Disclosures
“Ryan you have been jeopardized to OB Labor and Delivery, Saturday call for 24 hours, to fill in while another resident is in Puerto Vallarta.”
Discussion Topics

• HELLP Syndrome
• Thrombocytopenia and Neuraxial Anesthesia
• Invasive Placenta Pathology
• Obstetric Airway
• Team Approach
• Hemorrhage, Massive Resuscitation, Coagulopathy
• ROTEM
• Fibrinogen Concentrate
• Electrolyte abnormalities
• Acute Kidney Injury
• Emerging Technology
Our Patient

• 36 year old female, G2P1 at 30 weeks, 2 days presenting for cesarean delivery for HELLP syndrome.

• PMH: 2014 Cesarean delivery complicated by large broad ligament hematoma, requiring right uterine artery embolization.
Our patient: Uterine Didelphys

Source: Mayo Clinic: Uterine Didelphys Online
Uterine Didelphys

- Higher rates of infertility, miscarriage, intrauterine growth restriction, postpartum bleeds.


*Placenta percreta with concomitant uterine didelphys at 18 weeks of pregnancy: a case report and review of the literature.*

Tuşttaş Haberal E¹, Çekmez Y¹, Ulu İ¹, Divlek R¹, Göçmen A¹.

**PRESENTATION /CORD /PLACENTA / FLUID / CERVIX:**
- Presentation: Cephalic
- Umbilical Cord: 3 Vessel Cord. Normal insertion into the placenta.
Admission

- 2/8/18: felt unwell, home BP elevated to 160/100
- Triage: BP 167/101, Plts 73, AST 182, ALT 153

**HELLP syndrome**
TABLE 36-6 Diagnostic Criteria for Hemolysis, Elevated Liver Enzymes, and Low Platelets (HELLP) Syndrome

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Laboratory Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemolysis</td>
<td>Abnormal peripheral blood smear</td>
</tr>
<tr>
<td></td>
<td>Increased bilirubin &gt; 1.2 mg/dL</td>
</tr>
<tr>
<td></td>
<td>Increased LDH &gt; 600 IU/L</td>
</tr>
<tr>
<td>Elevated liver enzyme levels</td>
<td>Increased AST ≥ 70 IU/L</td>
</tr>
<tr>
<td></td>
<td>Increased LDH &gt; 600 IU/L</td>
</tr>
<tr>
<td>Thrombocytopenia</td>
<td>Platelet count &lt; 100,000/mm²</td>
</tr>
</tbody>
</table>


HELLP Syndrome

Multi-system manifestations and severe complications

**TABLE 36-5** Serious Maternal Complications in a Series of 442 Patients with Hemolysis, Elevated Liver Enzymes, and Low Platelets (HELLP) Syndrome

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. Patients</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disseminated intravascular coagulopathy</td>
<td>92</td>
<td>21</td>
</tr>
<tr>
<td>Placental abruption</td>
<td>69</td>
<td>16</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>33</td>
<td>8</td>
</tr>
<tr>
<td>Severe ascites</td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>26</td>
<td>6</td>
</tr>
<tr>
<td>Pleural effusions</td>
<td>26</td>
<td>6</td>
</tr>
<tr>
<td>Cerebral edema</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Retinal detachment</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Laryngeal edema</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Subcapsular liver hematoma</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Acute respiratory distress syndrome</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Maternal death</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

*Some women had multiple complications.*

HELLP Management

• Generally not candidates for expectant management.
• Acceptable to defer delivery until after corticosteroid administration to accelerate fetal lung maturity.
• IV Magnesium Sulfate for seizure prophylaxis.
• Antihypertensive medications for goal BP < 160/110.

HELPP and Neuraxial Anesthesia

- 205,000 epidural procedures, 1 epidural hematoma (HELPP).
- 50,000 spinal procedures, 1 spinal hematoma (HELPP).

Risk of Epidural Hematoma after Neuraxial Techniques in Thrombocytopenic Parturients

A Report from the Multicenter Perioperative Outcomes Group

Linden O. Lee, M.D., Brian T. Bateman, M.D., M.Sc., Sachin Kheterpal, M.D., M.B.A., Thomas T. Klumpner, M.D., Michelle Housey, M.P.H., Michael F. Aziz, M.D., Karen W. Hand, M.D., Mark MacEachern, M.L.I.S., Christopher G. Goodier, M.D., Jeffrey Bernstein, M.D., Melissa E. Bauer, D.O., on behalf of the Multicenter Perioperative Outcomes Group Investigators*
Epidural placement

- On 2/9, platelet count of 77, Epidural placed uneventfully.
Saturday Morning 2/10

- Betamethasone for fetal lung protection completed.
- Platelet count uptrending (77→164).
- Elevated transaminases downtrending (AST 194→71; ALT 160→92).
- BP’s out of severe range.

- Decision for Cesarean Delivery on morning of 2/10.
- Go time!
Epidural replacement

- 10:21 am: Epidural catheter replaced, CSE performed.
- 10:46 am: Surgical incision.
- 10:50 am: “Higher than expected EBL per surgeons given history of prior uterine procedures and neo-vascularization.”
  - Additional large bore peripheral IV placed.
Operative Course

- 10:51: Delivery of Neonate.
- Uterotonics: Oxytocin, Misoprostol, Carboprost.
- 11:03: Unanticipated Invasive Placenta Identified, need for emergent Hysterectomy.
- 11:15: EBL 1900cc.
Unidentified Invasive Placenta

Diagram showing layers of the placenta:
- **Normal**
- **1 Accreta**
- **2 Increta**
- **3 Percreta**

Layers:
- Endometrium
- Mymetrium
- Serosa
### TABLE 38-2
Risk for Placenta Accreta in Patients with Placenta Previa: Relationship to Number of Prior Cesarean Deliveries

<table>
<thead>
<tr>
<th>Number of Prior Cesarean Deliveries</th>
<th>% of Patients with Placenta Accreta</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>61</td>
</tr>
<tr>
<td>4 or more</td>
<td>67</td>
</tr>
</tbody>
</table>

The management of placenta percreta: Conservative and operative strategies

John M. O’Brien, MD, a John R. Barton, MD, a and Elvis S. Donaldson, MD b

Lexington, Kentucky
Conversion to General Anesthesia
## Incidence of Failed Intubation in Obstetrics

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Country</th>
<th>No.</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyons</td>
<td>1985</td>
<td>UK</td>
<td>2331</td>
<td>1:291</td>
</tr>
<tr>
<td>Rocke</td>
<td>1992</td>
<td>South Africa</td>
<td>1500</td>
<td>1:750</td>
</tr>
<tr>
<td>Hawthorne</td>
<td>1996</td>
<td>UK</td>
<td>5802</td>
<td>1:250</td>
</tr>
<tr>
<td>Tsen</td>
<td>1998</td>
<td>USA</td>
<td>536</td>
<td>1:536</td>
</tr>
<tr>
<td>Barnardo</td>
<td>2000</td>
<td>UK</td>
<td>8970</td>
<td>1:249</td>
</tr>
<tr>
<td>Rahman</td>
<td>2005</td>
<td>Australia</td>
<td>1095</td>
<td>1:274</td>
</tr>
<tr>
<td>Djabatey</td>
<td>2009</td>
<td>UK</td>
<td>3430</td>
<td>0</td>
</tr>
<tr>
<td>McKeen</td>
<td>2011</td>
<td>Canada</td>
<td>2633</td>
<td>1:1300</td>
</tr>
</tbody>
</table>

Difficult Airway Predictors

Incidence, Predictors, and Outcome of Difficult Mask Ventilation Combined with Difficult Laryngoscopy

A Report from the Multicenter Perioperative Outcomes Group

Sachin Kheterpal, M.D., M.B.A.,* David Healy, M.D., M.R.C.P., F.R.C.A.,* Michael F. Aziz, M.D.,†
Amy M. Shanks, M.S.,‡ Robert E. Freundlich, M.D., M.S.,§ Fiona Linton, M.B.Bch.,||
Ana Fernandez-Bustamante, M.D., Ph.D.,‡‡ Leslie C. Jameson, M.D.,§§ Tyler Tremper, D.B.S.,|||*
Kevin K. Tremper, Ph.D., M.D.#; on behalf of the Multicenter Perioperative Outcomes Group (MPOG) Perioperative Clinical Research Committee***

Table 3. Difficult Mask Ventilation Combined with Difficult Laryngoscopy Prediction Score

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Weighted Points</th>
<th>Unweighted Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mallampati III or IV</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Neck radiation changes or neck mass</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Male sex</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Limited thyromental distance</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Presence of teeth</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Body mass index ≥30 (kg/m²)</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Age ≥46</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Presence of beard</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Thick neck</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Sleep apnea</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Unstable cervical spine or limited neck extension</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Limited or severely limited jaw protrusion</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Total possible</td>
<td>44</td>
<td>12</td>
</tr>
<tr>
<td>Validation cohort c-statistic</td>
<td>0.81 (0.78–0.84)</td>
<td>0.81 (0.78–0.84)</td>
</tr>
</tbody>
</table>
Obstetric Airway Concerns

• Physiologic and anatomic changes.
• Affects airway, oxygenation and metabolism.
• Often in emergency situations during off hours.
Changes in Pregnancy

- Airway Edema.
- Decreased Functional Residual Capacity.
- Increased Oxygen Consumption.
- Weight Gain.
- Breast Enlargement.
- Decreased Lower Esophageal Sphincter Tone.
- Delayed Gastric Emptying in Labor.
Changes in Pregnancy

- **Airway Edema.**
- Decreased Functional Residual Capacity.
- Increased Oxygen Consumption.
- Weight Gain.
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- Airway Edema.
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- **Increased Oxygen Consumption.**
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Changes in Pregnancy

- Airway Edema.
- Decreased Functional Residual Capacity.
- Increased Oxygen Consumption.
- **Weight Gain.**
- **Breast Enlargement.**
- Decreased Lower Esophageal Sphincter Tone.
- Delayed Gastric Emptying in Labor.
Changes in Pregnancy

- Airway Edema.
- Decreased Functional Residual Capacity.
- Increased Oxygen Consumption.
- Weight Gain.
- Breast Enlargement.
- **Decreased Lower Esophageal Sphincter Tone.**
- **Delayed Gastric Emptying in Labor.**
Post-Extubation

- 855 pregnancy-associated deaths
- No deaths during induction of general anesthesia.
- Five deaths from hypoventilation or airway obstruction during emergence, extubation or recovery.
Airway Management and Line Placement

- Rapid sequence induction.
- Significant airway edema noted.
- Successful intubation, confirmed by chest rise, bilateral breath sounds, and ETCO2.
- Central access obtained.
- Belmont Rapid Blood Infuser attached.
Emergent Peripartum Hysterectomy

• Definitive treatment.
• Morbidity: 56%.
• Mortality: 2.6% (~1/40).
• EBL can often be more than a patient’s blood volume (hint: we had a lot more than that...)
• Pregnant uterus receives ~700 mL/min blood

Hemorrhage

• Massive transfusion initiated.
Hemorrhage

- EBL now 16L (and counting...)
- Belmont maxed out.
- Metabolic acidosis.
Pharmacy to OR STAT

• Mott OR Pharmacist to OB L&D in an emergency.
Tranexamic Acid: CRASH-2 Trial

TXA: 1.5% absolute risk reduction in mortality.

NNT: 66

Reductions in bleeding, multi-organ failure.
TXA for Obstetric Hemorrhage – WOMAN trial

- ARR 0.4%, when adjusted for baseline risk, actually 0.8%.

- NNT: 125

- TXA *maybe* beneficial in setting of reducing risk of death from hemorrhage.
Peri-code

• Bleeding (and transfusion, pressors) continue.

• Hemorrhage continues even after the Cesarean-Hysterectomy is completed.

• Vascular surgery emergently to OR.
Coagulopathy

• Massive transfusion: Transfusion of >10 pRBC within 24 hours (replacement of one blood volume).

• All coagulation elements exhibit derangement, including procoagulant, anticoagulant, fibrinolytic and antifibrinolytic proteins.

• Resuscitation
  – Extensive hemodilution.
  – Reduced thrombin activation.
  – Enhanced fibrinolysis.
  – Consumption of products, platelets.
Fibrinogen
Fibrinogen Concentrate

• Hemostatic management of hemorrhage.
• Comparable clinical outcomes.
• Logistically favorable.
• Less blood product administration.

Fibrinogen concentrate in bleeding patients (Review)

Wikkelsø A, Lunde J, Johansen M, Stensballe J, Wetterslev J, Møller AM, Afshari A
# Fibrinogen Math!

<table>
<thead>
<tr>
<th></th>
<th>Fibrinogen Concentrate</th>
<th>Cryoprecipitate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dose</strong></td>
<td>900-1300 gram per vial</td>
<td>750mg-1250 gram per unit</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>10-50 cc</td>
<td>125-150 cc</td>
</tr>
<tr>
<td><strong>Contents</strong></td>
<td>Fibrinogen</td>
<td>Fibrinogen, Factor 8, vWF, Factor 13, Fibronectin</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>$886 per vial</td>
<td>$3000 per unit</td>
</tr>
</tbody>
</table>

UMHS Blood Bank Internal Data, Dept. of Pathology
Transfusion-Associated Electrolyte Abnormalities

- Hypocalcemia
- Hyperkalemia
- Hypokalemia
Hypocalcemia

- Stored blood anticoagulated with citrate.
- 1 unit pRBC = 3 grams of citrate.
- Massive transfusion or Hepatic Impairment limits citrate metabolism.
- Citrate toxicity: Hypotension, prolonged QT interval, decreased cardiac contractility.

Electrolyte Abnormalities

**Hyperkalemia**
- Potassium concentration increases in stored blood.
- Potassium concentration worsens with irradiation and reduced with washing.
- Transfusion > 7 units pRBC independently associated with hyperkalemia.
- Case reports: Hyperkalemic Arrest during massive transfusion.

**Hypokalemia**
- Occurs following restoration of red cell membrane ATPase pump.
- Metabolic alkalosis lowers serum potassium (from citrate administration).
- Co-infusion of potassium-poor solutions, such as normal saline, Plts and FFP.

Management of Hyperkalemia

- Calcium
- Insulin
- Dextrose
- Albuterol
- Loop Diuretics
- Bicarbonate
- Binding resins
- Emergent Dialysis

EKG Source: Burns, E. Hyperkalemia. LITFL
Resuscitation

- EBL 30,000 mL +
- pRBC: 31 units
- FFP: 18 units
- Plts: 30 packs
- Fibrinogen Concentrate: 8 grams
- PCC: 2000 units
- Crystalloid: 10L
Acute Kidney Injury

- Oliguria 235 mL.
- Profound hypovolemia and hypotension.
- Surgical Ureterolysis.
Emerging Technology

- **Indications**: sub-diaphragmatic hemorrhage, blunt abdominal or pelvic trauma.
- **Contra-indications**: PEA arrest >10 minutes, age >70, concern for traumatic aortic dissection.
Patient Follow-up

- POD 0: SICU admit, Plt count 27.
- POD 1: OR Bring Back, Abdominal Closure.
- POD 4: Hemodialysis started.
- POD 5: Extubated.
- POD 6: Plt count 70, Neuro intact, Epidural removed.
- POD 7: Plt count >100.
- POD 15: Discharged Home!
Special Thanks

- Dr. Justin Engelhardt
- Dr. Carlo Pancaro
- Dr. Bryant Wu
- Dr. Sean Maxwell
- Dr. Dan Horner
- Dr. Amy Blevins
- Our amazing COBAN’s and Anes Techs
- Our OB, Vascular surgery colleagues
Thank you