The Annual General Pediatric Review & Self Assessment

Nicklaus Children's Hospital

CRITICAL CARE

Paul Martinez, MD, FAAP

Assistant Professor of Clinical Pediatrics

Herbert Wertheim College of Medicine, Florida International University

Critical Care Medicine

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Miami, FL

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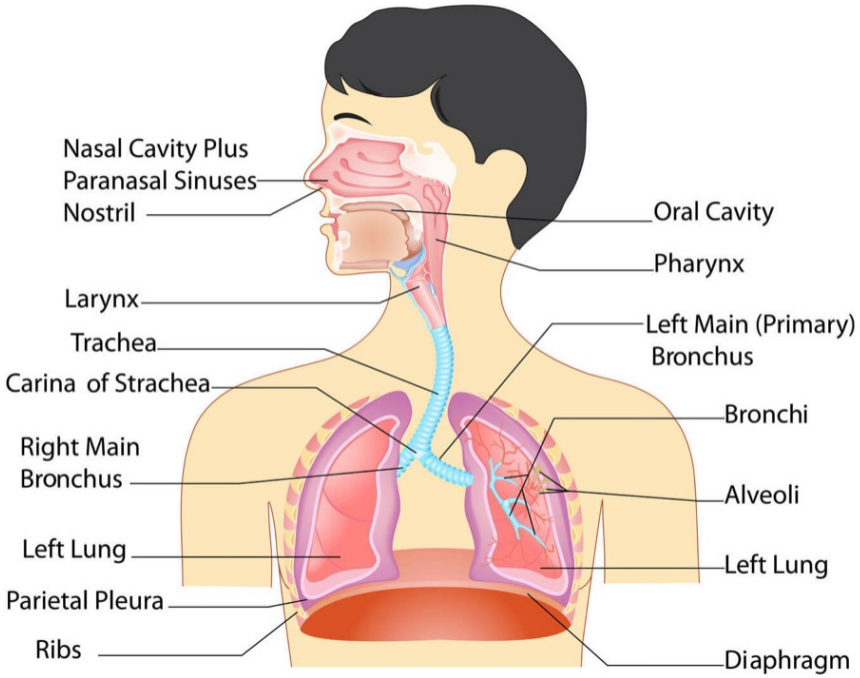
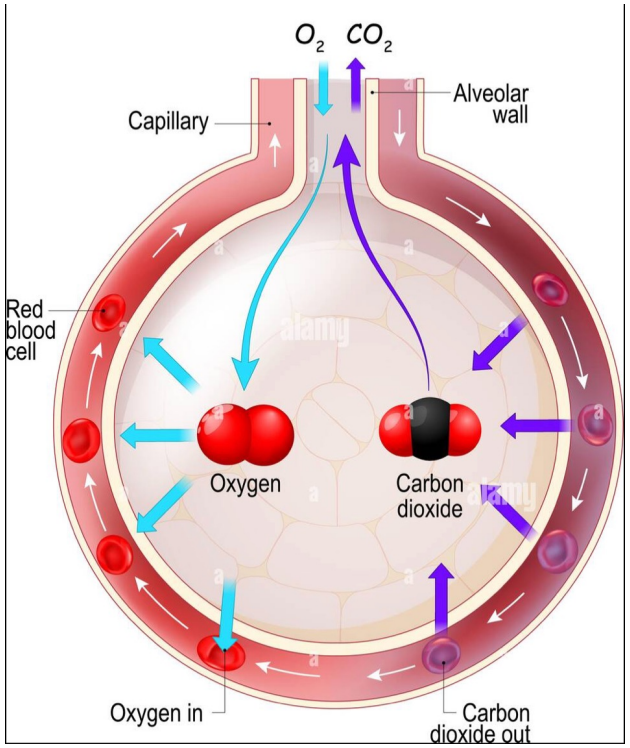
Objectives

- 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

Respiratory System



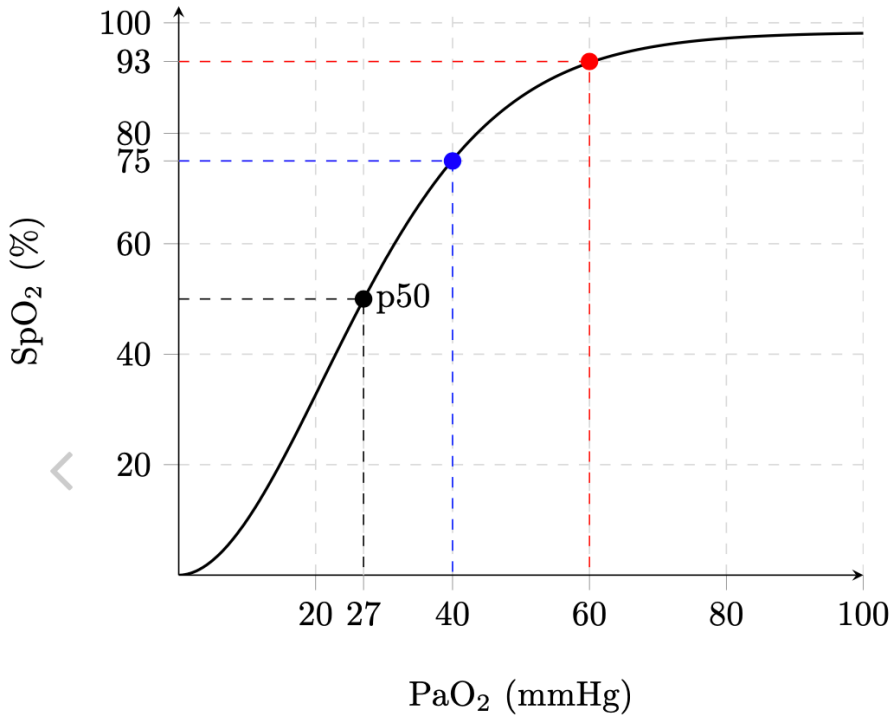
Respiratory System - O_2 in and CO_2 out



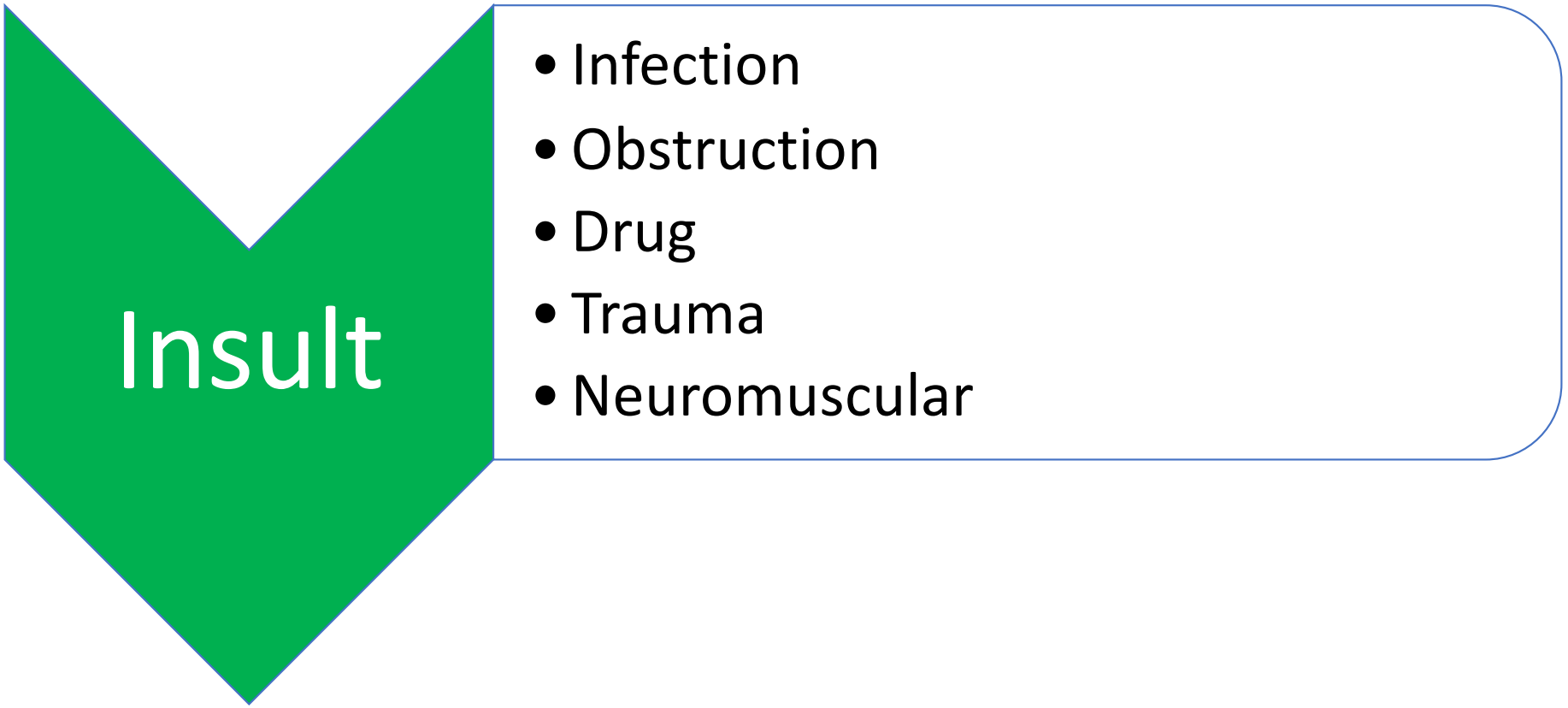
Acute Respiratory Failure - Definition

- Characterized by the acute inability to oxygenate or ventilate
- Broadly speaking
  - $S_pO_2 \leq 90\%$ (PaO2 $\leq$ 60 mmHg)
    And/or
  - P_aCO_2 or $P_cCO_2 \geq 50$ mmHg
- Most common predisposition to cardiac arrest in the pediatric population

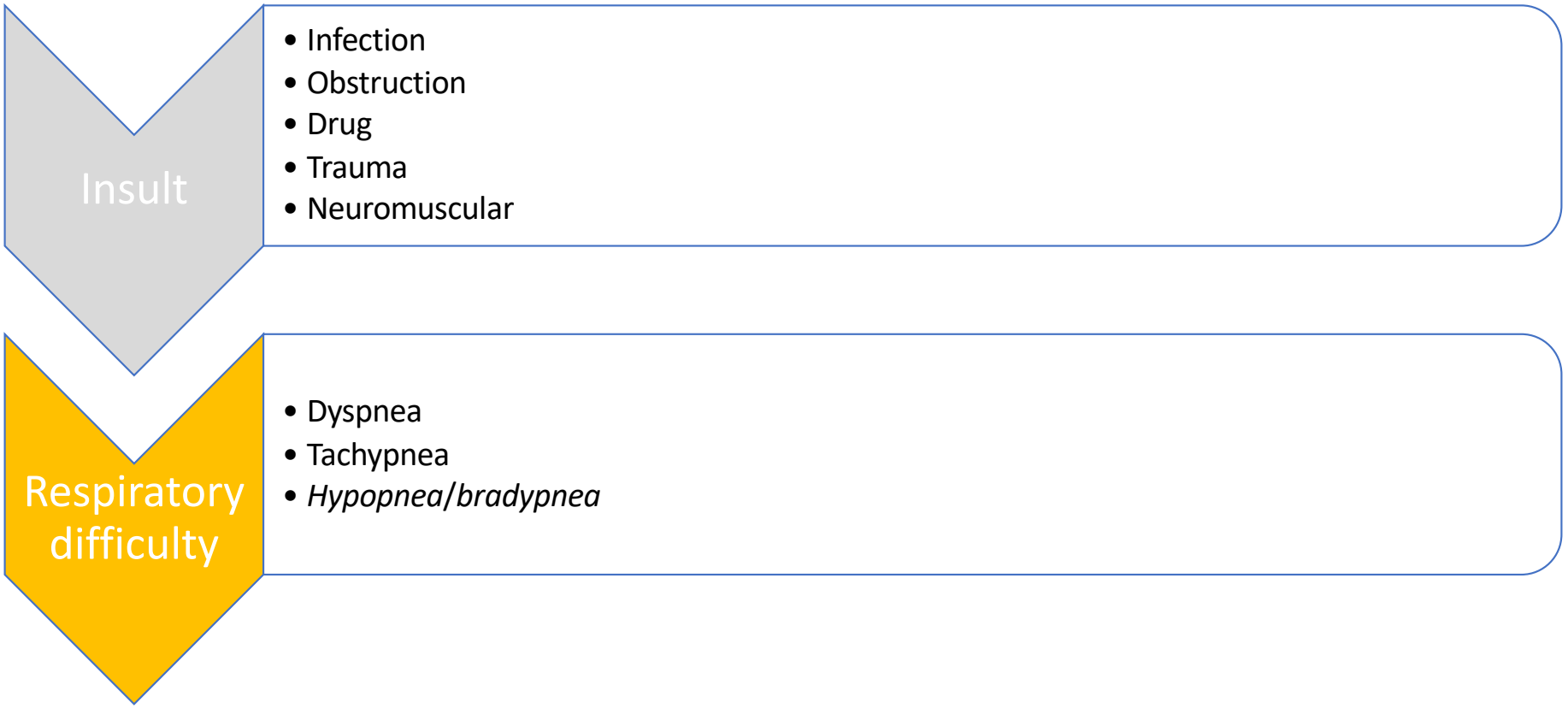
Acute Respiratory Failure – Hemoglobin Dissociation Curve



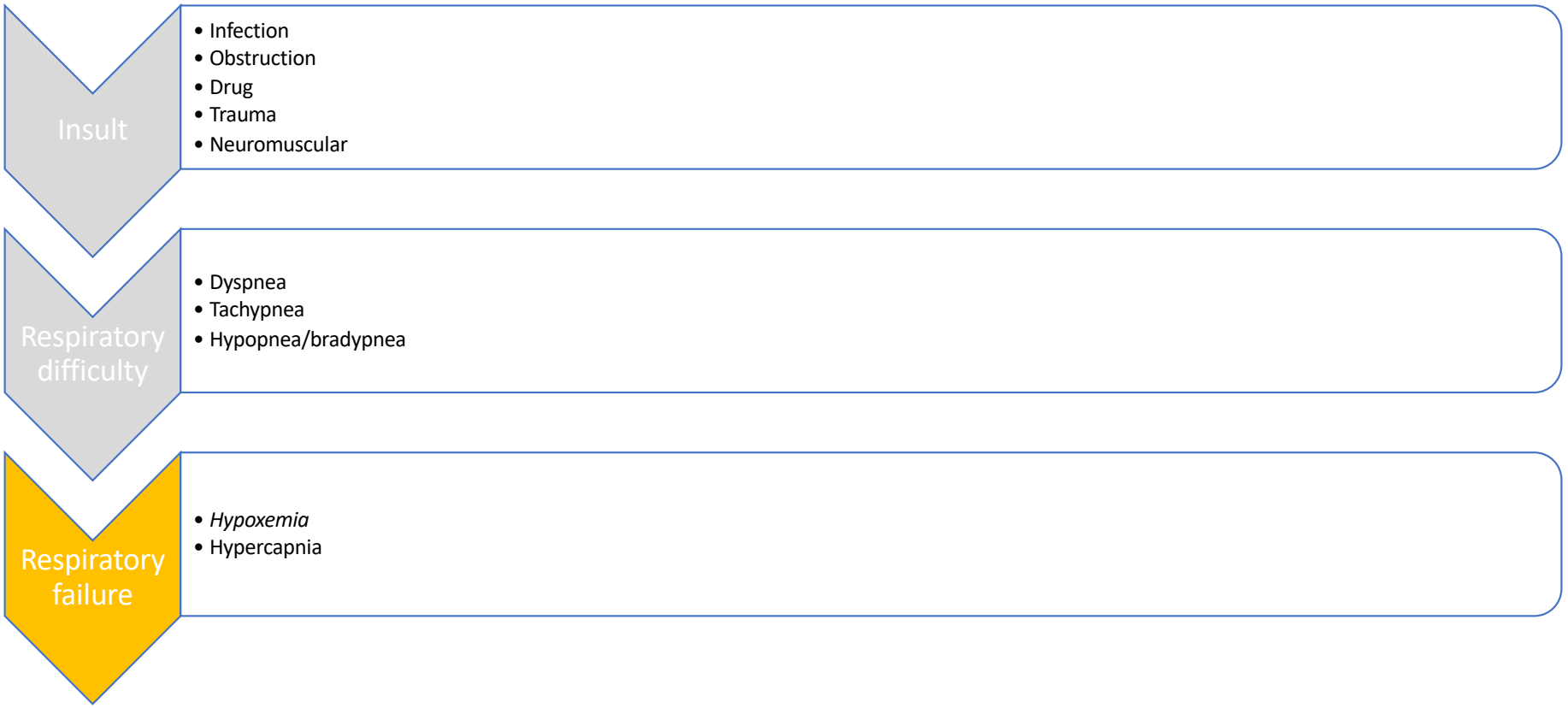
Acute Respiratory Failure - Progression



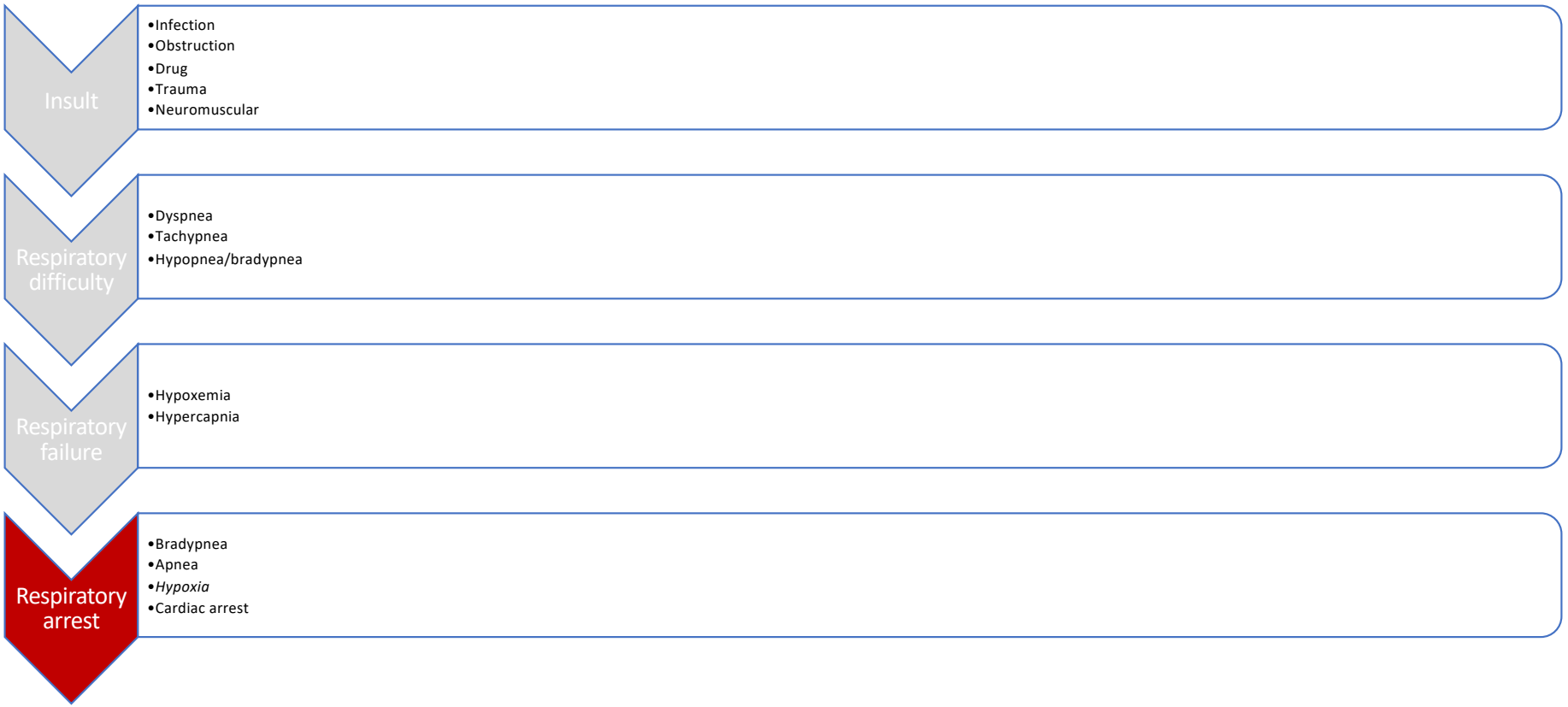
Acute Respiratory Failure - Progression



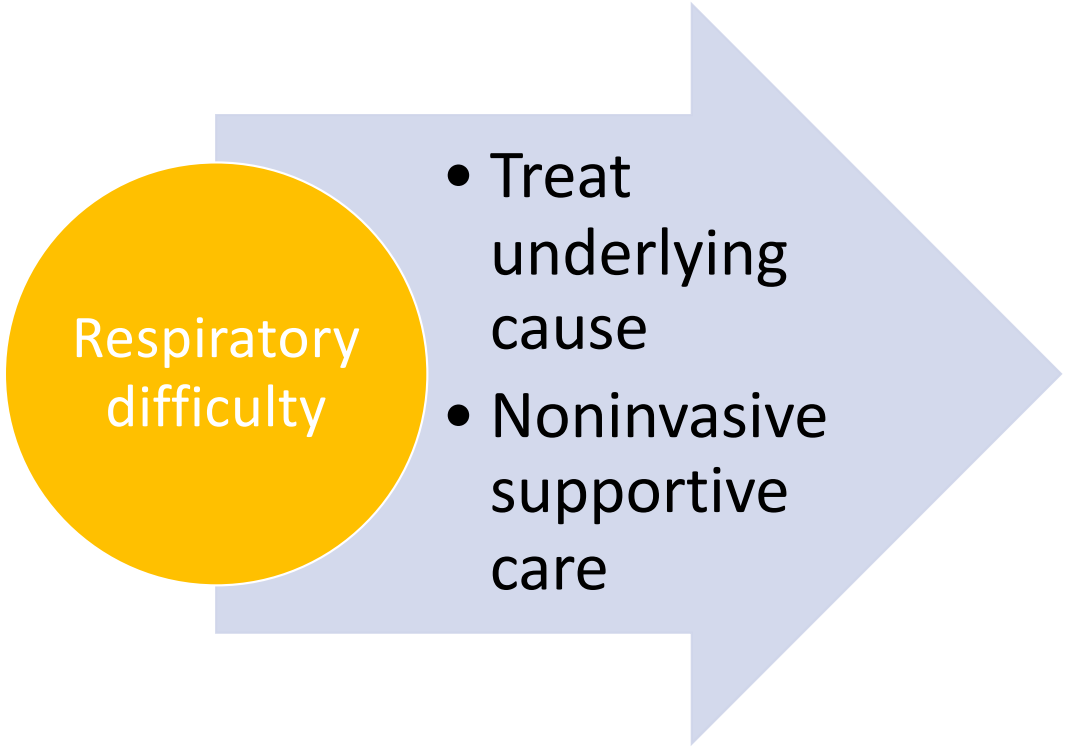
Acute Respiratory Failure - Progression



Acute Respiratory Failure - Progression



Acute Respiratory Failure - Treatment



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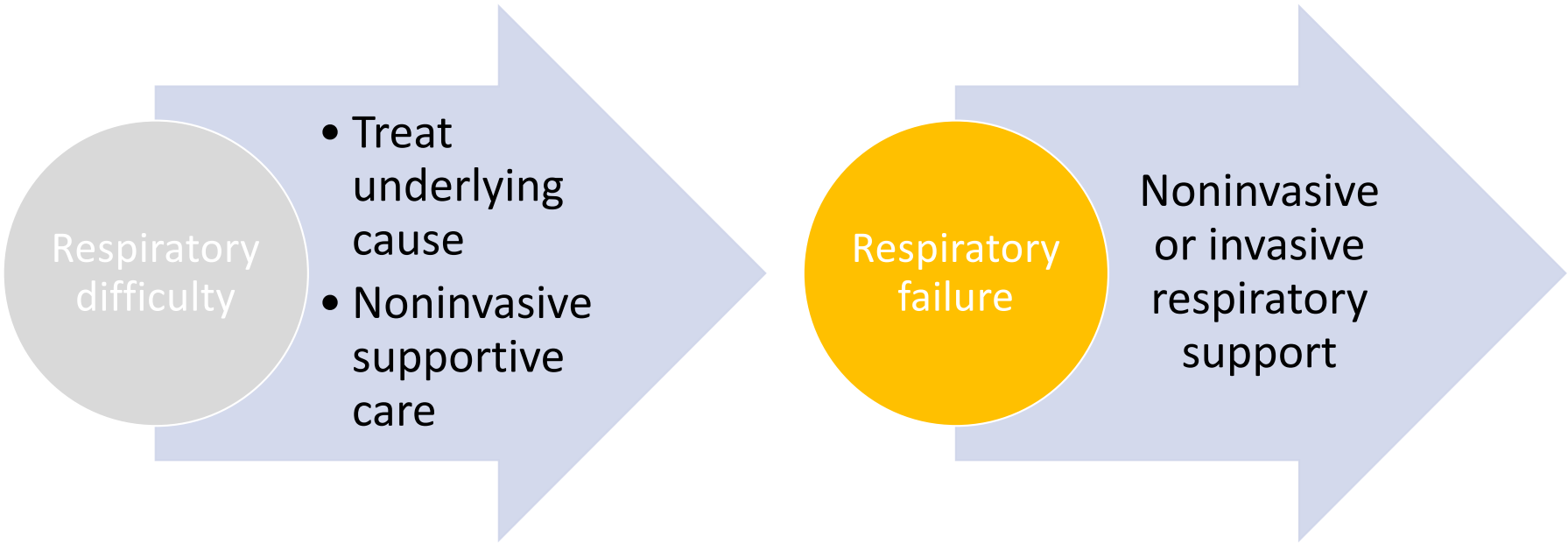
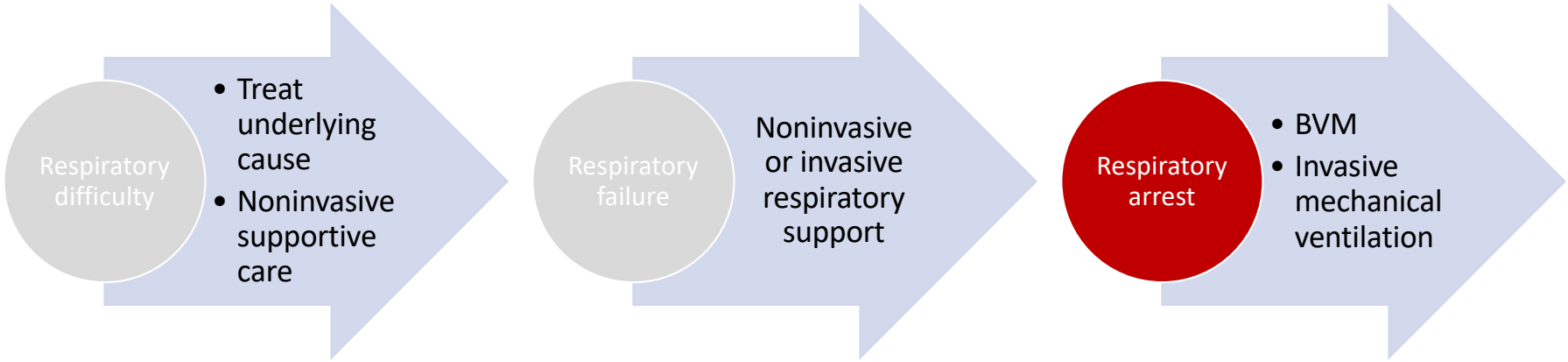


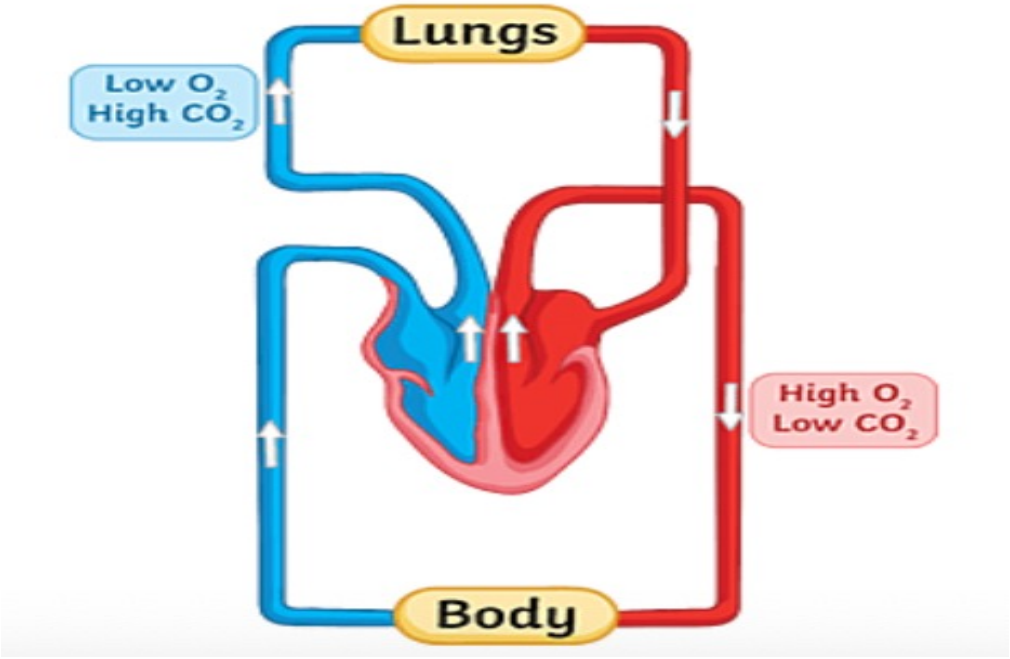
Acute Respiratory Failure - Treatment



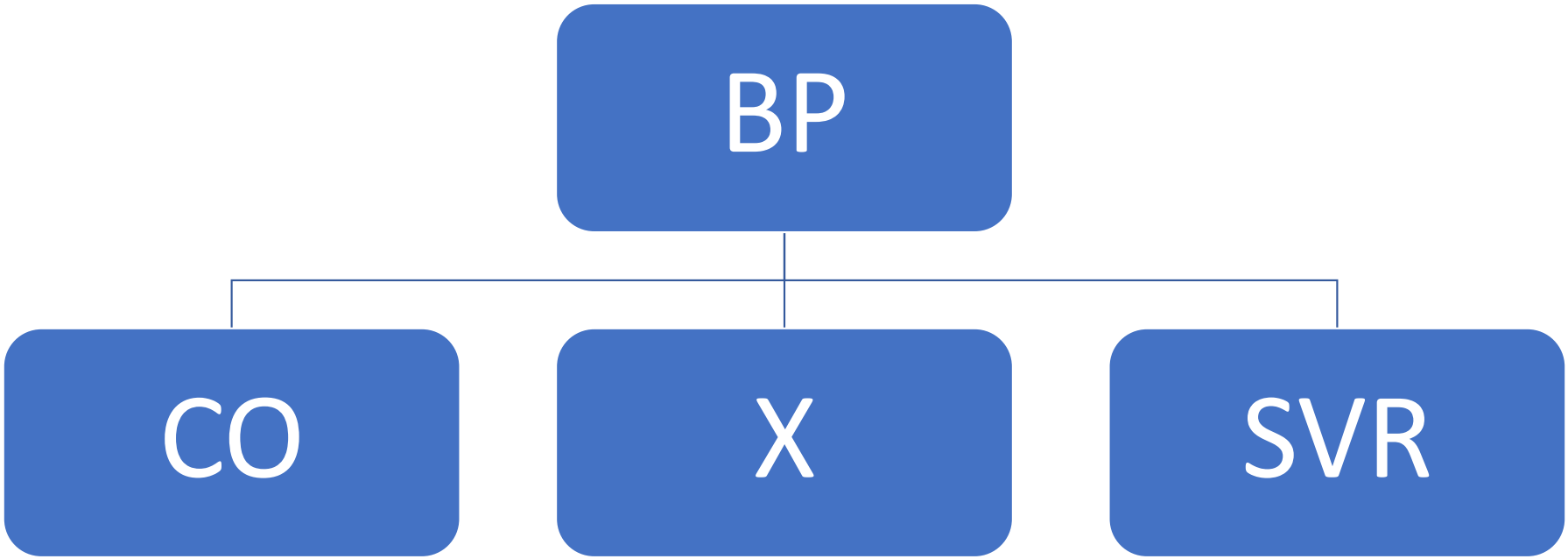
Acute Respiratory Difficulty - Mimics

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

Circulatory System



Blood Pressure



Shock:
Oxygen delivery
vs
Oxygen consumption

DO2 vs VO2

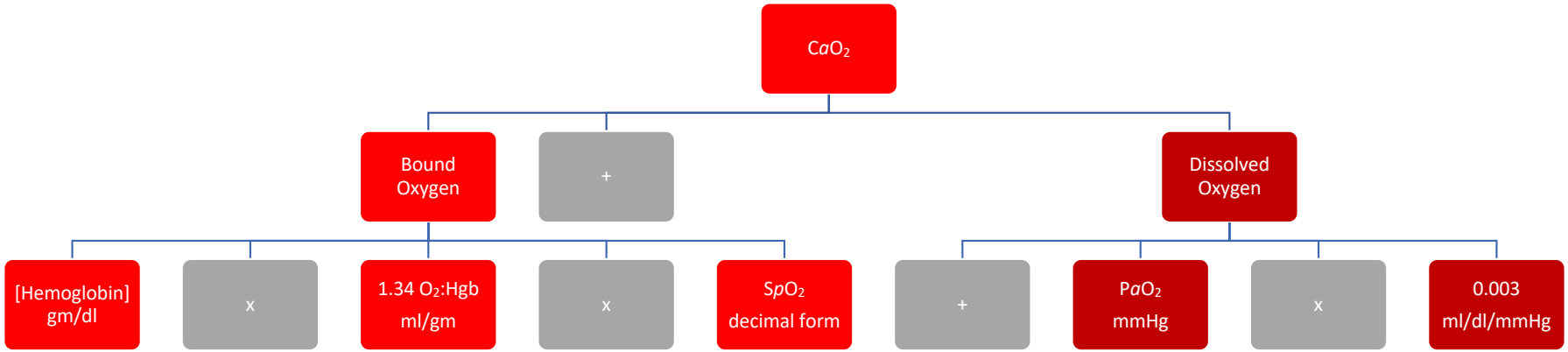
Shock - Definition

- 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*

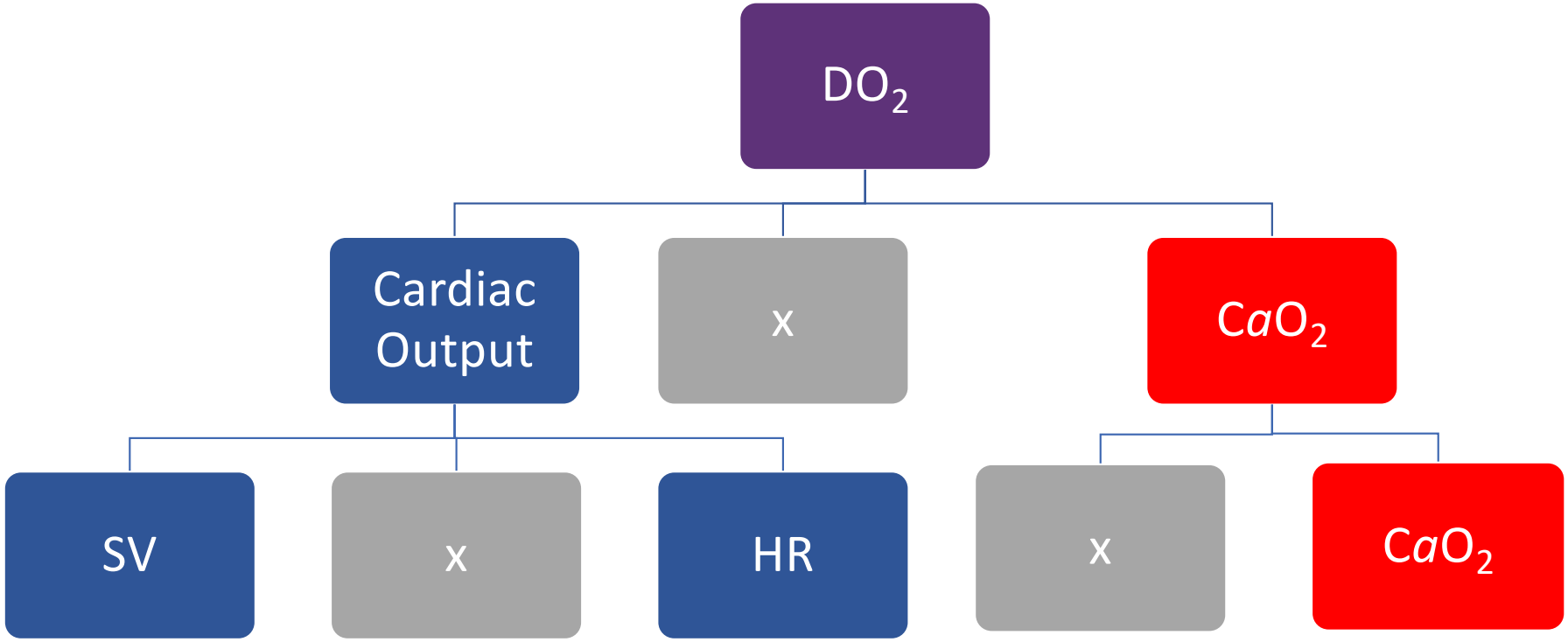
Oxygen Delivery

$DO_2 = CO \times C_aO_2$

Shock – Arterial Oxygen Content



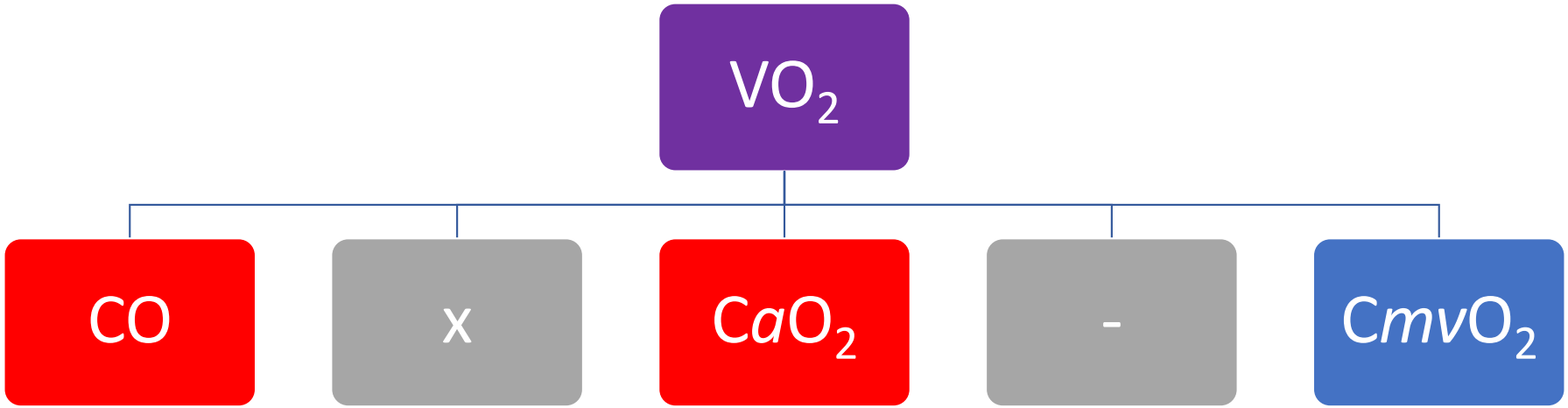
Shock – Oxygen Delivery



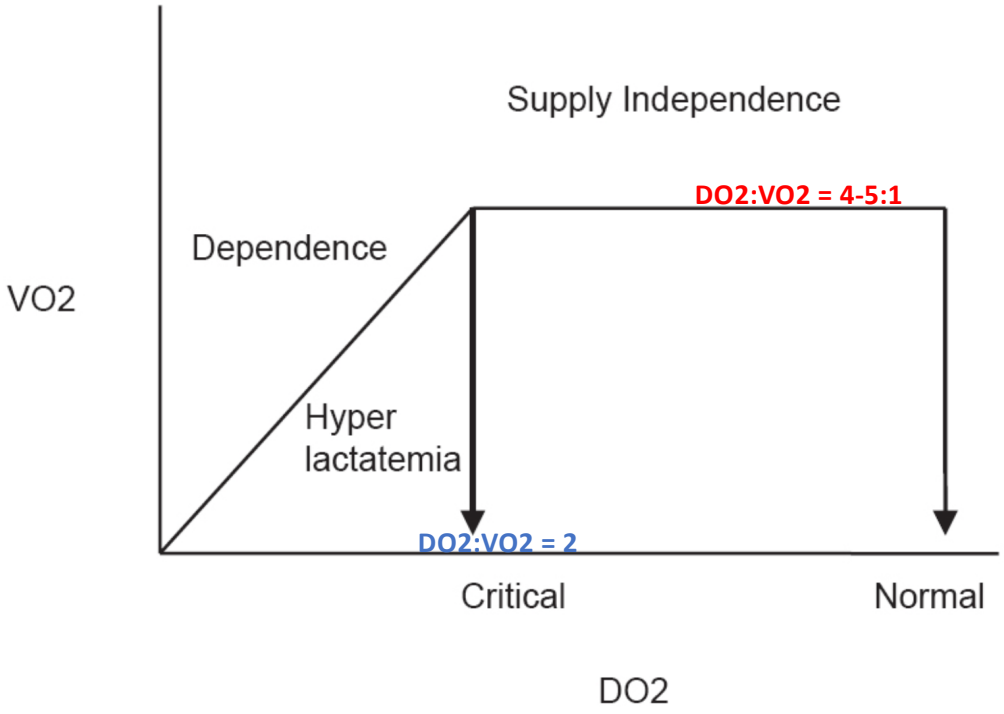
Oxygen Consumption

$$VO_2 = CO \times (C_aO_2 - C_{mv}O_2)$$

Shock – Oxygen Consumption



Shock – VO_2 versus DO_2



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

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)

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

Anaphylactic Shock – Treatment

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

Neurogenic Shock - Treatment

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

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

Cardiogenic Shock – Treatment

- Cautious fluid resuscitation
- Prostaglandin E_1 (neonate, infant)
- Vasoactive medication +/- low-dose epinephrine or dobutamine
- Manage airway
- Positive pressure ventilation +/-

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

Shock – Obstructive - neonate

- Rarest form of shock
- In neonates – usually occurs secondary to ductal dependent lesion
  - Coarctation
  - Valvular atresia
- Prostaglandin E_1 to preserve ductal-dependent circulation:
  - Systemic – AV, MV atresia
  - Pulmonary – PV, TV atresia

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

Organ Failure - Definition

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

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):				

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

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

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

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

Thank You