Postpartum Hemorrhage: Stemming the Tide

February 2020
I have no conflicts of interest to disclose.

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Anesthesiology and Obstetrics and Gynecology
Assistant Director, Informatics and Systems Improvement
Maternal Mortality Rates Per 100,000 Live Births


Figure adapted from NPR.org, https://www.npr.org/2017/05/12/528097899/us-has-the-worst-rate-of-maternal-deaths-in-the-developed-world
Accessed: July 31, 2019
Maternal Mortality Rates Per 100,000 Live Births

More than 50,000 women are severely injured during childbirth each year in America. About 700 mothers die. USA TODAY investigates why the U.S. is the most dangerous place to give birth in the developed world.

PART III
This data could save moms’ lives. But it’s secret.
An analysis found hospitals with complication rates above the norm.

PART II
What states aren't doing to save new moms' lives
Eighteen states haven't studied these deaths and others tend to blame moms.

PART I
Why are so many American mothers dying?
Maternal mortality rates rise as hospital safety measures go unused.

ARTICLE
Why we’re revealing secret childbirth complication rates
See rates for hundreds of maternity hospitals

DATABASE
Childbirth complication rates at maternity hospitals
USA TODAY calculated rates for hospitals in 13 states
Maternal Mortality

- Postpartum hemorrhage (PPH) is a leading cause of maternal death.

CDC.gov
Preventable Maternal Mortality

- Death from postpartum hemorrhage is often preventable

Preventable Maternal Mortality

- Death from postpartum hemorrhage is often preventable and is often related to delayed and ineffective care.

We are at a turning point.
Outline

- Epidemiology and definition
  - Risk Factors
- Diagnosis
  - Early Identification
- Pathogenesis
- Treatment
  - Transfusion Management
- Preparation
Incidence

- In the US: 3%
- Worldwide: 6-11%


Incidence

- In the US: 3%
- Worldwide: 6-11%

- Incidence is increasing
  - 26% increase in US between 1994-2006
  - Severity is also increasing


Risk Factors

**Before Pregnancy**
- Maternal Age <19
- Maternal Age >35
- Grand Multiparity (≥ 5 births)
- Prior Cesarean Delivery

**Antepartum**
- Hypertensive Disease of Pregnancy
- Diabetes
- Polyhydramnios
- Infection

**Intra/Post-partum**
- Placenta Previa/Abruption
- Multiple Gestation
- Macrosomia (>4,000g)
- Fibroids

Risk Factors

- Not all risk factors are equal

Risk Factors

• Not all risk factors are equal
  • Multiple Gestation – OR 2.8 (2.6 - 3.0)
  • Amnionitis – OR 2.9 (2.5 - 3.4)
  • Preeclampsia – OR 3.1 (2.9 - 3.3)
  • Eclampsia – OR 5.1 (4.3 - 6.2)

Risk Factors

- Risk factors are not completely predictive
• Risk factors are not completely predictive

• 62% of women who hemorrhage will have no identifiable risk factors
Diagnosis
• Traditionally:
  • Vaginal Delivery: 500cc of blood lost
  • Cesarean Delivery: 1000cc of blood lost

• Recently:
  • 1000cc blood lost
  • Blood loss accompanied by signs or symptoms of hypovolemia


• Visual Estimation of Blood Loss
  • Most frequently practiced
  • Most people receive no formal training in estimating EBL
  • Training might not improve estimation
  • Often underestimates blood loss
  • Underestimation increases as blood loss increases


Diagnosis

- Signs or symptoms of hypovolemia with blood loss
  - Increased blood volume in pregnancy limits sensitivity


Diagnosis

- Signs or symptoms of hypovolemia with blood loss
  - Increased blood volume in pregnancy limits sensitivity

<table>
<thead>
<tr>
<th>Estimated Blood Loss</th>
<th>Clinical Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1000cc</td>
<td>--</td>
</tr>
<tr>
<td>&gt;1000-1500cc</td>
<td>tachycardia, tachypnea, slight ↓ systolic blood pressure</td>
</tr>
<tr>
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<td>↑ tachycardia, ↑ tachypnea, systolic blood pressure &lt; 80 mmHg, altered mental status</td>
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</tbody>
</table>


Diagnosis

- Signs or symptoms of hypovolemia with blood loss
  - Increased blood volume in pregnancy limits sensitivity
  - **Early recognition is key!**

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Table 1. The Maternal Early Warning Criteria

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP (mm Hg)</td>
<td>&lt;90 or &gt;160</td>
</tr>
<tr>
<td>Diastolic BP (mm Hg)</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Heart rate (beats per min)</td>
<td>&lt;50 or &gt;120</td>
</tr>
<tr>
<td>Respiratory rate (breaths per min)</td>
<td>&lt;10 or &gt;30</td>
</tr>
<tr>
<td>Oxygen saturation on room air, at sea level, %</td>
<td>&lt;95</td>
</tr>
<tr>
<td>Oliguria, mL/hr for ≥2 hours</td>
<td>&lt;35</td>
</tr>
<tr>
<td>Maternal agitation, confusion, or unresponsiveness; Patient with preeclampsia reporting a non-remitting headache or shortness of breath</td>
<td></td>
</tr>
</tbody>
</table>

Pathogenesis
Pathogenesis – The Four T’s

Tone

E. Mavrides, S. Allard, E. Chandraharan, et al., on behalf of the Royal College of Obstetricians and Gynaecologists
Prevention and management of postpartum haemorrhage. BJOG (2016)
Pathogenesis – The Four T’s

**Tone**

**Trauma**

Pathogenesis – The Four T’s

Tone

Trauma

Tissue

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- Tone
- Trauma
- Tissue
- Thrombin

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Uterine Atony: Overdistention, Muscle Fatigue, GA, Chorioamnionitis

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Pathogenesis – The Four T’s

**Tone**
- Uterine Atony: Overdistention, Muscle Fatigue, GA, Chorioamnionitis

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- Genital Tract Laceration, Uterine Inversion, Surgical Misadventure

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**Thrombin**

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- Retained Placenta, Invasive Placenta, Placental Abruption

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Thrombin
- Placental Abruption, Pre-Eclampsia, Coagulopathy

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Prevention and management of postpartum haemorrhage. BJOG (2016)
Uterine atony causes 80% of PPH

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Prevention and management of postpartum haemorrhage. BJOG (2016)
Treatment
Management of Postpartum Hemorrhage

- EBL > 1000cc, brisk bleeding, or signs of hypovolemia
  - Resuscitate
  - Determine Cause and Treat
Management of Postpartum Hemorrhage

Resuscitate

- Call for help
- Establish (multiple) large-bore IV access
- Obtain baseline laboratory studies: CBC, INR, fibrinogen, viscoelastometric testing (if available)
- Type and Screen/Type and Cross
- Correct hypovolemia
- Escalate monitoring
- Monitor urine output
- Move to the OR quickly

Determine Cause and Treat
Management of Postpartum Hemorrhage

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Determine Cause and Treat

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Treatment

- **Oxytocin**
  - First line therapy

- **Methylergonovine (Methergine)**
  - Judicious use in patients with HTN

- **Carboprost (Hemabate)**
  - Judicious use in patients with reactive airway disease

- **Misoprostol (Cytotec)**

**Determine Cause and Treat**

- Tone
- Trauma
- Tissue
- Thrombin

*Wikimedia Commons*
Treatment

Determine Cause and Treat

- Uterine massage
- Intrauterine balloon tamponade
- Uterine compression sutures

Tone

Trauma

Tissue

Thrombin
Treatment

Determine Cause and Treat

- Evaluation by obstetric team
- Laceration repair
- Uterine exploration
- Manual removal of placenta
- Curettage

Tone
Trauma
Tissue
Thrombin
Treatment

- Evaluation of clotting
- Replace clotting factors, platelets
- Hematology consult for congenital clotting disorders to target treatment

Determine Cause and Treat
- Tone
- Trauma
- Tissue
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Management of Postpartum Hemorrhage

Resuscitate

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Determine Cause and Treat

- Tone
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Transfusion Management
pRBC : FFP - Fixed ratio?
1:1?
pRBC : FFP - Fixed ratio?

1:1?

More than 80% of institutions report using 1:1 ratio

Obstetric hemorrhage causes hypofibrinogenemia

Coagulation impairment after 1-2 liters blood loss

From Carlo Pancaro, MD, used with permission.
Effect of empiric FFP administration in PPH

**Abruption**
Fibrinogen 220 mg/dL

FFP contains about 200 mg/dL fibrinogen

*Normal fibrinogen (third trimester) = 373 - 619 mg/dL*

Collins et al. Theoretical modeling of fibrinogen supplementation with therapeutic plasma, cryoprecipitate, or fibrinogen concentrate. BJA 113:585-95 2014.

Effect of empiric FFP administration in PPH

**Abruption**
Fibrinogen 220 mg/dL

**Uterine Atony/Surgical Bleeding**
Fibrinogen 400 mg/dL

FFP contains about 200 mg/dL fibrinogen

*Normal fibrinogen (third trimester) = 373 - 619 mg/dL*

Collins et al Theoretical modeling of fibrinogen supplementation with therapeutic plasma, cryoprecipitate, or fibrinogen concentrate. BJA 113:585-95 2014.

Using Viscoelastometric Testing to Guide Transfusion Therapy
Viscoelastometric Testing

**ROTEM® parameters**

- **A5 = Clot Firmness (mm) 5 minutes after CT**
- **AX = Clot Firmness (mm) x minutes after CT**
- **CT = Clotting Time (sec)**
- **CFT = Clot Formation Time (sec)**
- **MCF = Maximum Clot Firmness (mm)**
- **Maximum Lysis (%)**
- **Clot Quality**

Viscoelastometric Testing

haemoview.com.au
Viscoelastometric Testing

- **INTEM**
  - Intrinsic system screening test

- **EXTEM**
  - Extrinsic system screening test

- **FIBTEM**
  - Isolated fibrinogen contribution to clot firmness

Viscoelastic fibrinogen testing correlates with severity of PPH

Fibrinogen concentrate versus placebo for treatment of postpartum haemorrhage:
A multicentre, prospective, double blind randomised control trial

Study design

PPH
1000–1500 mL

FIBTEM
Low for term*

Fibrinogen concentrate**

Placebo

Primary endpoint
Number of units of RBC, FFP, cryoprecipitate and platelets

** Fibrinogen dose calculated to increase FIBTEM to normal for term

Sample size 54
ISRCTN46295339
Sponsor Cardiff University
Funder CSL Behring

* Fibtem <16 mm
** Dose adjusted to given increment to above 23 mm

No difference in outcome when a goal:
- FIBTEM A5 > 16mm (300 mg/dL) used as threshold.
- FIBTEM A5 > 12mm (200 mg/dL) used as threshold.

No benefit to treat fibrinogen level > 200 mg/dL
Introduction of an algorithm for ROTEM-guided fibrinogen concentrate administration in major obstetric haemorrhage

S. Mallaiah, P. Barclay, I. Harrod, C. Chevannes and A. Bhalla

- EBL > 1500cc with coagulopathy
- 2011-2012: “shock pack”
  - Emphasis on early transfusion
- 2012-2013: “fibrinogen phase”
  - Emphasis on ROTEM guidance
  - Use of fibrinogen concentrate

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<table>
<thead>
<tr>
<th></th>
<th>Shock Pack (n = 42)</th>
<th>Fibrinogen (n = 51)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU admission</td>
<td>4 (9%)</td>
<td>1 (2%)</td>
<td>NS</td>
</tr>
<tr>
<td>TACO</td>
<td>4 (9%)</td>
<td>0</td>
<td>0.0367</td>
</tr>
<tr>
<td>TRALI</td>
<td>0</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td>Postpartum hysterectomy</td>
<td>6 (14%)</td>
<td>3 (6%)</td>
<td>NS</td>
</tr>
<tr>
<td>Death</td>
<td>0</td>
<td>0</td>
<td>NS</td>
</tr>
</tbody>
</table>

Anaesthesia. 2015 Feb;70(2):166-75
Point-of-care viscoelastic testing improves the outcome of pregnancies complicated by severe postpartum hemorrhage

Denis Snegovskikh, M.D. a,*, Dmitri Souza, M.D., Ph.D. b, Zachary Walton, M.D., Ph.D. a, Feng Dai, Ph.D. c, Rachel Rachler d, Angelique Garay e, Victoria V. Snegovskikh, M.D. f, Ferne R. Braveman, M.D. e, Errol R. Norwitz, M.D., Ph.D. g

- Retrospective cohort study: 2011-2015
- Before and after study
  - standard massive transfusion protocol vs. point-of-care ROTEM-based protocol
- ROTEM-guided administration of:
  - Cryoprecipitate (FIBTEM)
  - FFP (CT)
  - Platelets (MCF)

Transfusion Management

- Reduction in:
  - pRBC, FFP and platelet administration
  - Length of hospital stay
  - ICU admissions
  - Reduction in hysterectomies

Table 2
Postoperative outcomes of the study population*.

<table>
<thead>
<tr>
<th></th>
<th>PCVT (n = 28)</th>
<th>Non-PCVT (n = 58)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematocrit on postoperative day 1 (%)</td>
<td>24.7 (23.0–26.6)</td>
<td>27.8 (24.5–30.0)</td>
<td>0.004</td>
</tr>
<tr>
<td>Hysterectomy, yes</td>
<td>7 (25.0%)</td>
<td>31 (53.5%)</td>
<td>0.013</td>
</tr>
<tr>
<td>Estimated blood loss (mL)</td>
<td>2000 (1600–2500)</td>
<td>3000 (2000–4000)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Crystalloids (mL)</td>
<td>3500 (3100–4500)</td>
<td>3500 (3000–4100)</td>
<td>0.88</td>
</tr>
<tr>
<td>Hextend (mL)</td>
<td>0 (0–250)</td>
<td>0 (0–500)</td>
<td></td>
</tr>
<tr>
<td>Red blood cells (units)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 0</td>
<td>11 (39.3%)</td>
<td>3 (5.2%)</td>
<td></td>
</tr>
<tr>
<td>- 1</td>
<td>7 (25.0%)</td>
<td>3 (5.2%)</td>
<td></td>
</tr>
<tr>
<td>- ≥2</td>
<td>10 (35.7%)</td>
<td>52 (89.6%)</td>
<td></td>
</tr>
<tr>
<td>Fresh frozen plasma (units)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 0</td>
<td>25 (80.3%)</td>
<td>16 (27.6%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>- ≥1</td>
<td>3 (10.7%)</td>
<td>42 (72.4%)</td>
<td></td>
</tr>
<tr>
<td>Albumin (units)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 0</td>
<td>28 (100%)</td>
<td>51 (87.9%)</td>
<td>0.09</td>
</tr>
<tr>
<td>- 500 to 1000</td>
<td>0 (0%)</td>
<td>7 (12.1%)</td>
<td></td>
</tr>
<tr>
<td>Cryoprecipitate (units)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 0</td>
<td>22 (78.6%)</td>
<td>47 (81.0%)</td>
<td>0.78</td>
</tr>
<tr>
<td>- ≥5</td>
<td>6 (21.4%)</td>
<td>11 (19%)</td>
<td></td>
</tr>
<tr>
<td>Platelets (units)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 0</td>
<td>28 (100%)</td>
<td>32 (55.2%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>- ≥5</td>
<td>0 (0%)</td>
<td>26 (44.8%)</td>
<td></td>
</tr>
<tr>
<td>Length of hospitalization after delivery (days)</td>
<td>4 (3–4)</td>
<td>5 (4–6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ICU admission</td>
<td>1 (3.6%)</td>
<td>25 (43.1%)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

* Data are expressed as n (%), median (interquartile range).

### Table 3
Cost of hospitalization for patients with severe postpartum hemorrhage managed with or without PCVT*.

<table>
<thead>
<tr>
<th></th>
<th>PCVT  (n = 17)</th>
<th>Non-PCVT (n = 37)</th>
<th>Total (n = 54)</th>
<th>(P)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect</td>
<td>$5746.65 (SD 2458.16)</td>
<td>$8585.65 (SD 4412.28)</td>
<td>$7691.89 (SD 4101.13)</td>
<td>0.004</td>
</tr>
<tr>
<td>Direct</td>
<td>$6056.29 (SD 2519.45)</td>
<td>$11833.43 (SD 7182.55)</td>
<td>$10014.70 (SD 6655.29)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$11802.94 (SD 4936.91)</td>
<td>$20419.08 (SD 11550.47)</td>
<td>$17706.59 (SD 10690.84)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

* Data are expressed as mean (SD).

Tranexamic Acid
Randomized controlled trial, 2010-2016

193 hospitals, 21 countries, 20,060 women

1g tranexamic acid vs. placebo at clinical diagnosis of hemorrhage
Effect of early tranexamic acid administration on mortality, hysterectomy, and other morbidities in women with post-partum haemorrhage (WOMAN): an international, randomised, double-blind, placebo-controlled trial

- Randomized controlled trial, 2010-2016
- 193 hospitals, 21 countries, 20,060 women
- 1g tranexamic acid vs. placebo at clinical diagnosis of hemorrhage

<table>
<thead>
<tr>
<th></th>
<th>Tranexamic acid group (n=10 036)</th>
<th>Placebo group (n=9985)</th>
<th>RR (95% CI)</th>
<th>p value (two-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeding</td>
<td>155 (1.5%)</td>
<td>191 (1.9%)</td>
<td>0.81 (0.65-1.00)</td>
<td>0.045</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>10 (0.1%)</td>
<td>11 (0.1%)</td>
<td>0.90 (0.58-1.39)</td>
<td>0.82</td>
</tr>
<tr>
<td>Organ failure</td>
<td>25 (0.3%)</td>
<td>18 (0.2%)</td>
<td>1.38 (0.75-2.53)</td>
<td>0.29</td>
</tr>
<tr>
<td>Sepsis</td>
<td>15 (0.2%)</td>
<td>8 (0.1%)</td>
<td>1.87 (0.79-4.40)</td>
<td>0.15</td>
</tr>
<tr>
<td>Eclampsia</td>
<td>2 (0.02%)</td>
<td>8 (0.1%)</td>
<td>0.25 (0.05-1.17)</td>
<td>0.057</td>
</tr>
<tr>
<td>Other</td>
<td>20 (0.2%)</td>
<td>20 (0.2%)</td>
<td>0.99 (0.54-1.85)</td>
<td>0.99</td>
</tr>
<tr>
<td>Any cause of death</td>
<td>227 (2.3%)</td>
<td>256 (2.6%)</td>
<td>0.88 (0.74-1.05)</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Data are n (%), unless otherwise indicated. RR = risk ratio.

Table 2: Effect of tranexamic acid on maternal death
Effect of early tranexamic acid administration on mortality, hysterectomy, and other morbidities in women with post-partum haemorrhage (WOMAN): an international, randomised, double-blind, placebo-controlled trial

- Tranexamic acid mortality: 155/10036 - 1.5%
- Placebo mortality: 191/9985 - 1.9%
- Mortality in USA for PPH: 1.7 per 100,000

<table>
<thead>
<tr>
<th>Condition</th>
<th>Tranexamic acid group (n=10,036)</th>
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<td>Pulmonary embolism</td>
<td>10 (0.1%)</td>
<td>11 (0.1%)</td>
<td>0.90 (0.58-1.35)</td>
<td>0.82</td>
</tr>
<tr>
<td>Organ failure</td>
<td>25 (0.3%)</td>
<td>18 (0.2%)</td>
<td>1.38 (0.75-2.53)</td>
<td>0.29</td>
</tr>
<tr>
<td>Sepsis</td>
<td>15 (0.2%)</td>
<td>8 (0.1%)</td>
<td>1.87 (0.79-4.40)</td>
<td>0.15</td>
</tr>
<tr>
<td>Eclampsia</td>
<td>2 (0.02%)</td>
<td>8 (0.1%)</td>
<td>0.25 (0.05-1.17)</td>
<td>0.052</td>
</tr>
<tr>
<td>Other</td>
<td>20 (0.2%)</td>
<td>20 (0.2%)</td>
<td>0.99 (0.54-1.85)</td>
<td>0.99</td>
</tr>
<tr>
<td>Any cause of death</td>
<td>227 (2.3%)</td>
<td>256 (2.6%)</td>
<td>0.88 (0.74-1.05)</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Data are n (%), unless otherwise indicated. RR = risk ratio.

Table 2: Effect of tranexamic acid on maternal death

Lancet. 2017 May 27;389(10084):2105-2116
The Michigan Medicine PPH Transfusion Protocol
Return to OB Anesthesiology—pager #9016
POSTPARTUM HEMORRHAGE

ONGOING BLEEDING

± 1 g Tranexamic Acid

FIBTEM A10

< 8 mm

3 g Fibrinogen

< 12 mm

2 g Fibrinogen

≥ 12 mm

EXTEM A10

≥ 43 mm

Platelets

< 43 mm

EXTEM CT

< 80 sec

Crystalloids

≥ 80 sec

Plasma

WATCH
• Ca++
• K+
• Mg++
• Lactate
• TP
• UO

TREAT
• Hct < 24
• Platelets < 75
• Fibrinogen < 200
• 1:1:1 if no lab results

EXTEM ML > 5% or FIBTEM CT > 600 sec

Rebolus 1 g Tranexamic Acid + 100 mg/hr continuous infusion

Department of Anesthesiology
Preparation and Response
Maternal Early Warning System
**Table 1. The Maternal Early Warning Criteria**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP (mm Hg)</td>
<td>&lt;90 or &gt;160</td>
</tr>
<tr>
<td>Diastolic BP (mm Hg)</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Heart rate (beats per min)</td>
<td>&lt;50 or &gt;120</td>
</tr>
<tr>
<td>Respiratory rate (breaths per min)</td>
<td>&lt;10 or &gt;30</td>
</tr>
<tr>
<td>Oxygen saturation on room air, at sea level, %</td>
<td>&lt;95</td>
</tr>
<tr>
<td>Oliguria, mL/hr for ≥2 hours</td>
<td>&lt;35</td>
</tr>
<tr>
<td>Maternal agitation, confusion, or unresponsiveness; Patient with preeclampsia reporting a non-remitting headache or shortness of breath</td>
<td></td>
</tr>
</tbody>
</table>
Maternal Early Warning System
Preparation and Response

Maternal Early Warning System

- Diagnose
- Identify Trigger
- Respond
- Monitor
- Evaluate
- Alert

Active Alerts

Low BP=72/45. HR=83.
Acetaminophen given 4.6 hours ago. Please check pain level.

Check monitors and medical record before making medical decisions.

CAUTION: Limited by federal law to investigational use only.
Preparation and Response
Simulation Training
Impact of simulation and team training on postpartum hemorrhage management in non-academic centers

Nicole E. Marshall¹, Jeroen Vanderhoeven³, Karen B. Eden², Sally Y. Segel¹, and Jeanne-Marie Guise¹.².³

¹Department of Obstetrics and Gynecology, ²Department of Medical Informatics and Clinical Epidemiology, and ³Department of Public Health and Preventive Medicine, Oregon Health & Science University, Portland, OR, USA

- Effect of simulation and team training on response to simulated hemorrhage
- 6 rural and urban non-academic centers
- Simulated PPH followed by didactic
• Improvement in:
  • Recognition of PPH
  • Time to use oxytocin
  • Time to perform uterine massage
  • Time to use a secondary uterotonic

Table 2. Time of PPH management before and after training.

<table>
<thead>
<tr>
<th>Time from baby’s head out</th>
<th>Before</th>
<th>After</th>
<th>Reduction</th>
<th>p value (paired t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognized PPH</td>
<td>124.8 ± 51.7</td>
<td>94.5 ± 35.5</td>
<td>30.3 ± 57.7</td>
<td>0.02</td>
</tr>
<tr>
<td>Use first medication*</td>
<td>135.4 ± 42.4</td>
<td>87.3 ± 49.2</td>
<td>48.1 ± 65.9</td>
<td>0.003</td>
</tr>
<tr>
<td>Perform uterine massage†</td>
<td>134.1 ± 34.9</td>
<td>105.7 ± 45.2</td>
<td>28.5 ± 50.0</td>
<td>0.01</td>
</tr>
<tr>
<td>Use second medication†‡</td>
<td>216.0 ± 73.0</td>
<td>147.0 ± 48.2</td>
<td>69.0 ± 71.9</td>
<td>0.0003</td>
</tr>
<tr>
<td>Correct PPH‡</td>
<td>404.0 ± 154.5</td>
<td>349.0 ± 110.6</td>
<td>55.0 ± 191.9</td>
<td>0.19</td>
</tr>
</tbody>
</table>

*Oxytocin.
†Misoprostol or carboprost.
‡The single team that did not resolve the scenario in 10 min by using three indicated medications was excluded from this time point.
• Simulation training in Tanzania

• Results:
  • Reduction in incidence of PPH
  • Increase in oxytocin use
  • Increase in uterine massage
Postpartum Hemorrhage Protocols
Use of a postpartum hemorrhage management protocol is recommended by ACOG.
Comprehensive maternal hemorrhage protocols reduce the use of blood products and improve patient safety

Laurence E. Shields, MD; Suzanne Wiesner, RN; Janet Fulton, RN, PhD; Barbara Pelletreau, RN

• Comprehensive PPH protocol across 29 hospitals comprising 60,000 births annually.
• 2010-2012
Preparation and Response – PPH Protocol

• PPH protocol:
  – hemorrhage risk assessment
  – early escalation of care and monitoring
  – sending laboratory studies
  – uterotonic administration
  – transfusion guidance

• 26% reduction in blood product administration.

# STAGE 2
## OB Hemorrhage

### Ongoing bleeding and/or vital sign instability, and < 1500 ml cumulative blood loss (EBL/QBL)

### MOBILIZE

<table>
<thead>
<tr>
<th>Primary Nurse:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>✗ Activate OB Hemorrhage Protocol</td>
<td></td>
</tr>
<tr>
<td>✗ Call/Birth Center Page Team Leader and Anesthesiology to room</td>
<td></td>
</tr>
<tr>
<td>✗ Notify Charge Nurse</td>
<td></td>
</tr>
<tr>
<td>✗ Assign designees to continue Blood Bank communication</td>
<td></td>
</tr>
<tr>
<td>✗ Designate a provider, nurse, or SW as family support person</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Team Leader or designee:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>✗ Bring Hemorrhage Cart to patient’s location if not in OR</td>
<td></td>
</tr>
<tr>
<td>✗ Notify Charge Nurse</td>
<td></td>
</tr>
<tr>
<td>✗ Assign designees to continue Blood Bank communication</td>
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<tr>
<td>✗ Designate a provider, nurse, or SW as family support person</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OR Team Leader:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>✗ Prepare OR &amp; staff for patient transfer if not already there</td>
<td></td>
</tr>
</tbody>
</table>

### ACT

<table>
<thead>
<tr>
<th>OB/Nurse/Anesthesia Team Leaders</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>✗ Continue IV oxytocin, IV crystalloid, uterine massage</td>
<td></td>
</tr>
<tr>
<td>✗ Obtain and document quantitative blood loss q 10 minutes</td>
<td></td>
</tr>
<tr>
<td>✗ Continue uterotonie medication per protocol (Virtual Hemorrhage Pack in Pyxis)*</td>
<td></td>
</tr>
</tbody>
</table>

**Give once, if no response, move to next agent**

| ✗ Administer methergine 0.2 mg IM (if not hypertensive); may repeat dose q 2 hr | |
| ✗ Administer misoprostol 800 mcg buccal or rectal | |
| ✗ Administer hemabate 0.25 mg IM (if not asthmatic); may repeat dose q 15 min | |

**Don’t delay other interventions while waiting for response. Consider move to OR.**

| ✗ Vital signs, including O2 sat & level of consciousness (LOC) q 5 minutes | |
| ✗ Administer oxygen to maintain O2 sats at > 95% & keep patient warm | |
| ✗ Empty bladder; straight cath or place Foley with urimeter | |
| ✗ Transfusion | |
| ✗ Bring 2 units PRBCs to bedside (mobile refrigerator on unit or blood bank) | |

**Consider activation of Massive Transfusion Protocol**

| ✗ Transfuse PRBCs based on clinical signs & response; don’t wait for lab results | |
| ✗ Order labs STAT (CBC, CMP, Coag/Fibrinogen, Point-of-care labs) | |

### Second nurse or OR techs:

| ✗ Obtain portable light and OB procedure tray | |
| ✗ Assist with transfer to OR (if indicated) | |

### THINK

<table>
<thead>
<tr>
<th>Vaginal birth</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>✗ Trauma (vaginal, cervical, or uterine)</td>
<td>Visualize &amp; repair</td>
</tr>
<tr>
<td>✗ Retained placenta</td>
<td>D&amp;C</td>
</tr>
<tr>
<td>✗ Uterine atony/LUS bleeding</td>
<td>Bakri</td>
</tr>
<tr>
<td>✗ Other</td>
<td>Arterial embolization (IR)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cesarean Section</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>✗ Atony</td>
<td>B-Lynch, Intrauterine Balloon</td>
</tr>
<tr>
<td>✗ Uterine Inversion</td>
<td>Anesthesia &amp; uterine relaxation for manual reduction</td>
</tr>
<tr>
<td>✗ Amniotic Fluid Embolism</td>
<td>Maximally aggressive respiratory, vasopressor, and blood product support</td>
</tr>
<tr>
<td>✗ VS worse than blood loss</td>
<td>consider uterine rupture or broad ligament tear with internal bleeding move to laparotomy</td>
</tr>
</tbody>
</table>

### Once stabilized:

| ✗ Postpartum Debrief | |
| ✗ Update Postpartum Risk Assessment: Modified postpartum management with increased surveillance | |

---

**Cumulative blood loss (EBL/QBL) > 1500 ml, > 2units PRBCs given, VS unstable or suspicion for DIC?**

**Proceed to STAGE 3**
# STAGE 2

**OB Hemorrhage**

Ongoing bleeding and/or vital sign instability, and < 1500 ml cumulative blood loss (EBL/QBL)

## MOBILIZE

<table>
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<tbody>
<tr>
<td>❑ Activate OB Hemorrhage Protocol</td>
<td></td>
</tr>
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<td>❑ Call/Birth Center Page Team Leader and Anesthesiology to room</td>
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<td></td>
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<tr>
<td>❑ Notify Charge Nurse</td>
<td></td>
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<tr>
<td>❑ Assign designees to continue Blood Bank communication</td>
<td></td>
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<td>❑ Designate a provider, nurse, or SW as family support person</td>
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<th>OR Team Leader:</th>
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## ACT

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Continue IV oxytocin, IV crystalloid, uterine massage</td>
</tr>
<tr>
<td>❑ Obtain and document quantitative blood loss q 10 minutes</td>
</tr>
<tr>
<td>❑ Continue uterotonic medication per protocol (Virtual Hemorrhage Pack in Pyxis)*</td>
</tr>
</tbody>
</table>

* Virtual Hemorrhage Pack in Pyxis

<table>
<thead>
<tr>
<th>Second nurse or OR techs:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Obtain portable light and OB procedure tray</td>
<td></td>
</tr>
<tr>
<td>❑ Assist with transfer to OR (if indicated)</td>
<td></td>
</tr>
</tbody>
</table>

| ❑ Administer methergine 0.2 mg IM (if not hypertensive); may repeat dose q 2 hr |  |
| ❑ Administer misoprostol 800 mcg buccal or rectal |  |
| ❑ Administer hemabate 0.25 mg IM (if not asthmatic); may repeat dose q 15 min |  |

Give once, if no response, move to next agent

| ❑ Vital signs, including O2 sat & level of consciousness (LOC) q 5 minutes |  |
| ❑ Administer oxygen to maintain O2 sats at > 95% & keep patient warm |  |
| ❑ Empty bladder; straight cath or place Foley with urimeter |  |

<table>
<thead>
<tr>
<th>❑ Transfusion</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>❑ Bring 2 units PRBCs to bedside (mobile refrigerator on unit or blood bank)</td>
<td></td>
</tr>
<tr>
<td>❑ Consider activation of Massive Transfusion Protocol</td>
<td></td>
</tr>
<tr>
<td>❑ Transfuse PRBCs based on clinical signs &amp; response; don’t wait for lab results</td>
<td></td>
</tr>
<tr>
<td>❑ Order labs STAT (CBC, CMP, Coag/Fibrinogen, Point-of-care labs)</td>
<td></td>
</tr>
<tr>
<td>❑ Don’t delay other interventions while waiting for response. Consider move to OR.</td>
<td></td>
</tr>
</tbody>
</table>

## THINK

Once stabilized:

| ❑ Postpartum Debrief |  |
| ❑ Update Postpartum Risk Assessment: Modified postpartum management with increased surveillance |  |

### Vaginal birth

- Trauma (vaginal, cervical, or uterine)
  - Visualize & repair
- Retained placenta
  - D&C
- Uterine atony/LUS bleeding
  - Bakri
- Other
  - Arterial embolization (IR)

### Cesarean Section

- Atony
  - B-Lynch, Intrauterine Balloon
- Uterine Inversion
  - Anesthesia & uterine relaxation for manual reduction
- Amniotic Fluid Embolism
  - Maximally aggressive respiratory, vasopressor, and blood product support
- VS worse than blood loss
  - Consider uterine rupture or broad ligament tear
    - move to laparotomy

Cumulative blood loss (EBL/QBL) > 1500 ml, > 2 units PRBCS given, VS unstable or suspicion for DIC?

Proceed to STAGE 3
### STAGE 2
**OB Hemorrhage**

Ongoing bleeding and/or vital sign instability, and < 1500 ml cumulative blood loss (EBL/QBL)

#### MOBILIZE

**OB/Nurse/Anesthesia Team Leaders**
- Continue IV oxytocin, IV crystalloid, uterine massage
- Obtain and document quantitative blood loss q 10 minutes
- Continue uterotonic medication per protocol (Virtual Hemorrhage Pack in Pyxis)*

**Give once, if no response, move to next agent**
- Administer methergine 0.2 mg IM (if not hypertensive); may repeat dose q 2 hr
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- Administer hemabate 0.25 mg IM (if not asthmatic); may repeat dose q 15 min

**Don’t delay other interventions while waiting for response. Consider move to OR.**

#### ACT

**OB/Nurse/Anesthesia Team Leaders**
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- Obtain and document quantitative blood loss q 10 minutes
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#### THINK

**Once stabilized:**
- Postpartum Debrief
- Update Postpartum Risk Assessment: Modified postpartum management with increased surveillance

**Vaginal birth**
- Trauma (vaginal, cervical, or uterine) → Visualize & repair
- Retained placenta → D&C
- Uterine atony/LUS bleeding → Bakri
- Other → Arterial embolization (IR)

**Cesarean Section**
- Atony → B-Lynch, Intrauterine Balloon
- Uterine Inversion → Anesthesia & uterine relaxation for manual reduction
- Amniotic Fluid Embolism → Maximally aggressive respiratory, vasopressor, and blood product support
- VS worse than blood loss → consider uterine rupture or broad ligament tear with internal bleeding → move to laparotomy

---

Cumulative blood loss (EBL/QBL) > 1500 ml, > 2 units PRBCs given, VS unstable or suspicion for DIC?

**Proceed to STAGE 3**
### STAGE 2
**OB Hemorrhage**

Ongoing bleeding and/or vital sign instability, and < 1500 ml cumulative blood loss (EBL/QBL)

<table>
<thead>
<tr>
<th>MOBILIZE</th>
<th>ACT</th>
<th>THINK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Nurse:</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| ❏ Activate OB Hemorrhage Protocol | ❏ Continue IV oxytocin, IV crystalloid, uterine massage | Vaginal birth  
• Trauma (vaginal, cervical, or uterine) ➔ Visualize & repair  
• Retained placenta ➔ D&C  
• Uterine atony/LUS bleeding ➔ Bakri  
• Other ➔ Arterial embolization (IR) |
| ❏ Call/Birth Center Page Team Leader and Anesthesiology to room | ❏ Obtain and document quantitative blood loss q 10 minutes | Cesarean Section  
• Atony ➔ B-Lynch, Intrauterine Balloon  
• Uterine Inversion ➔ Anesthesia & uterine relaxation for manual reduction  
• Amniotic Fluid Embolism ➔ Maximally aggressive respiratory, vasopressor, and blood product support  
• VS worse than blood loss ➔ consider uterine rupture or broad ligament tear with internal bleeding ➔ move to laparotomy |
| | ❏ Continue uterotonic medication per protocol (Virtual Hemorrhage Pack in Pyxis)* | | |
| | ❏ Vital signs, including O2 sat & level of consciousness (LOC) q 5 minutes | | |
| | ❏ Administer oxygen to maintain O2 sats at > 95% & keep patient warm | | |
| | ❏ Empty bladder; straight cath or place Foley with urimeter | | |
| | ❏ Transfusion | | |
| | ❏ Bring 2 units PRBCs to bedside (mobile refrigerator on unit or blood bank) | | |
| | ❏ Consider activation of Massive Transfusion Protocol | | |
| | ❏ Transfuse PRBCs based on clinical signs & response; don’t wait for lab results | | |
| | ❏ Order labs STAT (CBC, CMP, Coag/Fibrinogen, Point-of-care labs) | | |
| | ❏ Don’t delay other interventions while waiting for response. Consider move to OR. | | |

---

Cumulative blood loss (EBL/QBL) > 1500 ml, > 2units PRBCS given, VS unstable or suspicion for DIC?

Proceed to STAGE 3
Provider Education

Welcome to SOAP’s Provider Education Corner

Under this section, you will find practical guidance, online lectures and podcasts, CME/CEU activities, bundles and toolkits, and other high quality resources. Educational products are geared toward practicing clinicians who desire to either brush up on or to take deep dives into modern obstetric anesthesia practices.

https://soap.org/education/provider-education/
Obstetric Hemorrhage

Obstetric Hemorrhage Bundle
- Slide Set
- Risk Assessment Tables:
  - Prenatal & Antepartum
  - Labor & Delivery Admission and Intrapartum
- Checklists:
  - Hemorrhage Stages 1-4 Revised June 2019
  - Recommended Instruments Revised March 2019 (HEM Cart & Medication Kit)
- Posters:
  - Managing Maternal Hemorrhage
  - Massive Transfusion Protocol (Blood Bank)
  - Surgical Management

Guidance Documents
- Patients Who Decline Blood Products

Additional Resources
- SMI Obstetric Team Debriefing Form
- CMQCC Obstetric Hemorrhage Toolkit
- AWHONN Quantification of Blood Loss Video
- AWHONN Postpartum Hemorrhage Project

Take Home Points
• Maternal mortality in the US is rising, while it is decreasing in other developed countries.
• Improving our response to PPH may reverse this trend.
• Early identification of PPH is important.
• Get involved early.
• Quickly escalate care.
• Consider viscoelastic testing/send labs early.
• PPH protocols improve outcomes.