Respiratory Physiology of Pregnancy

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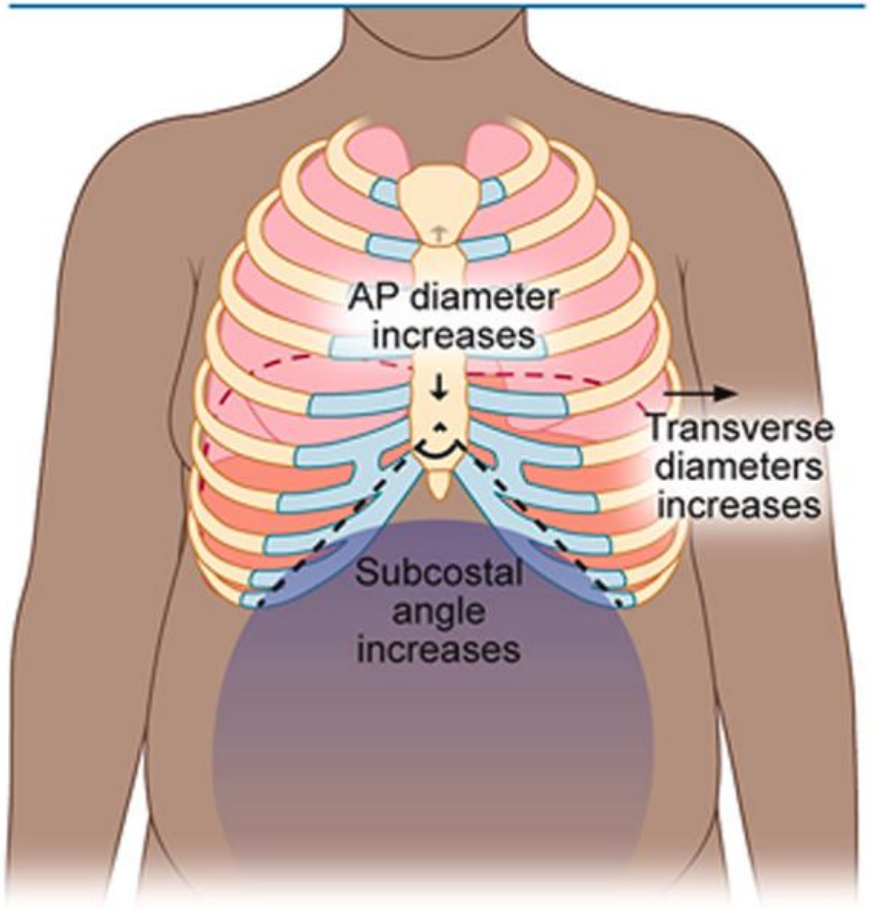
Objectives

Discuss	Discuss	Discuss
Anatomic, physiologic, and hormonal changes in pregnancy that affects a patient's respiratory status.	Approach to initial assessment in a pregnant patient with respiratory failure.	Basic management for pregnant patients in respiratory failure.

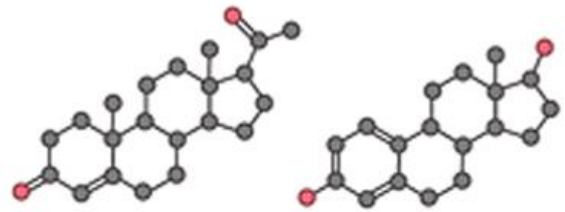
Anatomical and Physiologic Changes

Respiratory Physiological Changes in Pregnancy:
Understanding the Impact of Pregnancy on Pulmonary Function and Gas Exchange

Anatomical Changes



Hormonal Changes



Progesterone & Estrogen

Increases minute ventilation and reduces arterial $PaCO_2$

Relaxin

Loosens ligaments and cartilage to allow for ribcage expansion

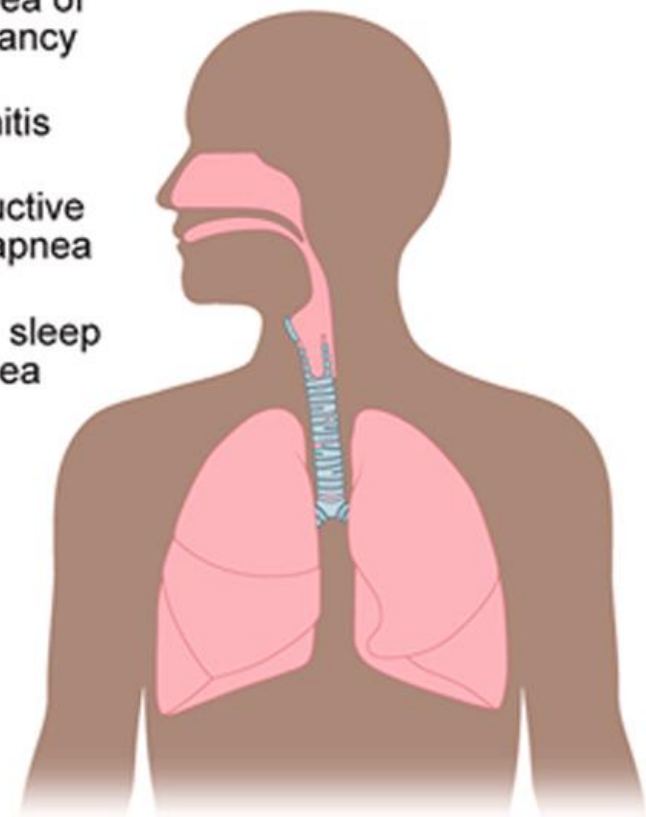
Physiological Changes

Dyspnea of pregnancy

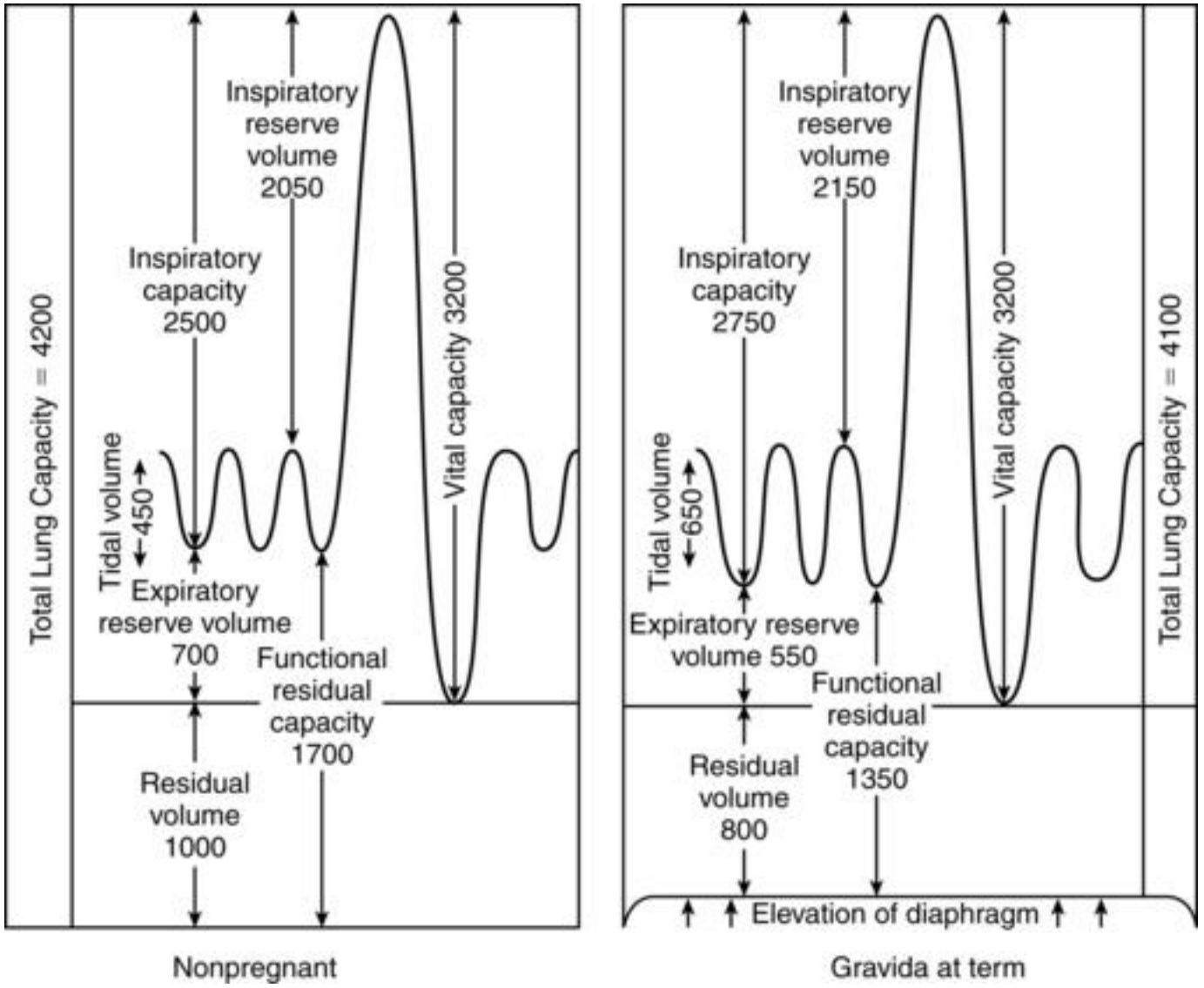
Rhinitis

Obstructive sleep apnea

Central sleep apnea



Lungs

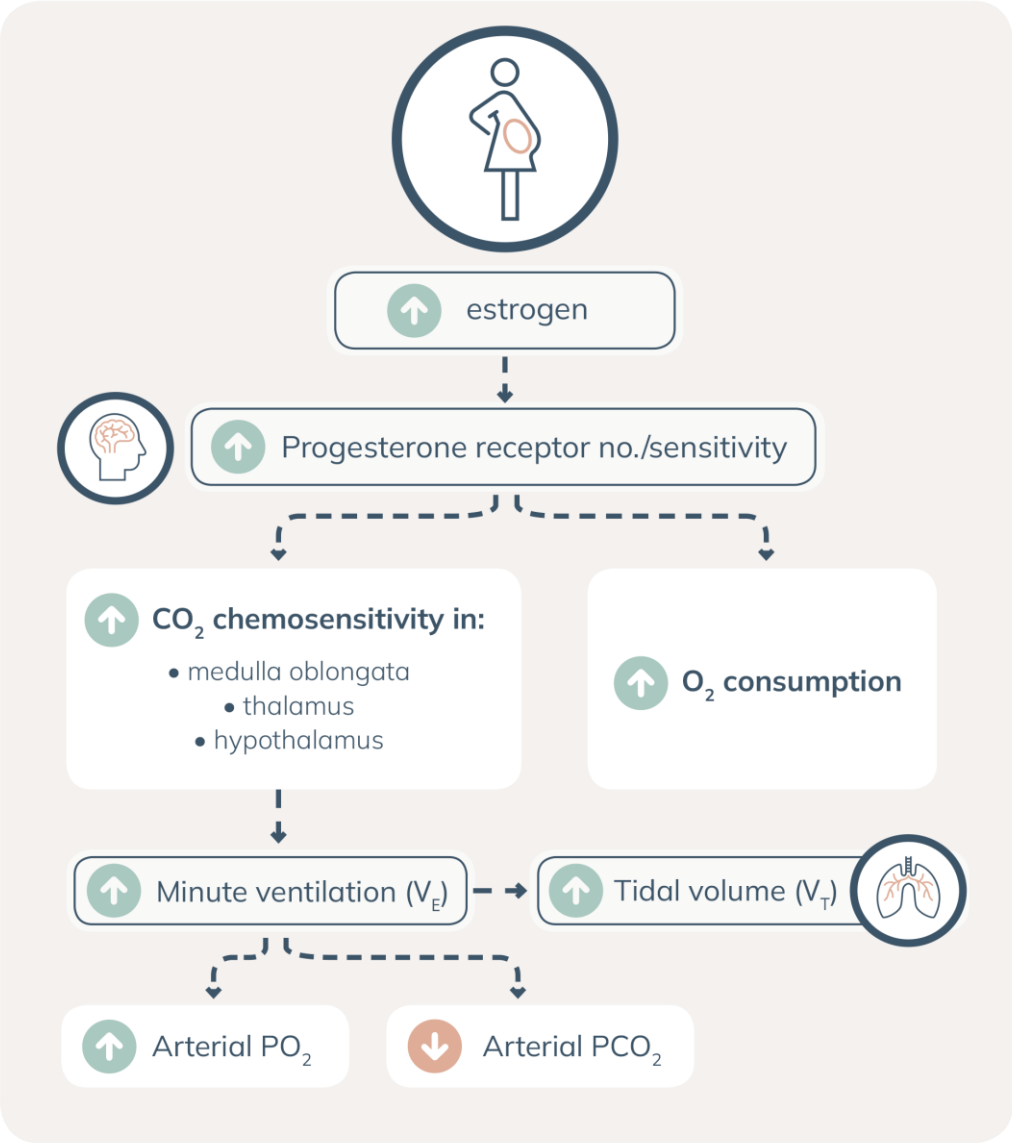


- Changes in lung volume occur due to elevation of the diaphragm and chest wall compliance.
- Most significant changes in pregnancy:
  - ⬆ in Vt: 30% to 40%
    ⬇ 500 → 700 mL
  - ⬇ in Expiratory Reserve Volume: 15% to 20%
  - ⬇ in Residual Volume: 20% to 25%
  - ⬇ in Functional Residual Capacity: 20% to 30%

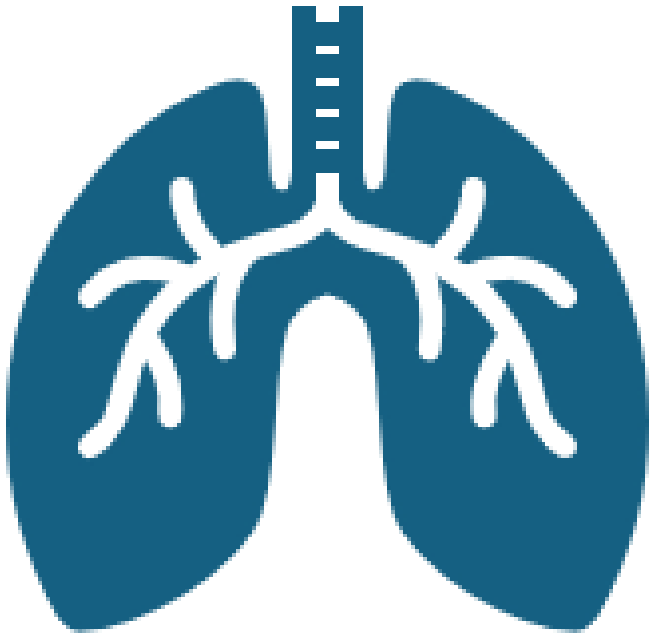
- TLC, FEV1 and FEV1/VC do NOT change in

Hormones on Ventilation

- Increase in minute ventilation (MV).
  - Tidal volume increases without any significant changes in respiratory rate.
- Increase in MV → increase in PaO2 and decrease in PCO2.
  - Leads to mild respiratory alkalosis
  - PCO2 ~28-32mmHg
- There is a 20-30% increase in oxygen consumption.
- No change in DLCO



Clinical Implications



Clinical Implications

- Decrease in FRC → rapid oxygen desaturation during apnea.
  - DECREASED PULMONARY RESERVE
- Elevated diaphragm and uterus increases aspiration risk.
- Changes to upper airway in pregnancy lead to more difficult airway.
  - INTUBATION BECOMES HIGH RISK
- “Normal” ABGs are different in pregnant patients.

New ABG Baselines

Table 1
Arterial blood gas (ABG) changes in pregnancy (sea level)

ABG Measurement	Nonpregnant State	Pregnant State	
		First Trimester	Third Trimester
pH	7.40	7.42–7.46	7.43
P_aO_2 (mm Hg)	93	105–106	101–106
P_aco_2 (mm Hg)	37	28–29	26–30
Serum HCO_3 (mEq/L)	23	18	17

Respiratory Physiology in Pregnancy

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Causes of Respiratory Failure in Pregnanc

Specific to pregnancy	Pulmonary edema due to preeclampsia
	ARDS due to chorioamnionitis
	ARDS related to placental abruption
	Peripartum cardiomyopathy
	Amniotic fluid embolism
	Tocolytic-associated pulmonary edema
	Trophoblastic embolism
Risk increased by pregnancy	Venous thromboembolism
	Gastric acid aspiration
	Transfusion related acute lung injury
	Asthma
	ARDS due to sepsis, often pyelonephritis
	Pneumonia (e.g. varicella, fungal)
	Stenotic valvular heart disease, pulmonary hypertension
Nonspecific conditions	Trauma
	Drugs/toxins
	Pancreatitis

Approach to Respiratory Failure

Initial Assessment

- Airway, Breathing, and Circulation (ABCs).
- Continuous Pulse Ox
  - Goal SpO2 ≥ 95%
- Fetal Monitoring (if pregnancy is viable)
- History: PE, HF, Asthma, Pre-eclampsia/Eclampsia
- Type of Respiratory Failure
  - Hypoxic Respiratory Failure: PaO_2 < 60 mmHg (e.g., ARDS, pneumonia)
  - Hypercapnic Respiratory Failure: $PaCO_2$ > 45 mmHg (e.g., asthma, neuromuscular disease)
    - **Respiratory Compromise if $PaCO_2$ > 30 mmHg**

Diagnostics

- Labs: CBC, CMP, BNP, and Lactate
- ABG (interpret within the norms of pregnancy)
- Chest X-ray
  - Safe with shielding
- CT-Angiography or V/Q scan for PE
- Echocardiography

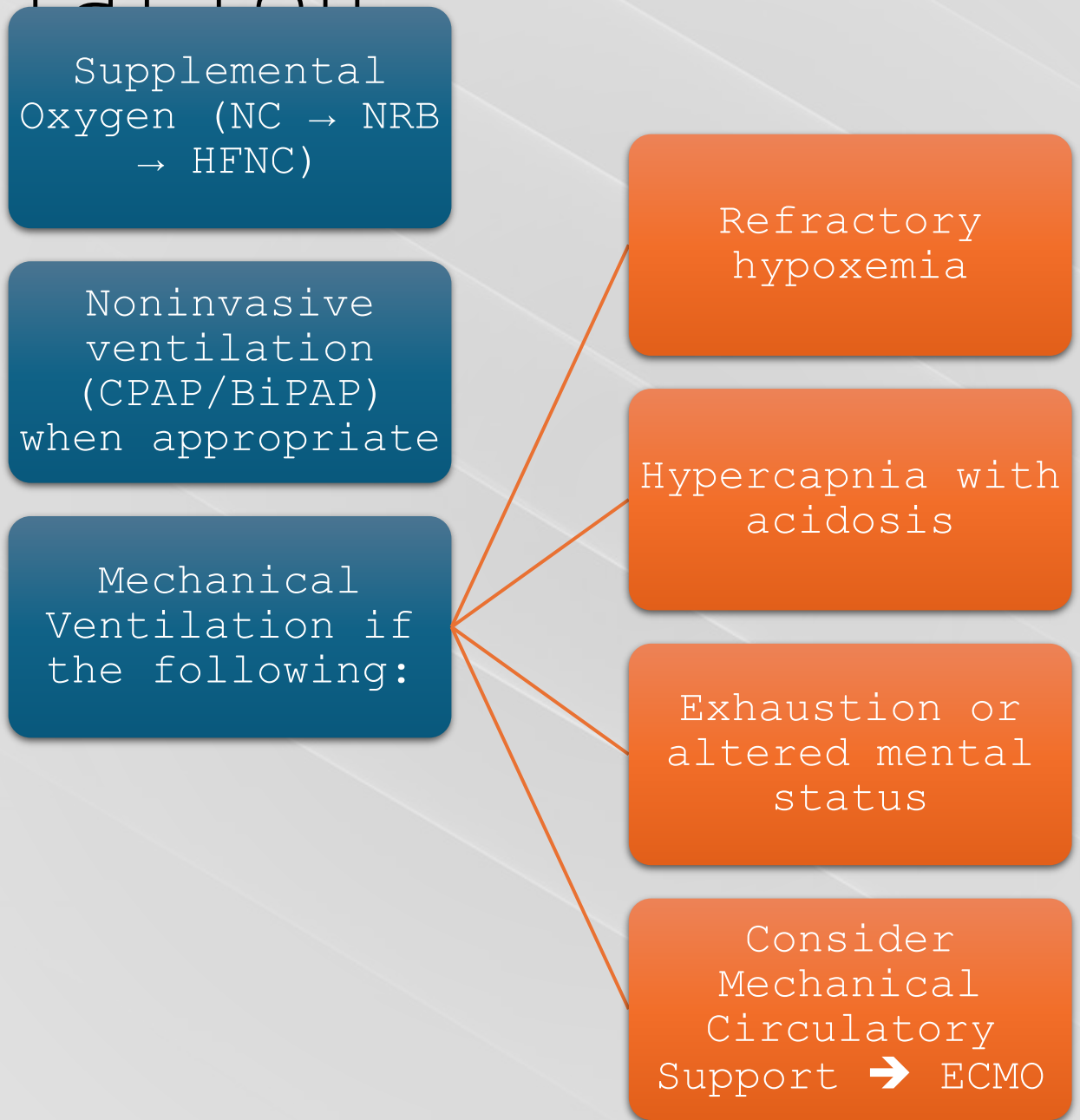
Management-General Principles

Stabilizing the mom = stabilizing the fetus

Goal oxygen sats:

Maintain $SpO_2 \geq 95\%$	Maintain $PaO_2 \geq 70$ mmHg	$PaCO_2$ near pregnancy baseline

Management-Oxygen and Ventilation



Management- Condition Specific Issues

- **Asthma:** β-agonists, inhaled/systemic steroids, magnesium
- **Pneumonia:** pregnancy-safe antibiotics, antivirals
- **Pulmonary edema:** diuretics, treat underlying cause
- **PE:** anticoagulation (LMWH preferred)
- **ARDS:** low tidal volume, PEEP optimization, paralytics, prone positioning, ECMO

SUMMARY

- ***Physiologic changes impact pulmonary reserve***
- Imaging is safe with precautions
- New baseline O2 saturation goal: **> 95%**
  - **Maintain PaO2 ≥ 70 mmHg**
- New ABG Baseline – Respiratory Alkalotic State
  - **Respiratory Compromise if $PaCO_2$ > 30 mmHg**
- Recognize failure early
- **Positive Pressure requires vigilance** due to elevated aspiration risk
- Intubation is HIGH RISK

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