Critical Care of the Obstetric Patient

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Outline

- Common causes of admissions to the ICU
- Physiologic changes of pregnancy
- Causes of obstetrical hemorrhage
- Review amniotic fluid embolus (AFE)
- Discuss pre-eclampsia/eclampsia
- ARDS in the pregnant patient
- Fetal outcomes

Case Report

29 yo G1P0 woman was admitted at 39 weeks gestation for induction of labor. She had a h/o IDDM since the age of six. She had not suffered any complications related to her diabetes. Her pregnancy had been uncomplicated.


Case Report

Following admission she was given prostaglandin intravaginal gel. 5 hours later she had spontaneous rupture of membranes followed by rapid progression of labor. A tetanic contraction of her uterus occurred and she was moved to the OR. She was noted to be fully dilated and the decision was made to proceed with delivery by vacuum extraction. The baby was born with Apgars of 5 and 8.

Case Report

Her delivery was complicated by a fourth degree vaginal tear. Following delivery of the placenta the patient received oxytocin, and the tear was repaired under local. Excessive vaginal bleeding was noted but uterine tone was felt to be good. The patient was resuscitated for ongoing hemorrhage despite good uterine tone.


Case Report

Coagulation studies revealed a PT of 27.5, a PTT of 149 and a fibrinogen of 60. Her Hgb was 8.6. She received embolization of the vaginal arteries and was transferred to the ICU. Over the next several hours the patient continued to bleed profusely despite ongoing resuscitation and correction of her coagulopathy. She was taken to the OR and received a hysterectomy to control the bleeding. She recovered without sequelae.


Epidemiology

- Critical illness in a pregnant woman affects ~0.3% of pregnancies
- 0.07-1.35% of deliveries require maternal ICU admission
- Maternal mortality rates 2-30%
- Majority of women are admitted post-partum (~70%)

Pollock et al, Intensive Care Med 2010; 36: 1465
Selo-Ojeme et al, Arch Gynecol Obstet 2005; 272: 207
Gilbert et al, Obstet and Gynecol, 2003; 102: 897-903
Leveroro et al, Arch Gynecol Obstet, 2001; 265:195-198
Mahutte et al, Obstet and Gynecol 1999; 94: 263-266
Kilpatrick et al, Chest,1992; 101:1407-12

Obstetric Admissions to the Intensive Care Unit: Outcomes and Severity of Illness

Table 2. ICU Admitting Diagnoses of All 233 Obstetric Patients, by Type of Admission (Antepartum, Postpartum) and Indication Type (Medical, Obstetric)

<table>
<thead>
<tr>
<th>Admission Type</th>
<th>Antepartum (n = 62)</th>
<th>Postpartum (n = 171)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Diagnosis (n = 62)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preeclampsia</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Drug overdose</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Amnionitis</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Septicemia</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Anemia</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hypovolemia</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Obstet</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Obstet</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Hypovolemia</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Preeclampsia</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Meningitis</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Arthritis</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Antithyroid</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Is mortality prediction feasible in obstetric patients?

Gilbert et al, Obstet and Gynecol, 2003; 102: 897-903

RWJ; adm 1991-1998
*SAPS score predicts mortality in ob pts adm with medical diagnoses
Obstetric Admissions to the Intensive Care Unit

- McGill University ICU services
- Retrospective analysis
- 131 OB admissions (GA = 14 weeks and later plus 6 weeks postpartum) from 1991-1997
- Incidence: 0.3% of all deliveries
- 78% admitted postpartum
- Mortality rate = 2.3%

Mahutte et al, Obstet and Gynecol, 1999; 94: 263-266

Obstetric Admissions to the Intensive Care Unit

- Most women admitted were young, multiparous, preterm and postpartum
- Minority had preexisting medical problems that contributed to their admission:
  - Cardiac disease, Asthma, Blood dyscrasia, Chronic HTN
- 3 deaths out of 131 admissions: massive intracranial bleed, autoimmune cirrhosis, mixed CTD with sepsis

Mahutte et al, Obstet and Gynecol, 1999; 94: 263-266

Obstetric Admissions to the Intensive Care Unit: 5 most common reasons

1. **Hemorrhage**
   - abnormal placentation, uterine atony, lacerations, retained products of conception, severe coagulopathy/DIC

2. **Hypertension**
   - preeclampsia/eclampsia with or without HELLP (Hemolysis, Elevated Liver enzymes, Low Platelet count), pheochromocytoma

3. **Cardiac disease**
   - valvular diseases, cardiomyopathy, arrhythmias

4. **Respiratory disorders**
   - pulmonary edema, asthma

5. **Infection**
   - pyelonephritis, chorioamnionitis

*Snyder et al, J Matern Fetal Neonat Med 2013; 26(5): 503-506*
Pregnant and Post partum admissions to the ICU: a systematic review
Pollock et al; Intensive Care Med 2010; 36: 1465-1474

- 40 eligible studies from several databases reporting outcomes for 7,887 women were analyzed (all retrospective and majority single center)
- 24 studies developing countries, 15 from developing countries and 1 from US and India
- Confirms low incidence of ICU admission (median 2.7/1000)
- Most common reasons for admission:
  - Hypertensive d/o of pregnancy
  - Obstetrical hemorrhage
- Higher rate of mortality in developing countries (14% vs. 3%)

Respiratory Changes in Pregnancy

<table>
<thead>
<tr>
<th>Pulmonary Function</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Forced Expiratory Volume in 1 second</td>
<td>No change</td>
</tr>
<tr>
<td>Functional Residual Capacity</td>
<td>Decreased 10-25%</td>
</tr>
<tr>
<td>Total Lung Capacity</td>
<td>Minimal decrease</td>
</tr>
<tr>
<td>Minute Ventilation</td>
<td>Increased 20-40%</td>
</tr>
<tr>
<td>Alveolar Ventilation</td>
<td>Increased 50-70%</td>
</tr>
</tbody>
</table>

Lapinsky S., Crit Care Med, 2005 Vol. 33, No. 7 1616-1622

Lung Volume Changes in Pregnancy


Cardiovascular Changes in Pregnancy

<table>
<thead>
<tr>
<th>Hemodynamics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate</td>
<td>Increased 10-30%</td>
</tr>
<tr>
<td>Pulmonary Artery Occlusion Pressure</td>
<td>No change</td>
</tr>
<tr>
<td>Cardiac Output</td>
<td>Increased 30-50%</td>
</tr>
<tr>
<td>Systemic Vascular Resistance</td>
<td>Decreased 20-30%</td>
</tr>
<tr>
<td>Pulmonary Vascular Resistance</td>
<td>Decreased 20-30%</td>
</tr>
</tbody>
</table>

Lapinsky S., Crit Care Med, 2005 Vol. 33, No. 7 1616-1622
Cardiovascular Changes in Pregnancy (continued)

• Blood volume increases up to 2 L (30-50% above normal intravascular volume)
  – High uterine and placental blood flow demand (up to 600 mL/min at term)
  – Increased pelvic venous capacitance
  – Protects mother against blood loss during delivery

• Body position alters hemodynamics after 20 weeks
  – 30% reduction in ejection fraction in supine position
  – Left lateral position improves venous return

Arterial Blood Gas in the Pregnant Patient

<table>
<thead>
<tr>
<th>Arterial Blood Gas</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PaO2*</td>
<td>No change</td>
</tr>
<tr>
<td>PaCO2</td>
<td>Reduced to 28-32 Torr</td>
</tr>
<tr>
<td>Serum Bicarbonate</td>
<td>Reduced to 18-21 mEq/L</td>
</tr>
</tbody>
</table>

*oxygen consumption increases nearly 20% at term but is offset by increase in cardiac output

Lapinsky S., Crit Care Med, 2005 Vol. 33, No. 7 1616-1622

Fetal Oxygen Delivery

• Determinants:
  – Maternal arterial oxygen content
  – Uterine Blood Flow
  – Hgb Concentration
  – Maternal and Fetal Oxygen – Hgb dissociation curves

Lapinsky S., Crit Care Med, 2005 Vol. 33, No. 7 1616-1622

Case Report

Diagnosis:

Post-partum hemorrhage secondary to amniotic fluid embolus leading to a severe coagulopathy (DIC)

## Obstetric Admissions to the Intensive Care Unit

1. **Hemorrhage** → abnormal placenta, atony, lacerations, retained products of conception, severe coagulopathy/DIC
2. **Hypertension** → preeclampsia/eclampsia with or without HELLP (Hemolysis, Elevated Liver enzymes, Low Platelet count)
3. **Cardiac disease** → valvular diseases, cardiomyopathy, arrhythmias
4. **Respiratory disorders** → pulmonary edema (ARDS), asthma
5. **Infection** → pyelonephritis, chorioamnionitis

*Mahutte et al, Obstet and Gynecol, 1999: 263-266*

## Hemorrhage

- Accounts for ~17% of maternal deaths
- **Causes:**
  - Abnormal placenta: Acreta (deep in wall), Increta (penetrates muscle), or Percreta (through wall and into another organ)
  - Uterine atony
  - Cervical/Vaginal laceration
  - Coagulopathy/DIC (Amniotic fluid embolus, Abruptio placentae, HELLP, Retained dead fetus)
- **Treatment:**
  - Supportive with volume resuscitation
  - Drugs (uterine atony → ergot derivatives, prostaglandin analogues, oxytocin) (coagulopathy → Factor VIII)
  - Extreme cases of hemorrhage: embolization of uterine or iliac

*Lapinsky S., Crit Care Med, 2005 Vol. 33, No. 7 1616-1622*

## Amniotic Fluid Embolism

- Exceedingly rare
- United States registry and United Kingdom registry
  - US: 46 in 1995
  - UK: 44 in 2005
- Estimated to occur in 1 in 8,000 to 1 in 80,000 deliveries
- High mortality (60% in older reports; 27% in newer population based study; 37% in 2005 UK registry)

*Gist et al, Anesthesia and Analgesia, 2009: 108: 1599-1602*

## Amniotic Fluid Embolus

- Neonatal outcome poor with mortality rate of 20-25%
- Occurs intrapartum or immediate postpartum period
- NO PROVEN RISK FACTORS
- ONSET CANNOT BE PREDICTED

*Gist et al, Anesthesia and Analgesia, 2009: 108: 1599-1602*
Amniotic Fluid Embolism

1. Amniotic fluid enters maternal circulation through endocervical veins, placental insertion site, or uterine trauma site
2. Acute pulmonary hypertension → right heart failure, hypoxia, cardiac arrest
3. Left ventricular failure (mechanism unclear)
   - Hypoxic injury during initial phase
   - Release of inflammatory mediators
   - Direct depressant effect of amniotic fluid on myocardium
4. Pulmonary edema

Treatment is supportive

- Correct hypoxemia
- Correct hypotension
- Improve inotropy
- Consider blood products/Factor VIIa for coagulopathy
- Determine whether fetus should be delivered
- Consider rescue therapies

- Inhaled nitric oxide
- Ventricular assist devices
- ECLS/ECMO

Pre-eclampsia/Eclampsia

- Proteinuria and hypertension occurring after the 20th week of pregnancy
- + seizures = eclampsia

Mushambi et al, Br J Anaesth, 1996; 76: 133-148
Pre-eclampsia/Eclampsia

Complications:
- Refractory hypertension
- Neurologic dysfunction (seizures, intracranial hemorrhage)
- Elevated ICP
- Renal Failure
- Liver rupture or failure
- HELLP syndrome (Hemolytic Anemia, Elevated Liver enzymes, Low Platelet count)
- Pulmonary edema/ARDS
- DIC

Gist et al, Anesthesia and Analgesia, 2009; 108: 1599-1602
Lapinsky S., Crit Care Med, 2005 Vol. 33, No. 7 1616-1622

Pre-eclampsia/Eclampsia

• Management:
  - Delivery versus expectant management
  - Anti-hypertensive therapy
    • Hydralazine and /or Labetolol are the agents of choice
    • Use agents to prevent maternal hypertensive complications
    • Anti-hypertensive therapy not alter the natural history
    • Blood pressures normalize by 6 weeks post-partum
  - Seizure prophylaxis/treatment
    • Magnesium is the agent of choice
    • Continue post-partum for 12-48 hours
  - Fluid status should be monitored carefully
    • Follow UOP
    • Consider CVP monitoring

Gist et al, Anesthesia and Analgesia, 2009; 108: 1599-1602
Lapinsky S., Crit Care Med, 2005 Vol. 33, No. 7 1616-1622
ARDS in Pregnancy

Low Tidal Volume Ventilation and Hypercapnia

- Adequate fetal oxygenation requires a PaO2 > 70 mm Hg
- No human data on uteroplacental and umbilical blood flow with hypercapnia
- Fetal PaCO2 must be 10 mm Hg higher than maternal to allow exchange across the placenta
- Acidity shifts oxygen Hgb dissociation to the right → limiting ability of fetal Hgb to bind oxygen
- Limited data to suggest that a PCO2 range between 45 and 60 can be tolerated by the fetus
- Maternal PaCO2 = 45 mm Hg may be safe limit
- Insufficient evidence to know if HCO3 is transferred efficiently across the placenta

Preventative strategies in pregnancy

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Extracorporeal membrane oxygenation for severe ARDS in pregnant and postpartum women during the 2009 H1N1 pandemic

- Retrospective, observational study on the application of ECMO
- 7 tertiary hospitals in Australia and New Zealand
- 12 critically ill pregnant and postpartum women → 7 pregnant and 5 postpartum → VA ECMO x 2 and VV ECMO x 7
- 8 patients survived to d/c (66%) and 7 were ambulant
- Left uterine displacement important

Fetal outcomes of critically ill pregnant women admitted to the intensive care unit for non obstetric causes

- Retrospective cohort study
- Critically ill pregnant patients >18 yr admitted to intensive care units at Mayo Clinic from 1995-2005 (antepartum and non-obstetrical indications)
- Fetal outcomes were defined as follows:
  - Spontaneous abortions
  - Neonatal mortality
  - Fetal deaths
  - Adm to the neonatal intensive care unit, NICU LOS, and NICU complications
- 32 fetal loses of 93 maternal admissions

Nair et al; Intensive Care Med 2011; 37: 648-654

Fetal outcomes of critically ill pregnant women admitted to the intensive care unit for non obstetric causes

Risk factors associated with fetal loss:
1. maternal shock (odds ratio 6.85 (95% confidence interval 1.16–58, p < 0.04))
2. maternal transfusion of blood products (odds ratio 7.24 (95% confidence interval 1.4–49, p < 0.02))
3. gestational age (odds ratio 1.2 for every gestational week below 37 wk (95% confidence interval 1.1–1.3, p < 0.001))


Critical Care of the Obstetric Patient

• Common causes of admission to the ICU are hemorrhage, hypertension, cardiac disease, respiratory disorders, and infection
• Consider the physiologic changes in pregnancy
• Remember left uterine displacement!
• Consider rare causes of cardiovascular collapse and DIC
• Attempt low tidal volume ventilation in pregnant patients with ARDS but consider the effects on the fetus