ARDS in Pregnancy

UNM 3rd 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 PaO2 (100 – 110 mmHg)
- 20 – 33% increased O2 consumption
- 30-45% increase in Cardiac Output
- Increased Tidal Volume and Minute Ventilation
- Decreased PaCO2 (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 PaO2
- Hemoglobin concentration and saturation
  - Alkalosis → leftward shift oxyhemoglobin dissociation curve and increased O2 affinity → decreased O2 transfer
  - Acidosis → rightward shift oxyhemoglobin dissociation curve and decreased O2 affinity → increased O2 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 O2 Dissociation Curves

The graph shows the oxygen saturation of hemoglobin (% $O_2$) against the partial pressure of oxygen ($O_2$) for fetal hemoglobin (teal) and adult hemoglobin (orange).

- Fetal hemoglobin has a lower oxygen affinity compared to adult hemoglobin.
- At a partial pressure of 19, fetal hemoglobin is approximately 50% saturated, while adult hemoglobin is slightly higher.
- At a partial pressure of 26.8, fetal hemoglobin is about 50% saturated, whereas adult hemoglobin is significantly higher in saturation.
- At a partial pressure of 80, fetal hemoglobin remains relatively lower in saturation compared to adult hemoglobin.
CO2 transfer

- CO2 is unloaded from the umbilical artery to the uterine vein
- pCO2 fetal umbilical artery > pCO2 maternal uterine vein
**Table 3. The Berlin Definition of Acute Respiratory Distress Syndrome**

<table>
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<tr>
<th><strong>Timing</strong></th>
<th>Within 1 week of a known clinical insult or new or worsening respiratory symptoms</th>
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<tbody>
<tr>
<td><strong>Chest imaging</strong></td>
<td>Bilateral opacities—not fully explained by effusions, lobar/lung collapse, or nodules</td>
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<td><strong>Origin of edema</strong></td>
<td>Respiratory failure not fully explained by cardiac failure or fluid overload. Need objective assessment (eg, echocardiography) to exclude hydrostatic edema if no risk factor present</td>
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<td><strong>Oxygenation</strong></td>
<td></td>
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<td><strong>Mild</strong></td>
<td>(200 \text{ mm Hg} &lt; \frac{\text{PaO}_2}{\text{FiO}_2} \leq 300 \text{ mm Hg with PEEP or CPAP} \geq 5 \text{ cm H}_2\text{O} )</td>
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<tr>
<td><strong>Moderate</strong></td>
<td>(100 \text{ mm Hg} &lt; \frac{\text{PaO}_2}{\text{FiO}_2} \leq 200 \text{ mm Hg with PEEP} \geq 5 \text{ cm H}_2\text{O} )</td>
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<td><strong>Severe</strong></td>
<td>(\frac{\text{PaO}_2}{\text{FiO}_2} \leq 100 \text{ mm Hg with PEEP} \geq 5 \text{ cm H}_2\text{O} )</td>
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Abbreviations: CPAP, continuous positive airway pressure; \(\text{FiO}_2\), fraction of inspired oxygen; \(\text{PaO}_2\), partial pressure of arterial oxygen; PEEP, positive end-expiratory pressure.

*a* Chest radiograph or computed tomography scan.

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

*c* This may be delivered noninvasively in the mild acute respiratory distress syndrome group.
ARDS at UNM

- Mild: PaO2 / FiO2 166 – 250
- Moderate: PaO2 / FiO2 83 – 165
- Severe: PaO2 / FiO2 ≤ 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
  - PaO2 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???
ARDS modifications for pregnancy –
What does the research say???
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, i.e. 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 PaO2 > 70 mmHg
- Avoid maternal hypocapnia
- Limit maternal permissive hypercapnia, maintain PaCO2 < 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

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

Samanta, et al
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 PaO2 > 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
References