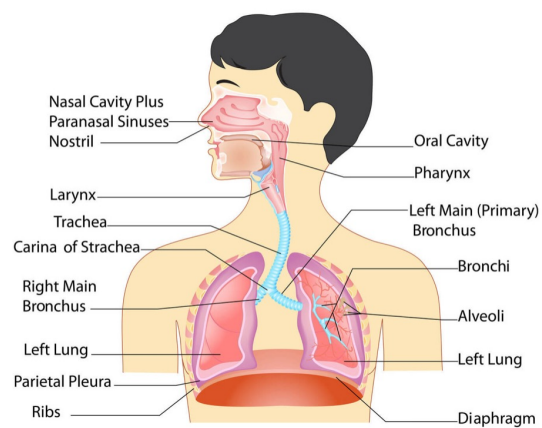
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Objectives

- Understand the definition of respiratory failure
- Recognize the progression to respiratory failure and understand the treatment options
- Understand the definition of shock
- Recognize shock and understand the treatment of its subtypes
- Recognize the common signs and symptoms associated with organ failure

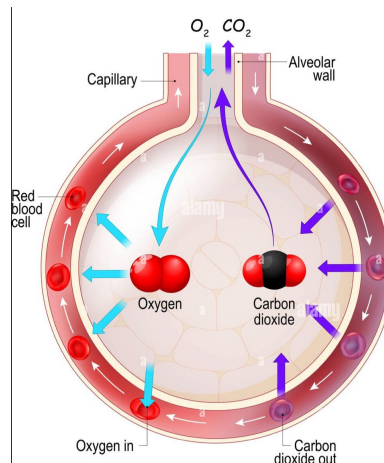
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Respiratory System



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Respiratory System - O₂ in and CO₂ out



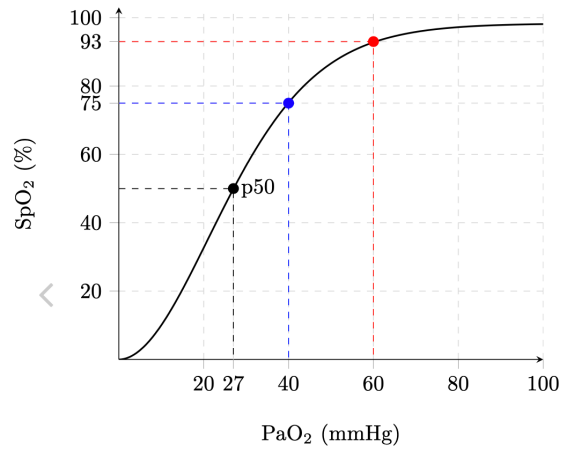
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Acute Respiratory Failure - Definition

- Characterized by the acute inability to oxygenate or ventilate
- Broadly speaking
 - $SpO_2 \leq 90\%$ ($PaO_2 \leq 60$ mmHg)
 - And/or*
 - $PaCO_2$ or $PcCO_2 \geq 50$ mmHg
- Most common predisposition to cardiac arrest in the pediatric population

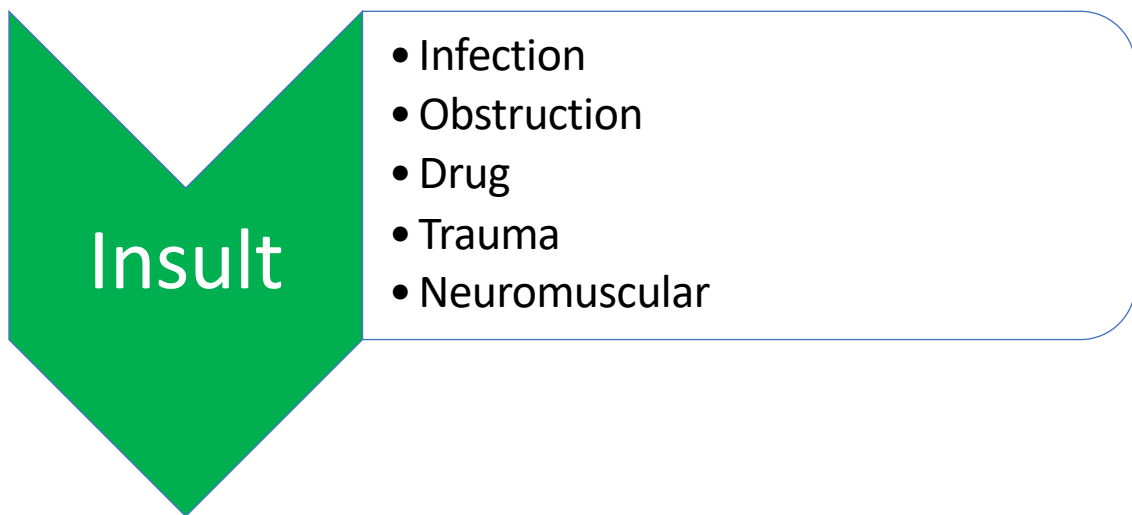
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Acute Respiratory Failure – Hemoglobin Dissociation Curve



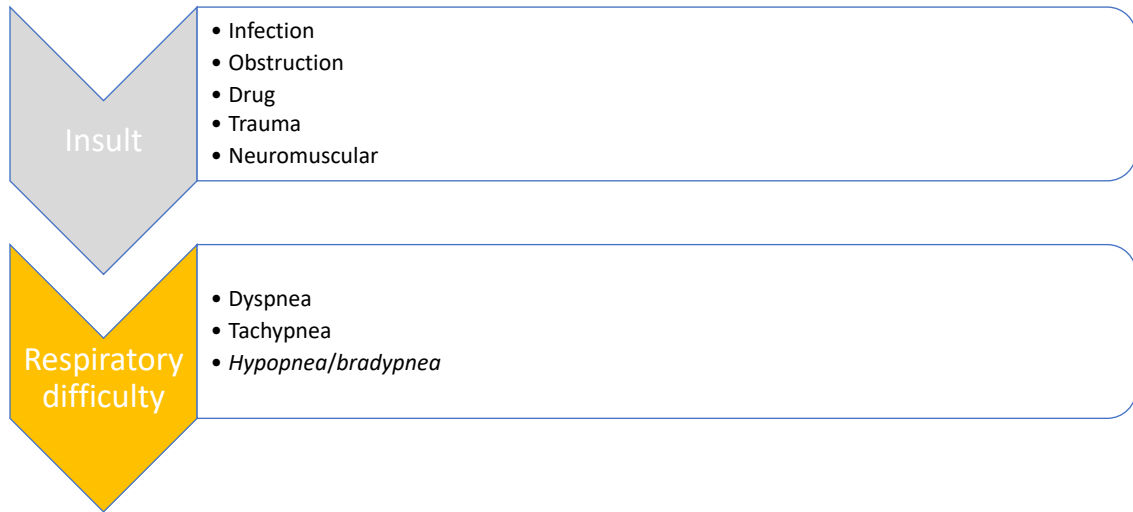
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Acute Respiratory Failure - Progression



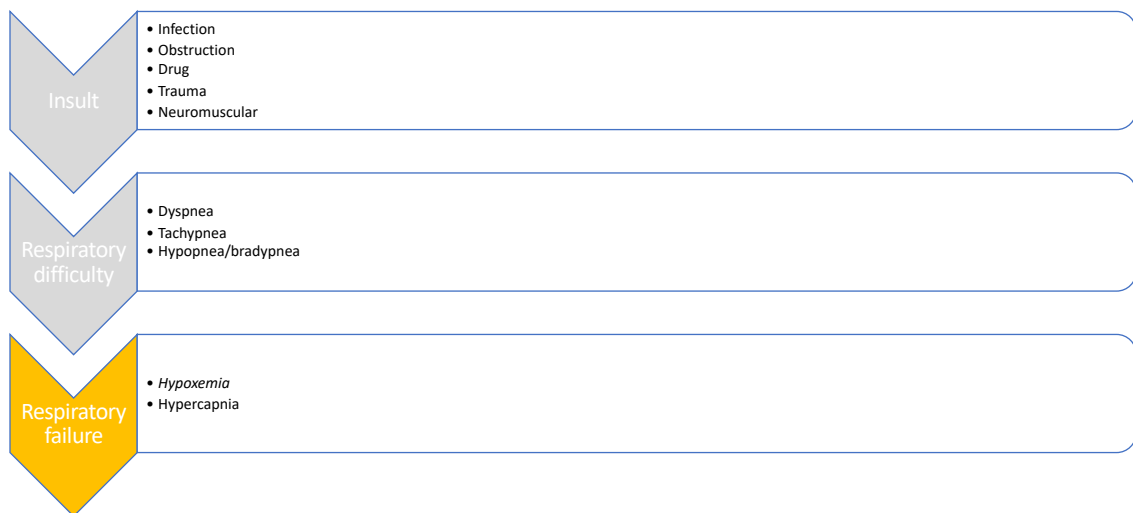
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Acute Respiratory Failure - Progression



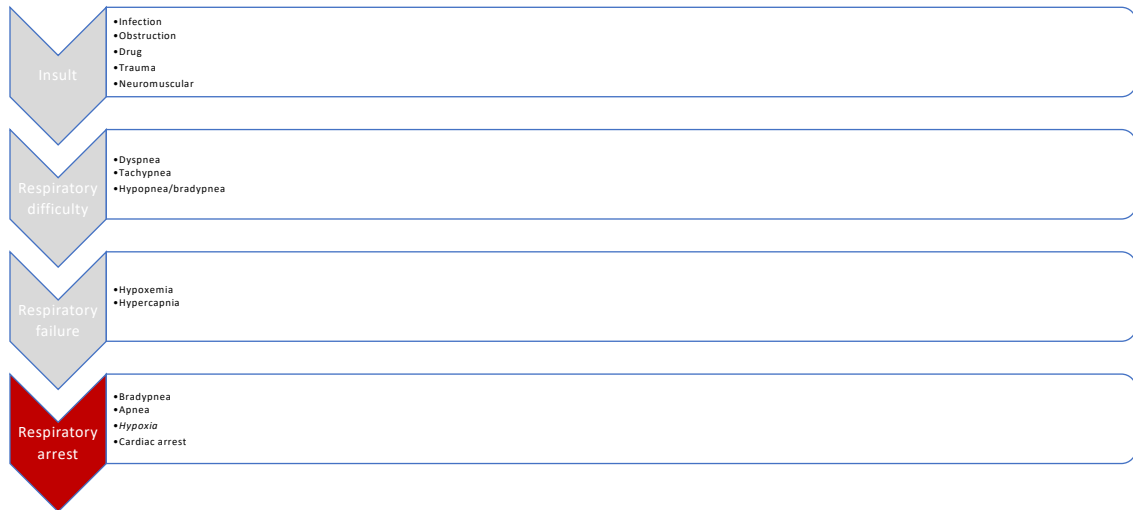
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Acute Respiratory Failure - Progression



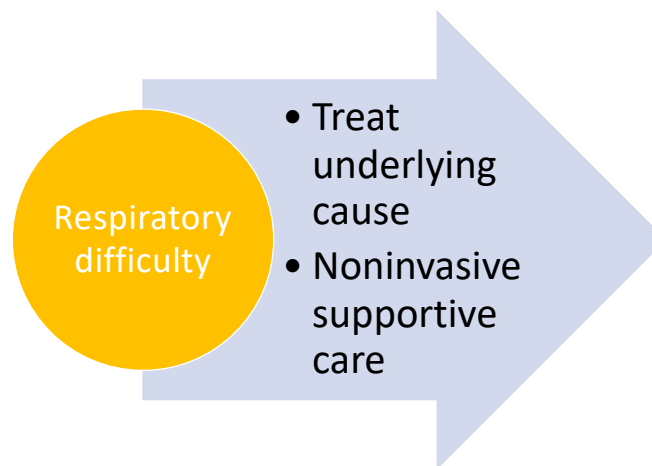
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Acute Respiratory Failure - Progression



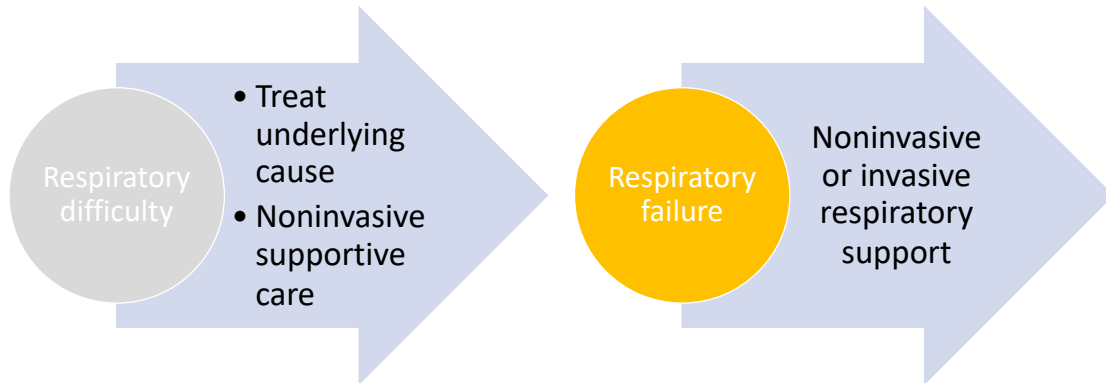
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Acute Respiratory Failure - Treatment



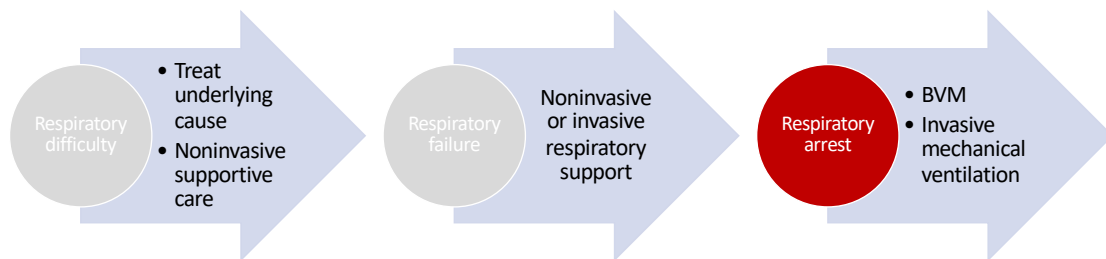
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Acute Respiratory Failure - Treatment



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Acute Respiratory Failure - Treatment



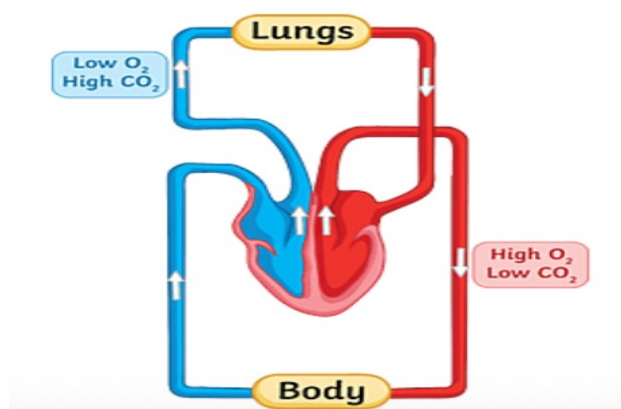
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Acute Respiratory Difficulty - Mimics

- Metabolic acidosis
 - DKA
 - Ingestion/intoxication
 - Infection (non-pulmonary)
 - Metabolic/IEM
 - Renal
- Cardiac disease
- CNS
- Pain
- Anxiety

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Circulatory System



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Shock: Oxygen delivery VS Oxygen consumption

DO₂ vs VO₂

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Shock - Definition

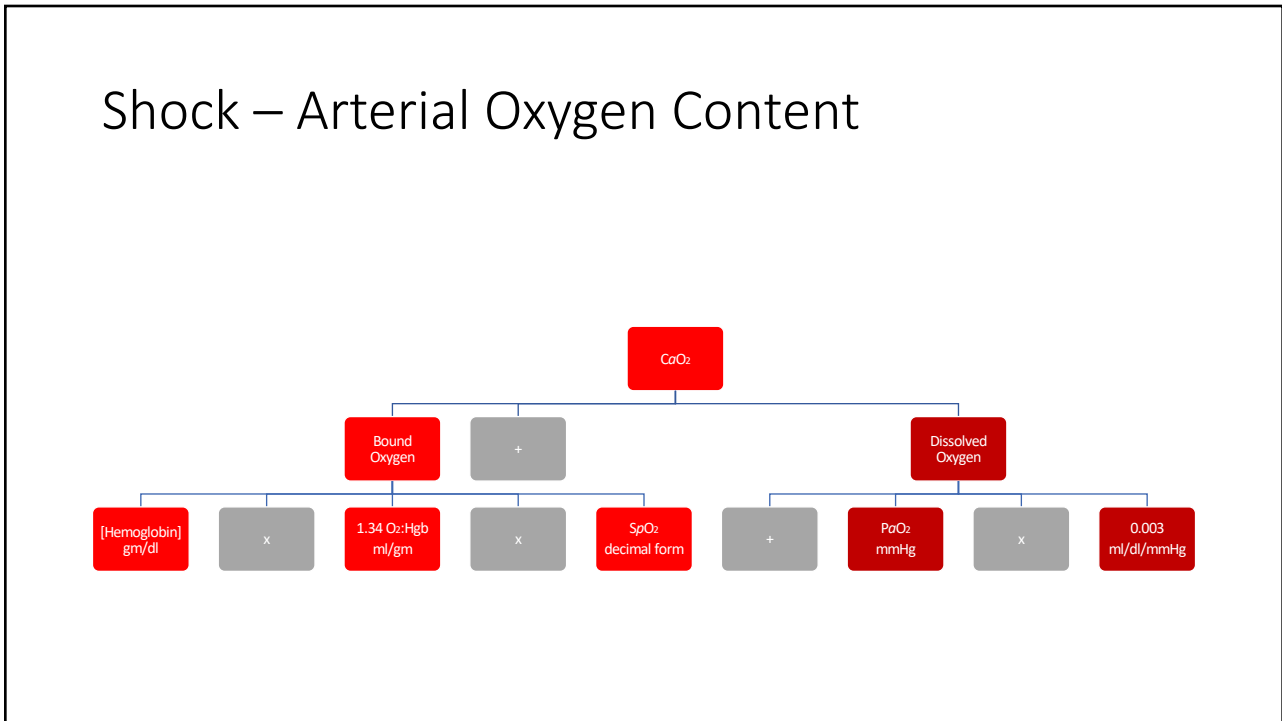
- Circulatory failure
- The inability of the body to meet the metabolic requirements of end-organs
 - The inability of the circulatory system to *deliver* adequate oxygen
 - The inability of the cells to *extract* adequate oxygen
- *Compensated versus Uncompensated*

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Oxygen Delivery

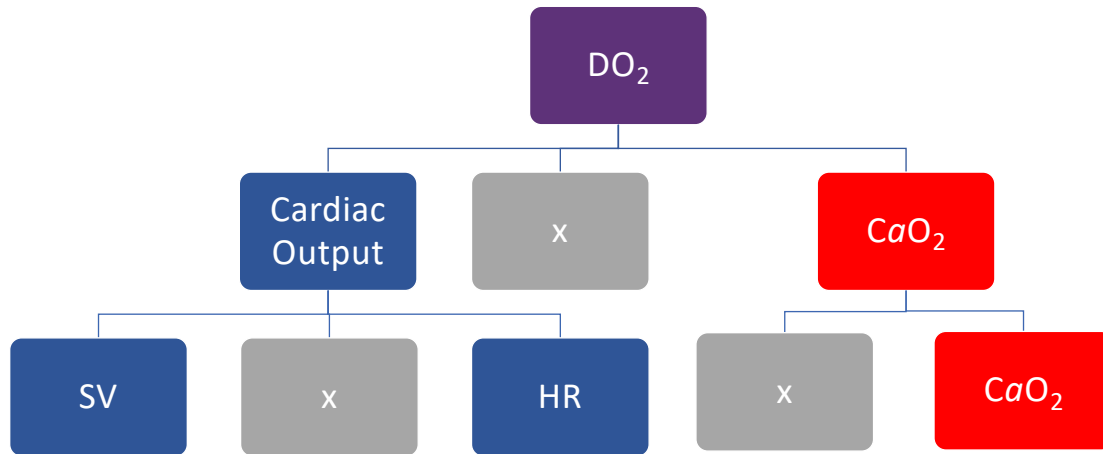
$$DO_2 = CO \times CaO_2$$

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Shock – Oxygen Delivery



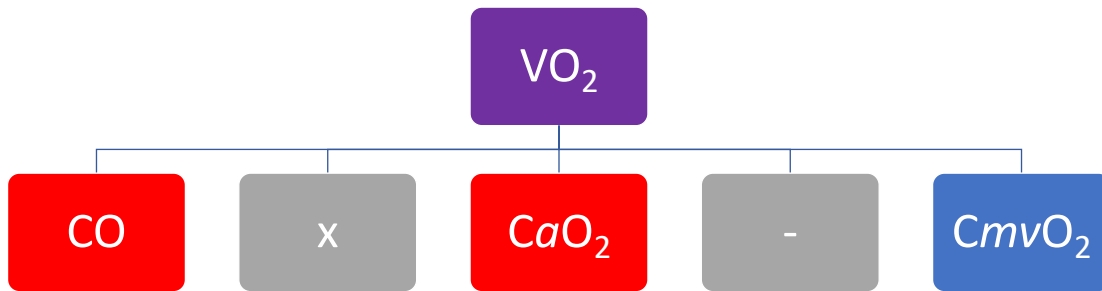
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Oxygen Consumption

$$VO_2 = CO \times (CaO_2 - CmvO_2)$$

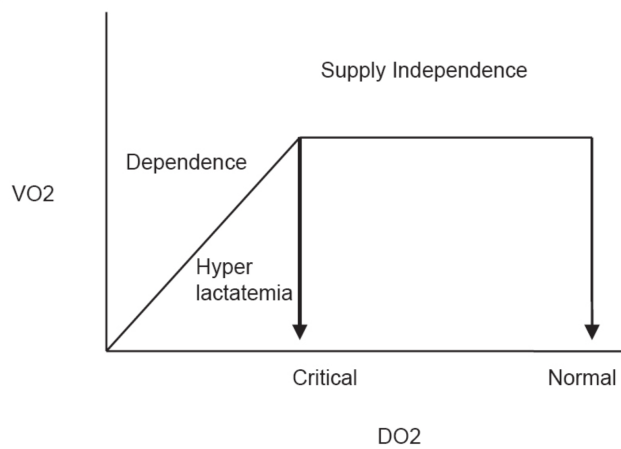
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Shock – Oxygen Consumption



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Shock – VO_2 versus DO_2



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Shock - Hypovolemic

- Most common type of shock in pediatric population
- History
 - Increased fluid loss and/or decreased fluid intake
 - Diminished urine production
 - Blood loss
 - Trauma
- Signs
 - Diminished peripheral perfusion, cool extremities
 - Dry mucous membranes
 - Weight loss
- Treatment
 - Fluids
 - Fluids
 - Fluids

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Shock - Distributive

- History
 - Fever, rash (infection)
 - Sudden onset, rash, pruritis, dyspnea, dysphagia (anaphylaxis)
 - Trauma (neurogenic)
- Signs
 - Fever, rash
 - Warm extremities with flash capillary refill
 - Cool extremities with delayed capillary refill
 - Rash (urticaria), wheezing
 - Evidence of trauma, bradycardia (relative)

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Septic Shock - Treatment

- Fluids
 - Up to 60 ml/kg within 15 – 60 minutes
- Antibiotics
 - Within one hour of presentation
- Vasopressor +/- epinephrine or norepinephrine
 - If hypotension persists despite fluid resuscitation
- Hydrocortisone +/-
 - If hypotensive despite vasoactive medication or if hypoglycemic

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Anaphylactic Shock – Treatment

- Manage airway
- Beta-adrenergic (aerosolized)
- Epinephrine IM
- Antihistamine
- Steroid IV
- Fluids
- Vasopressor +/- epinephrine

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Neurogenic Shock - Treatment

- Maintain in-line cervical stabilization and protect spine
- Manage airway
- Fluids
- Vasopressor - norepinephrine or phenylephrine (via central line)

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Shock - Cardiogenic

- History
 - Neonate, infant
 - Poor feeding
 - Diaphoresis
 - Suboptimal weight gain (or weight loss)
 - Underlying history of cardiac disease
- Signs
 - Tachypnea
 - Crackles or wheezes
 - Cool extremities with delayed capillary refill
 - Hepatomegaly

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Cardiogenic Shock – Treatment

- Cautious fluid resuscitation
- Prostaglandin E₁ (neonate, infant)
- Vasoactive medication +/- low-dose epinephrine or dobutamine
- Manage airway
- Positive pressure ventilation +/-

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Shock - Dissociative

- Pathologic state heralded by a failure of oxygen extraction at the cellular level
- Infection
 - May be related to *sepsis* – cellular dysregulation
- Fire or burn victim
 - May be secondary to *toxin* – cellular poisoning – cyanide toxicity
- Ingestion
 - Aspirin, cyanide

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Shock – Obstructive - neonate

- Rarest form of shock
- In neonates – usually occurs secondary to ductal dependent lesion
 - Coarctation
 - Valvular atresia
- Prostaglandin E₁ to preserve ductal-dependent circulation:
 - Systemic – AV, MV atresia
 - Pulmonary – PV, TV atresia

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Shock – Obstructive – non-neonate

- In children and adults - usually occurs secondary to saddle pulmonary embolus or cardiac tamponade
 - May be associated with trauma, malignancy, prolonged period of immobility, or central line
- Emergent treatment includes fluid resuscitation and vasopressor until underlying condition can be corrected
- Thrombolytic medication is an option if high index of suspicion for pulmonary embolus
- Pericardiocentesis emergently if pericardial effusion is suspected

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Organ Failure - Definition

- The inability of an organ to perform in its usual, expected capacity
- Single organ
 - Most commonly encountered
 - Good prognosis
- Multiple organs (≥ 2 systems)
 - Worse prognosis especially as more systems become involved

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Organ Failure - Brain

- Altered mental status
- Glasgow Coma Scale
 - 15 – Best
 - 3 – “Just for showing up”

PEDIATRIC GLASGOW COMA SCALE (PGCS)				
	> 1 Year	< 1 Year	Score	
EYE OPENING	Spontaneously	Spontaneously	4	
	To verbal command	To shout	3	
	To pain	To pain	2	
	No response	No response	1	
MOTOR RESPONSE	Obeys	Spontaneous	6	
	Localizes pain	Localizes pain	5	
	Flexion-withdrawal	Flexion-withdrawal	4	
	Flexion-abnormal (decorticate rigidity)	Flexion-abnormal (decorticate rigidity)	3	
	Extension (decerebrate rigidity)	Extension (decerebrate rigidity)	2	
	No response	No response	1	
	> 5 Years	2-5 Years	0-23 months	
VERBAL RESPONSE	Oriented	Appropriate words/phrases	Smiles/coos appropriately	5
	Disoriented/confused	Inappropriate words	Cries and is consolable	4
	Inappropriate words	Persistent cries and screams	Persistent inappropriate crying and/or screaming	3
	Incomprehensible sounds	Grunts	Grunts, agitated, and restless	2
	No response	No response	No response	1
TOTAL PEDIATRIC GLASGOW COMA SCORE (3-15):				

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Organ Failure – Acute Kidney Injury

- Rise in serum creatinine (increase by 0.3 mg/dl)
- Cystatin-C is a better predictor than sCr, but not in neonate/infant
- Diminished urine production (less than 0.5 ml/kg/hr)
- Uremia
- Metabolic acidosis
- Fluid retention
- Hypertension

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Organ Failure – Acute Liver Injury

- Diminished synthetic function
 - PT prolonged, INR increased
 - Hypoalbuminemia
- Diminished metabolic function
 - Hyperammonemia
 - Metabolic acidosis
 - Hypoglycemia
 - Jaundice
- Other symptoms
 - Bleeding
 - Pruritis
 - Altered mental status

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Organ Failure - Hematologic

- Bone marrow failure
 - Anemia, leukopenia, thrombocytopenia
- Endothelial activation (failure)
 - Platelet activation
 - Platelet aggregation in the microcirculation (thrombocytopenia)
 - Stasis of blood flow in the microcirculation
 - Impaired perfusion to end organs
 - Consumptive coagulopathy
 - WBC aggregation

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Organ Failure - Treatment

- Recognize impending organ failure
- Activate Rapid Response Team early
- Escalate level of care urgently if necessary
- Supportive care acutely as necessary
- Definitive care as soon as the diagnosis has been established

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Thank You

