



# ARDS in Pregnancy

UNM 3<sup>RD</sup> ANNUAL CRITICAL CARE SYMPOSIUM

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# Objectives

1. Review Maternal / Fetal Gas Exchange
2. Review Basics of Adult ARDS Management
3. ARDS Management in the Pregnant Female

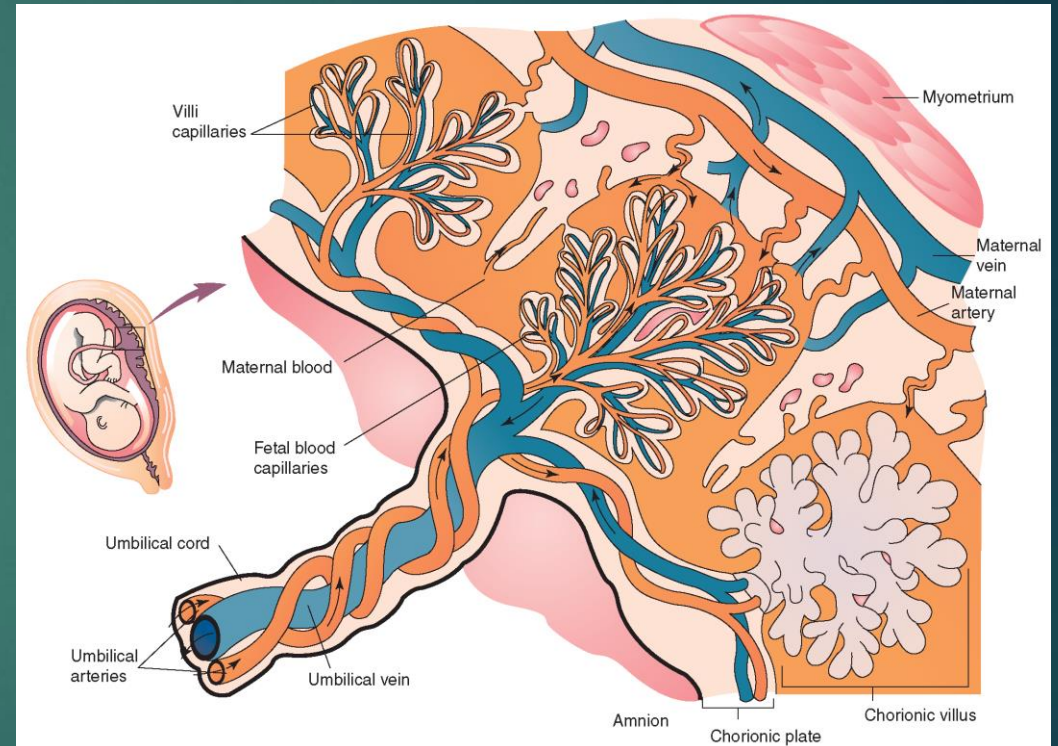
# Maternal Physiologic Changes in Pregnancy

- ▶ Increased PaO<sub>2</sub> (100 – 110 mmHg)
- ▶ 20 – 33% increased O<sub>2</sub> consumption
- ▶ 30-45% increase in Cardiac Output
- ▶ Increased Tidal Volume and Minute Ventilation
- ▶ Decreased PaCO<sub>2</sub> (27 – 34 mmHg)
- ▶ Chronic Respiratory Alkalosis (pH 7.4 – 7.45)
- ▶ Reduced serum bicarb (18 – 21 mmol/L)
- ▶ Reduced FRC
- ▶ Decreased LES tone
- ▶ Decreased chest wall compliance



# Fetal Oxygen Delivery

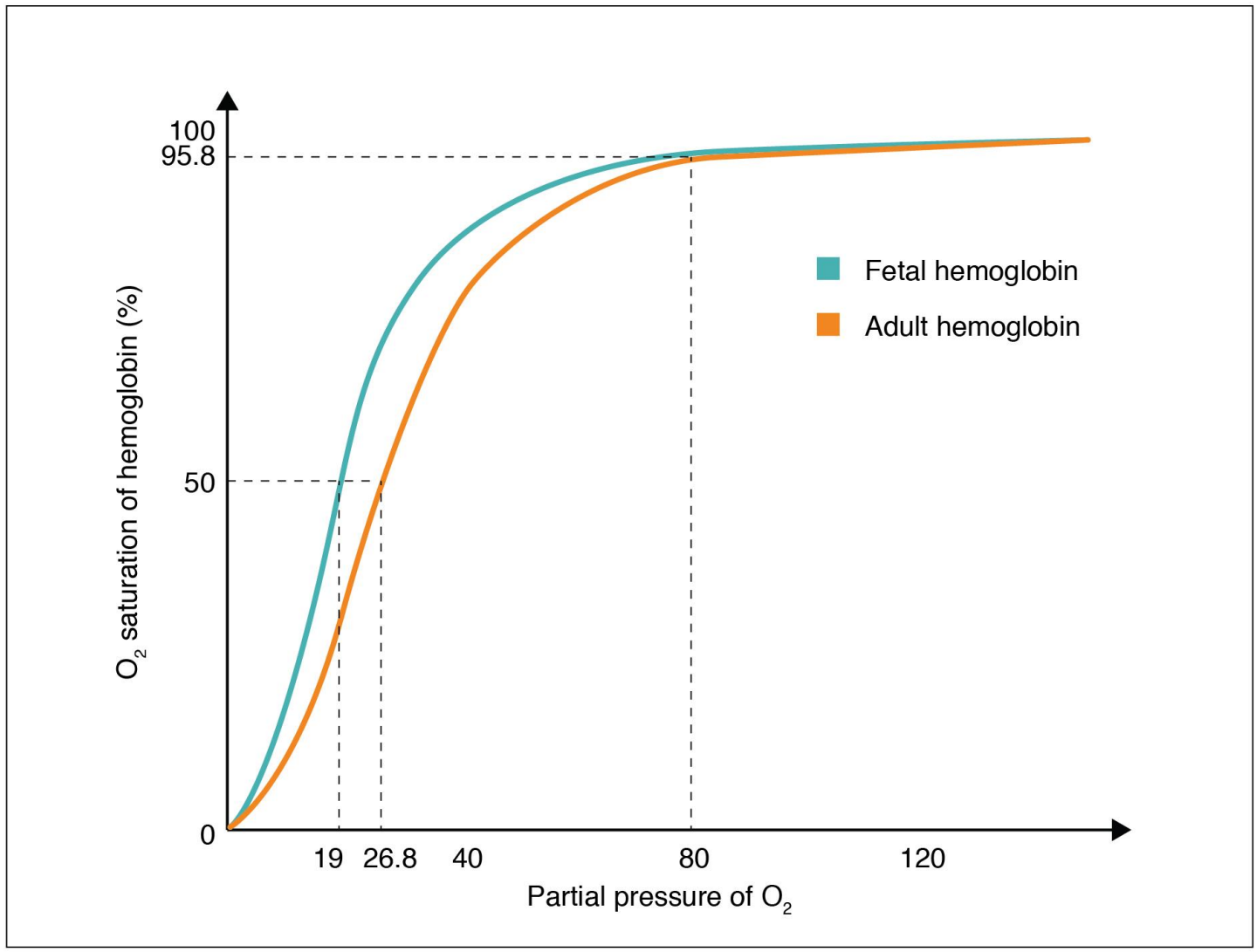
- ▶ Maternal delivery of oxygen to placenta
- ▶ Placental transfer of oxygen
- ▶ Fetal oxygen transport from placenta to fetal tissues



# Determinants of Uterine Artery Oxygen Delivery

- ▶ Maternal PaO<sub>2</sub>
- ▶ Hemoglobin concentration and saturation
  - ▶ Alkalosis → leftward shift oxyhemoglobin dissociation curve and increased O<sub>2</sub> affinity → decreased O<sub>2</sub> transfer
  - ▶ Acidosis → rightward shift oxyhemoglobin dissociation curve and decreased O<sub>2</sub> affinity → increased O<sub>2</sub> transfer
- ▶ Uterine artery blood flow / Maternal cardiac output
  - ▶ Alkalosis → vasoconstriction uterine artery
  - ▶ Maternal hypotension and/or increased endogenous or exogenous sympathetic stimulation → vasoconstriction uterine artery
  - ▶ Maternal hypoxia → vasoconstriction

# Maternal / Fetal O<sub>2</sub> Dissociation Curves



# CO<sub>2</sub> transfer

- ▶ CO<sub>2</sub> is unloaded from the umbilical artery to the uterine vein
- ▶ pCO<sub>2</sub> fetal umbilical artery > pCO<sub>2</sub> maternal uterine vein

**Table 3.** The Berlin Definition of Acute Respiratory Distress Syndrome**Acute Respiratory Distress Syndrome**

|                            |   |
|----------------------------|---|
| Timing                     | Within 1 week of a known clinical insult or new or worsening respiratory symptoms   |
| Chest imaging <sup>a</sup> | Bilateral opacities—not fully explained by effusions, lobar/lung collapse, or nodules   |
| Origin of edema            | Respiratory failure not fully explained by cardiac failure or fluid overload<br>Need objective assessment (eg, echocardiography) to exclude hydrostatic edema if no risk factor present |
| Oxygenation <sup>b</sup>   |   |
| Mild                       | $200 \text{ mm Hg} < \text{PaO}_2/\text{FIO}_2 \leq 300 \text{ mm Hg}$ with PEEP or CPAP $\geq 5 \text{ cm H}_2\text{O}$ <sup>c</sup>   |
| Moderate                   | $100 \text{ mm Hg} < \text{PaO}_2/\text{FIO}_2 \leq 200 \text{ mm Hg}$ with PEEP $\geq 5 \text{ cm H}_2\text{O}$  |
| Severe                     | $\text{PaO}_2/\text{FIO}_2 \leq 100 \text{ mm Hg}$ with PEEP $\geq 5 \text{ cm H}_2\text{O}$  |

Abbreviations: CPAP, continuous positive airway pressure; FIO<sub>2</sub>, fraction of inspired oxygen; PaO<sub>2</sub>, partial pressure of arterial oxygen; PEEP, positive end-expiratory pressure.

<sup>a</sup>Chest radiograph or computed tomography scan.

<sup>b</sup>If altitude is higher than 1000 m, the correction factor should be calculated as follows:  $[\text{PaO}_2/\text{FIO}_2 \times (\text{barometric pressure}/760)]$ .

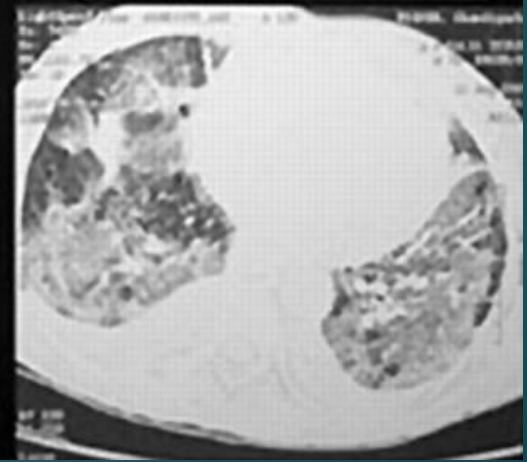
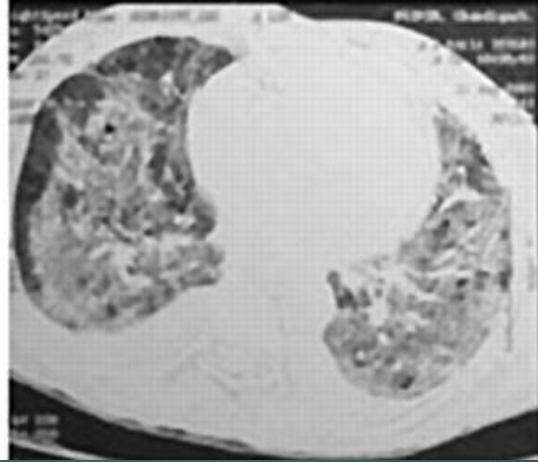
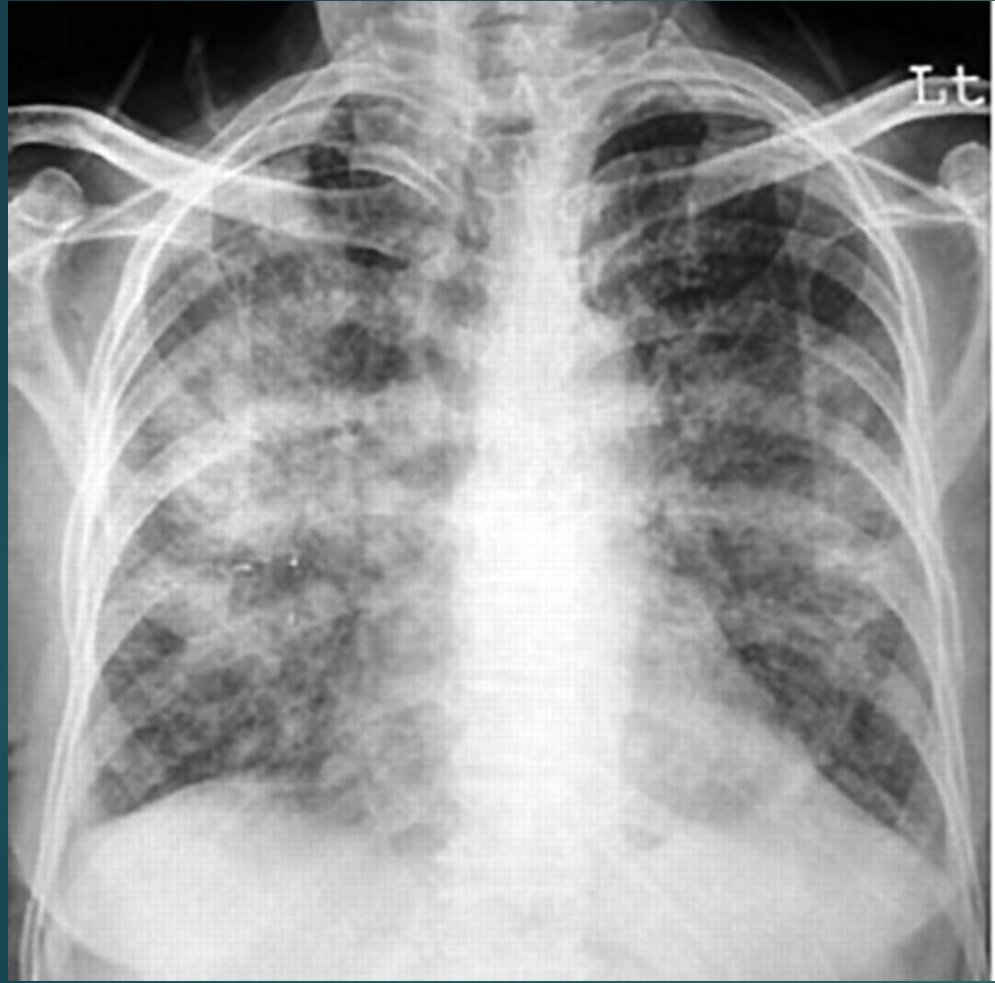
<sup>c</sup>This may be delivered noninvasively in the mild acute respiratory distress syndrome group.



# ARDS at UNM

- ▶ Mild:  $\text{PaO}_2 / \text{FiO}_2$  166 – 250
- ▶ Moderate:  $\text{PaO}_2 / \text{FiO}_2$  83 – 165
- ▶ Severe:  $\text{PaO}_2 / \text{FiO}_2 \leq 83$





# Causes of ARDS

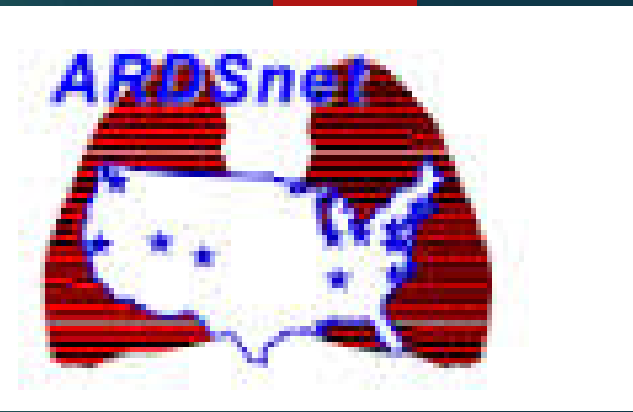
## ▶ Nonpregnancy Related

- ▶ Sepsis
- ▶ Aspiration
- ▶ Varicella / Influenza\*\*
- ▶ TRALI
- ▶ Air embolism
- ▶ Drug overdose
- ▶ Fat emboli
- ▶ Trauma
- ▶ Inhalation injury
- ▶ Near drowning
- ▶ Pancreatitis

## ▶ Pregnancy Related

- ▶ Pre-eclampsia / Eclampsia
- ▶ Tocolytic induced pulmonary edema
- ▶ Chorioamnionitis
- ▶ Amniotic fluid embolism
- ▶ Trophoblastic embolism
- ▶ Abruptio placentae
- ▶ Ovarian hyperstimulation syndrome
- ▶ Endometritis
- ▶ Septic abortion
- ▶ Retained POC
- ▶ H1N1 Influenza\*\*

# ARDS Management Strategies



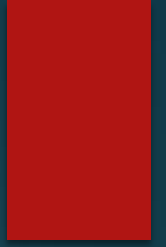
## ▶ General Principles

- ▶ PaO<sub>2</sub> goal: 55 – 80 mmHg
- ▶ Low tidal volume ventilation
- ▶ Use of PEEP
- ▶ Limited plateau pressures
- ▶ Permissive hypercapnia

## ▶ Adjunctive Therapies

- ▶ Conservative fluid management
- ▶ Paralytics
- ▶ Inhaled pulmonary vasodilators
- ▶ Prone positioning
- ▶ Open lung ventilation (HFOV or APRV)
- ▶ ECMO

ARDS modifications for pregnancy –  
What does the research say???



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# Prevalence and Mortality

- ▶ 16 to 70 cases / 100,000 pregnancies
- ▶ Overall maternal mortality 23-39%
- ▶ Rate of fetal loss 23%

# Noninvasive Ventilation

- ▶ Classically advised against due to decreased LES tone and delayed gastric emptying → increased risk of aspiration
- ▶ BUT recent case reports suggest it can be successfully applied in the appropriate patient population, ie. sitting up, fully awake and cooperative
- ▶ Always maintain a low threshold to move to mechanical ventilation





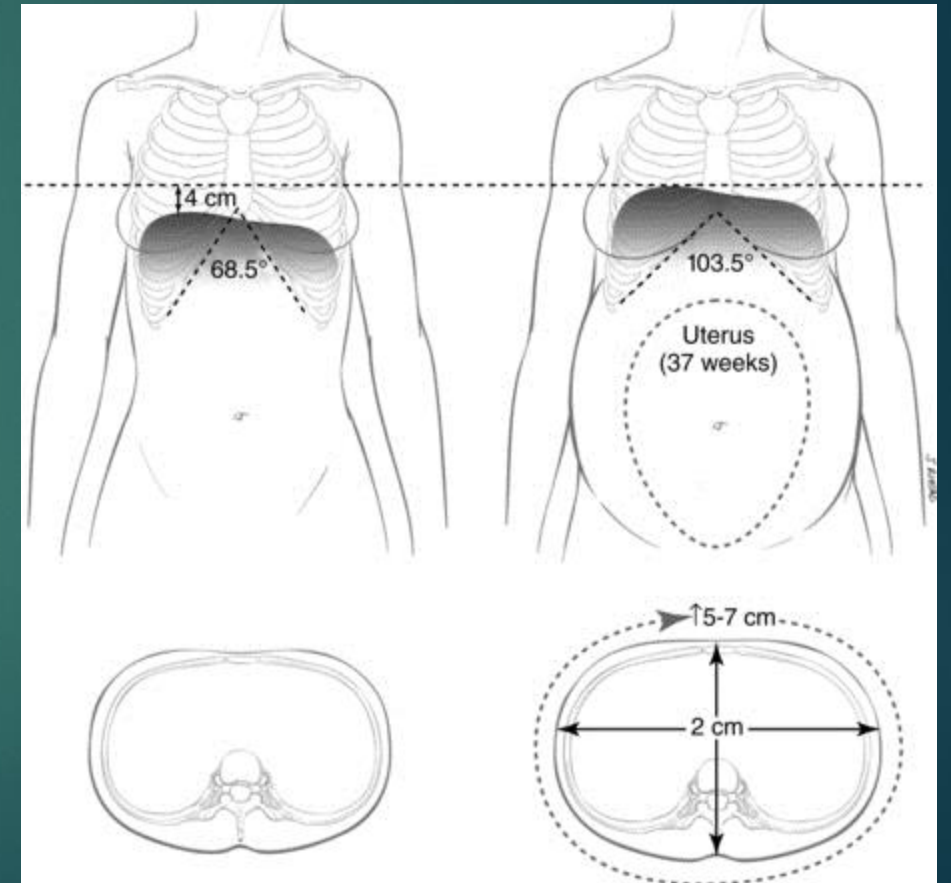
# Concerns for Intubation

- ▶ Intubation failure is 8 times more common than in nonpregnant patients
- ▶ Delayed gastric emptying and increased abdominal pressure → Increased risk of aspiration
- ▶ Decreased oxygen reserve
- ▶ Edema and hyperemia of airways



# Mechanical Ventilation Modifications

- ▶ Maintain PaO<sub>2</sub> > 70 mmHg
- ▶ Avoid maternal hypocapnia
- ▶ Limit maternal permissive hypercapnia, maintain PaCO<sub>2</sub> < 60
- ▶ Consider elevated intraabdominal pressures and decreased chest wall compliance with plateau pressure targets



# Adjunctive therapies

- ▶ Paralytics
- ▶ Inhaled pulmonary vasodilators
- ▶ HFOV
- ▶ APRV
- ▶ Proning
- ▶ ECMO

# Proning



Samanta, et al

- ▶ Limited case reports in late term pregnancy
- ▶ Creative positioning
- ▶ Use with caution

# ECMO

- ▶ 2 recently published systematic reviews on ECMO in pregnancy suggest benefit (Anselmi, Moore)
- ▶ Majority of cases from H1N1 outbreak
- ▶ Maternal survival up to 78%
- ▶ Infant survival up to 65%
- ▶ Hemorrhagic complication rate up to 57% in one small series

# Decision to Deliver

- ▶ Risk vs Benefit to Mother and Fetus
- ▶ Underlying cause of ARDS
- ▶ Fetal monitoring once viable – duration and frequency of monitoring on individual basis
- ▶ Joint decision with all providers
- ▶ Method of delivery up to providers
- ▶ Consideration of location of delivery with available necessary services if fetus is viable

# Key Points

- ▶ ARDS is a rare complication of pregnancy, may result from pregnancy or nonpregnancy related causes
- ▶ Maintain PaO<sub>2</sub> > 70 mmHg
- ▶ Avoid severe hypo or hypercapnia
- ▶ Adjunctive strategies remain grossly unchanged, although data is lacking
- ▶ Proning may be considered with caution
- ▶ ECMO may be appropriate strategy when other therapies fail
- ▶ Teamwork



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