Intraoperative Blood Loss Assessment Post Partum Hemorrhage: Tricky or Simple?

Natan Weksler, MD
Director Department of Anesthesiology and Critical Care
Mayanei Hayeshua Medical Center, Bnei Brack
Associate Professor on Anesthesiology and Critical Care
Faculty of Health Sciences
Ben Gurion University of the Negev
Beer Sheva 84101, Israel
Intraoperative Blood Loss Assessment - PPH

BACKGROUND

- Third trimester bleeding occurs in approximately 4% of patients.

- Approximately 50% will have an inconsequential cause and 50% will have a life-threatening event.
Postpartum Hemorrhage

- Traditional definition = > 500 ml blood loss
- Normally seen blood losses:
  - Vaginal delivery - 50% > 500ml
  - C/section - 1000ml
  - Elective C-hys - 1500ml
  - Emergent C-hys - 3000ml
Intraoperative Blood Loss Assessment - PPH

Postpartum Hemorrhage(2)

- Pregnancy is normally a state of hypervolemia and increased RBC mass
- Blood volume normally increased by 30-60% (1-2 L)
- Pregnant patients are therefore able to tolerate some degree of blood loss
- *Estimated* blood loss is usually about 1/2 of actual loss!
Intraoperative Blood Loss Assessment - PPH

Postpartum Hemorrhage(3)

- **Early** postpartum hemorrhage is within 1st 24 hours (also may be just called “postpartum hemorrhage”)
- **Late** postpartum hemorrhage (not addressed in this talk) is less common and occurs *after* the 1st 24 hours postpartum
Intraoperative Blood Loss Assessment - PPH

- Massive transfusion (MT) is commonly defined as the replacement of one circulating blood volume in a period of 24 hr.
Intraoperative Blood Loss Assessment - PPH

- A dynamic definition of MT, such as the transfusion of four or more red cell concentrates within one hour when ongoing need is foreseeable, or the replacement of 50% of the total blood volume within three hours
Severe hemorrhage has been classified as blood loss of more than 150 ml/min (within 20 min causing a loss of more than 50% of blood volume) or a sudden blood loss of more than 1500–2000 ml (uterine atony; loss of 25–35% of blood volume).
Assessment of Intraoperative Blood Loss - Importance

- Accurate and timely estimation of intra operative blood loss is important for appropriate replacement with crystalloid or colloids, as well as early request for the release of packed RBCs or ordering further packed cells.
- Underestimation and inadequate replacement will primarily lead to hypotension and tachycardia. Secondarily very low hemoglobin possesses risk of tissue injury due to impaired oxygenation.
- Over estimation and over transfusion on the other hand will increase the myocardial workload due to hypervolemia and increased viscosity. Over estimation of blood loss will expose the patient to the risks of blood transfusion. It has been suggested that risks of transfusion increases with intra operative transfusion.
Risks of Blood Transfusion

- HIV: 1:2,135,000
- Hepatitis A: 1:1,000,000
- Hepatitis B: 1:205,000
- Hepatitis C: 1:276,000
- HTLV I/II: 1:2,993,000
- Transfusion-related acute lung injury: 1:5,000
- Alloimmunization: 0.5%

Int. Anesthesia Clinics 2004
Intraoperative Blood Loss Assessment - Visual

- Visual estimation of blood loss is unreliable

(Kobe et al. Accuracy of blood loss determination by health care professionals. CRNA 1999;10:170–3)
Intraoperative Blood Loss Assessment - Visual

- Tall et al and Patton et al conducted controlled simulation blood loss scenarios for emergency personnel. Estimations were so inaccurate that they suggested that emergency personnel not waste time trying to visually estimate blood loss when that time could be used attending to the patient.

Health care professionals were able to estimate small volumes of blood more accurately than large volumes, and blood in containers more accurately than blood on sanitary pads or linens.

Intraoperative Blood Loss Assessment - Visual

- The visual estimation of blood loss really has no place in research methods specifically evaluating blood loss. Gross inaccuracies have been repeatedly documented. Visual estimation of blood loss is inaccurate; its continued use in clinical practice is likely related to ease of use and tradition rather than serving any clinical value. It may be time for visual estimation of blood loss during birth to be eliminated from routine assessment and documentation.

Intraoperative Blood Loss Assessment – Ht/ Hb Changes

The Actual Blood Loss (ABL) calculation:

• modified Gross’ formula:

• \( ABL = EBV \times \frac{\text{Hct (i)} - \text{Hct (f)}}{\text{Hct (m)}} \)

- \( \text{Hct (i)}, \text{Hct (f)} \) and \( \text{Hct (m)} \) were the initial, final and mean (of the initial and final) Hematocrits respectively.
Intraoperative Blood Loss Assessment

Estimated blood volume (mL)

\[ = \text{[body surface area (m}^2\text{)]} \times 2430 \text{ (women) [body surface area (m}^2\text{)]} \times 2530 \text{ (men)} \]
Intraoperative Blood Loss Assessment

Body surface area (m²)

\[ = 0.0235 \times [\text{height (cm)}]^{0.42246} \times [\text{weight (kg)}]^{0.51456} \]

**SIMPLE FORMULA TO ESTIMATE CIRCULATING BLOOD VOLUME**

EBV (blood volume) = Body Weight in Kg x 70 ml.kg⁻¹
Intraoperative Blood Loss Assessment – Ht/ Hb Changes

PITFALLS

• Immediately after acute blood loss, all the laboratory red cell indices are normal!
• This is because during acute blood loss, patient looses red cells but also plasma that goes along with them. So the blood remaining in the patient is totally normal – it’s just that there isn’t enough of it.
• Only after few hours (sooner, if the patient receives fluids), the blood will start to become more dilute as the patient pulls fluid from tissues into vessels.
Effect of Acute Blood Loss on Hematocrit

• Change usually delayed at least 4 hours

• Complete compensation takes 24 hours

• Above affected by degree of intravenous hydration
It is impossible to estimate the effect of blood transfusion on volume or hemoglobin concentration in actively bleeding individuals.5
Intraoperative Blood Loss Assessment - Gravimetric

- Measurement of blood loss by weight is the most accurate and practical method for determining the volume of blood not captured in graduated containers. This can be accomplished by subtracting the dry weight of absorbing materials (pads, sponges, etc) from the weight of blood-containing materials and using the conversion 1 gm weight = 1 mL to quantify the blood volume contained in the materials.

CMQCC OBSTETRIC HEMORRHAGE TOOLKIT OBSTETRIC HEMORRHAGE CARE GUIDELINES AND COMPRENDIUM OF BEST PRACTICES REVIEWED BY CADPH-MCAH: 1/6/10
• For birth without prior rupture of membranes, the following volumes can be used to estimate the contribution of amniotic fluid at term: normal fluid volume 700 ml; oligohydramnios 300 ml; polyhydramnios 1400 ml
Intraoperative Blood Loss Assessment - PPH

Blood: An Emotional Topic

“...the sweeping story of a substance that has been feared, revered, mythologized, and used in magic and medicine from earliest times—a substance that has become the center of a huge, secretive, and often dangerous worldwide commerce.”

—from the publisher's description of the book

Compensatory Mechanisms of Anemia

- Hb = 6.0-7.0 g/dL tolerable (blood loss controlled + good cardiac function)
  - ↑ Cardiac output
  - ↑ Coronary flow
  - ↓ Blood viscosity
  - ↓ O₂ consumption
  - ↑ O₂ extraction

Anemia: Lower the Transfusion Trigger Point?

- Hb 7.0 g/dL-9.0 g/dL sufficient in critically ill patients

- Much lower Hb tolerated (>5.0 g/dL) in nonstressed normal patients

- Patients with CAD may require Hb levels in slightly higher ranges (8.0 g/dL-9.0 g/dL) and avoid tachycardia
  - β-blockers
  - Euvolemia

- Minimum, safe (optimal) Hb/Hct unknown

- Trigger can be lowered to avoid transfusions
Intraoperative Blood Loss Assessment - PPH

The use of a single hemoglobin “trigger” for all patients and other approaches that fail to consider all important physiologic and surgical factors affecting oxygenation are not recommended.
Intraoperative Blood Loss Assessment - PPH

- Decisions regarding perioperative transfusion are often difficult and involve clinical judgment.
- The factors that influence an anesthesiologist’s or surgeon’s decision to transfuse include the patient’s cardiopulmonary reserve, the rate and magnitude of the blood loss, oxygen consumption, and atherosclerotic disease (cerebrovascular, cardiovascular, peripheral, and renal)
## Intraoperative Blood Loss Assessment - PPH

<table>
<thead>
<tr>
<th>Hemorrhage class</th>
<th>Acute blood loss (ml)</th>
<th>Percentage lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>900</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>1200–1500</td>
<td>20–25</td>
</tr>
<tr>
<td>3</td>
<td>1800–2100</td>
<td>30–35</td>
</tr>
<tr>
<td>4</td>
<td>2400</td>
<td>≥40</td>
</tr>
</tbody>
</table>

**Table 1** Classification of hemorrhage\(^{15}\)
Intraoperative Blood Loss Assessment - PPH

**Class 1**
The average 60 kg pregnant woman has a blood volume of 6000 ml at 30 weeks’ gestation. A volume loss of less than 900 ml in such a woman will rarely lead to any symptoms and signs of volume deficit and will not require any acute treatment. This has been described as class 1.

**Class 2**
A blood loss of 1200–1500 ml will manifest clinical signs, such as a rise in pulse and respiratory rate. There may also be recordable blood pressure changes, but not the classic cold, clammy extremities.

**Class 3**
Class 3 denotes patients where the blood loss is sufficient to cause overt hypotension. The blood loss is usually around 1800–2100 ml, and is accompanied by signs of tachycardia (120–160 bpm), cold clammy extremities and tachypnea.

At level III, unless intervention is rapid and appropriate, women may progress to irreversible shock.

**Class 4**
Class 4 is commonly described as massive obstetric hemorrhage. When the volume loss exceeds 40%, profound shock ensues, and the blood pressure and pulse are not easily recordable. Immediate and urgent volume therapy is necessary, as a fatal outcome secondary to circulatory collapse and cardiac arrest is not far away unless resuscitation is immediate and aggressive.
Intraoperative Blood Loss

PPH

Maternal Mortality
- Obstetrical Hemorrhage -

Peripartum Hemorrhage (PPH)

Predict  Prepare  Handle
Intraoperative Blood Loss Assessment - PPH

Maternal Mortality
- Obstetrical Hemorrhage -

Identify Patients at Risk

Multidisciplinary "Hemorrhage protocol"

Clinical management of PPH

Diagnosis
- Early shock
- Severity of Shock

Treatment
- Insure hemostasis
- Adequate replacement
Intraoperative Blood Loss Assessment - PPH

Maternal Mortality
- Obstetrical Hemorrhage -

- Identify Patients at Risk
- Multidisciplinary “Hemorrhage protocol”
- Clinical management of PPH

3. - Transfusion Protocol

- Immediate release of O neg Blood if required
- How fast can Crossmatched blood be made available
- Physical transport of Blood \( \rightarrow \) O.R. and samples O.R. \( \rightarrow \) Lab/Blood Bank
Intraoperative Blood Loss Assessment - PPH

Maternal Mortality
- Obstetrical Hemorrhage -

2. Optimize hemodynamic status

1. Acute isovolemic hemodilution
2. Acute hypervolemic hemodilution
3. Autologous donation
4. Preoperative transfusion
Intraoperative Blood Loss PPH Treatment

Blood Loss

- Replace 3 cc of crystalloid solution per cc of blood loss (crystalloid solutions leave the intravascular space)

- When using blood products or colloids, replace blood loss volume per volume
Intraoperative Blood Loss PPH Treatment

To increase the hemoglobin concentration by 1g/dl requires 4 ml/kg packed red blood cells or 6 ml/kg body weight of whole blood. The rate of blood transfusion depends on the clinical condition of the patient but should not take more than four hours.
## PPH Assessment - Pitfalls


<table>
<thead>
<tr>
<th>Hemorrhage class</th>
<th>Estimated blood loss (ml)</th>
<th>Blood volume loss (%)</th>
<th>Clinical signs and symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (normal loss)</td>
<td>&lt;500</td>
<td>&lt;10</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ALERT LINE</td>
</tr>
<tr>
<td>1*</td>
<td>500–1000</td>
<td>15</td>
<td>Minimal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ACTION LINE</td>
</tr>
<tr>
<td>2†</td>
<td>1200–1500</td>
<td>20–25</td>
<td>↓Urine output</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>↑Pulse rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>↑Respiratory rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Postural hypotension</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Narrow pulse pressure</td>
</tr>
<tr>
<td>3‡</td>
<td>1800–2100</td>
<td>30–35</td>
<td>Hypotension</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tachycardia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cold clammy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tachypnea</td>
</tr>
<tr>
<td>4§</td>
<td>&gt;2400</td>
<td>&gt;40</td>
<td>Profound shock</td>
</tr>
</tbody>
</table>
PPH Assessment - Pitfalls

- Hypotension is usually a late sign of blood loss, as heart rate increases in parturients to compensate blood loss.
- Hb or Hct are not very helpful in determining the degree of blood loss in acute phase and they are not immediately decrease during acute blood loss.
PPH Assessment - Pitfalls

*Easy to miss*

- Physicians underestimate blood loss by 50%
- Slow steady bleeding can be fatal
- Most deaths from hemorrhage seen after 5h
- Abdominal or pelvic bleeding can be hidden
Postpartum Hemorrhage and Blood Loss Assessment – Case 1

42 years parturient, G14P10
Unremarkable medical history
Very fast delivery
Delivered a healthy male baby weighing 4,200 G
Third phase of delivery ≥ 30 minutes
Referred to the Postpartum Unit
PPH – CASE 1

After approximately 60 minutes started to complain of fainting sensation and weakness

Midwife examination: BP 140/95 mmHg, Pulse Rate 118 bpm, Pulse Saturation 95% on Room Air

Increases fluid administration rate
About 20 minutes latter – the nurse was called again – no improvement

The midwife checked again the vital signs – BP 120/100, PR 130 bpm, O2 Sat 90%

The obstetrician was called and noticed a “mild to moderate” vaginal bleeding with an “adequately” uterine contraction.

Transferred to OR for “Boom” curettage
PPH – CASE 1

Curettage – no residua, empty uterus
Mild/moderate bleeding continued
Intrauterine balloon inserted
50 u oxitocyn/100 mL NaCl 0.9% infusion started
No improvement – prostaglandin administered
PPH – CASE 1

Hb at that moment – 9 g% (basal 10.6 g%)
“Wait and See” conduct assumed
Anesthesiologist refused to transfer from OR
A more seniority anesthesiologist called
12 F catheter inserted at femoral vein
A new Hb measurement sent – 8.5 g%
Coagulation tests normal at this moment
PPH – CASE 1

RBC concentrate infusion was started
After about 90 minutes still bleeding
Laparotomy performed
PPH – CASE 1

During operation:
Suction Bottle 2000 ml
Small puddle of blood on the floor
4 PC units administered
2 FFP
3000 ml Hartman’s solution
Constant decrease in etCO2 from 35 to 22 mm Hg
PPH – CASE 1

ABG - pH 7.2; pO2 280 mm Hg (FIO2 = 0.5)
pCO2 28 mm Hg
Hb 7.7 g%

The more senior anesthesiologist called again
Towels and sponges counted
55 towels mostly saturated with blood
40 pads and 80 sponges saturated with blood
Weighing 15 kg
Irrigation fluids 3 liters
Urine 2 liters
So $15 - (3 + 2) = 10$ l of blood
PPH – CASE 1

Total blood/blood products administered

- 21 units PC
- 15 units FFP
- 36 units thrombocytes
PPH – CASE 1

Final Lab results
Hb 9.6 g%
Thrombocytes 90,000
PTT 2 times control
INR 1.3
ABG pH 7.32; pO2 200 mm Hg/FIO2 0.5; pCO2 33 mm HG
Intraoperative Blood Loss Assessment - PPH

MESSAGE TO TAKE HOME !!!

• Blood loss can be easily measured by weighing swabs and operative drapes, together with measurement of the volume of fluids contained in the suction bottles.
Blood transfusion during operation

Isovolaemia should be maintained throughout any operation.

The extent of the blood loss should be estimated by:

- visual assessment of blood on drapes and swabs
- volume in the suction bottles
- weighing swabs
- serial hemoglobin or hematocrit estimation
PPH - Conclusions

Make it simple