Postpartum Hemorrhage

Editor:
Marjorie Greenfield, MD
Associate Professor
Department of Obstetrics and Gynecology
Case Western Reserve University School of Medicine
Cleveland, OH

Contributor:
Michelle A. Kominiarek, MD
Assistant Professor of Obstetrics and Gynecology
Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine
University of Illinois at Chicago
Chicago, IL

Table of Contents

Introduction .............................................. 2
Evaluation and Treatment. ............................ 3
Special Considerations ................................. 8
Prevention ............................................... 9
References .............................................. 11

Cover Illustration by Kathryn K. Johnson

NOTE FROM THE PUBLISHER:
This publication has been developed without involvement of or review by the American Board of Obstetrics and Gynecology.
Postpartum Hemorrhage

Michelle A. Kominarek, MD

INTRODUCTION

Postpartum hemorrhage (PPH) is the leading cause of maternal morbidity and mortality worldwide, although the prevalence varies between developing and developed countries.1 According to Centers for Disease Control and Prevention reports on trends in pregnancy-related mortality in the United States, the maternal mortality rate was 12.1 per 100,000 live births in 2003,2 and hemorrhage accounted for 18.2% of pregnancy-related deaths between 1991 and 1997.3 Serious morbidity related to PPH can include adult respiratory distress syndrome (ARDS), disseminated intravascular coagulation, renal failure, and Sheehan’s syndrome.

DEFINITIONS

Primary PPH

Early or primary PPH refers to excessive vaginal bleeding within the first 24 hours after delivery. Traditionally, primary PPH was defined as an estimated blood loss (EBL) of at least 500 mL for a vaginal delivery and at least 1000 mL for a cesarean delivery. Unfortunately, the description of blood loss at delivery is subjective, inaccurate, and usually underreported. Studies show that visual assessment of EBL can underestimate blood loss by 33% to 50%,4,5 which limits the interpretation of outcomes in any study of PPH. Comparisons of pre- and postpartum hemoglobin or hematocrit may be more accurate, and a 10% decrease in hematocrit levels has also defined PPH.6

Clinically, PPH is characterized by signs and symptoms of hypovolemia, including pallor, dizziness, hypotension, and oliguria, which are usually apparent when blood loss exceeds 10% of the total blood volume. However, maternal blood volume expands by 40% to 50% in a pregnancy, so that a patient may lose up to 20% of her blood volume before clinical signs and symptoms become apparent. Although a patient may meet blood loss criteria for PPH, blood transfusion rates provide better estimates of the hemorrhage severity.

Secondary PPH

Late or secondary PPH is defined as excessive vaginal bleeding occurring between 24 hours and 6 weeks after delivery.7 Secondary PPH is also referred to as persistent or delayed PPH and is estimated to occur in 1% to 3% of all deliveries.7 Unlike the quantitative definition of primary PPH, the definition of secondary PPH is more subjective and essentially requires sufficient bleeding to prompt the patient to seek medical attention. Patients usually present during the second postpartum week, and the most common etiology is retained placental fragments.7 In women with a personal or family history of menorrhagia or other bleeding problems, von Willebrand’s disease is an etiologic consideration.

ETIOLOGY AND RISK FACTORS

The etiology of PPH falls into 4 main categories: tone, tissue, trauma, and thrombin (Table 1). A contracting myometrium, local hemostatic factors in the decidua (tissue factor, plasminogen activator inhibitor), and systemic coagulation factors (platelets and clotting factors) all contribute to hemostasis after a normal delivery. The blood flow to a gravid uterus at term is between 800 and 1000 mL/min, and significant blood loss can occur rapidly if normal hemostatic mechanisms do not function. The major mechanism for hemostasis after delivery is the contraction of the uterus, not the formation of a clot or aggregation of platelets. Uterine atony is the cause in 75% to 90% of cases of PPH.6,9

Risk factors for PPH have been identified (Table 2); however, PPH more often occurs in the absence of risk factors. In a case-control study by Combs et al,4 previous PPH was one of the strongest predictors of recurrent PPH in the authors’ 17-factor logistic regression model. In a multivariate analysis, previous PPH had an odds ratio of 3.55 (95% confidence interval [CI], 1.24–10.19) for recurrent PPH (defined as a hematocrit decrease of ≥10 points between admission and post-delivery or the need for blood transfusion).4 Of note, several studies have disputed the relationship between grand multiparity (≥5 vaginal births) and PPH.6,7,9,11 Although several studies have examined whether race is a risk factor for PPH, only Asian race has been reported as a risk factor in more than 1 study.6,12

This manual reviews current approaches to the diagnosis and management of PPH. Also discussed are
management strategies in specific circumstances, such as abnormal placentation and patient refusal of blood products, and practical approaches for the prevention of PPH.

EVALUATION AND TREATMENT

PPH is a clinical event in which evaluation and management occur concomitantly. Treatment involves a series of steps that include supportive measures, pharmacologic and nonpharmacologic interventions, and surgery.

SUPPORTIVE MEASURES AND INITIAL STEPS

General supportive measures recommended for all cases of PPH include obtaining intravenous access for crystalloid infusion, notifying the blood bank that blood products may be needed, and promptly communicating with appropriate support services such as anesthesiology, nursing, and obstetrics and gynecology. Blood collection for baseline status includes a complete blood count, coagulation parameters (prothrombin time [PT], partial thromboplastin time [PTT]), and fibrinogen levels. Fibrinogen levels can be assessed at the bedside by placing 5 mL of the patient’s blood in a red-topped tube. Normally, blood clots within 8 to 10 minutes. If the blood does not clot or if the clot dissolves within 30 to 60 minutes, the fibrinogen concentration is low (< 150 mg/dL).

Given that uterine atony is the most common cause of PPH, initial management also includes bladder drainage and vigorous uterine massage. The next steps involve a careful search for and treatment of lacerations, pelvic hematomas, and retained products of conception.

PHARMACOLOGIC INTERVENTIONS

Uterotonic Drugs

One of the first interventions is to administer uterotonic drugs, usually in a sequence until hemostasis is achieved or other (nonpharmacologic) interventions become necessary. Table 3 lists the medications most commonly used as well as their doses, routes of administration, side effects, and contraindications. Compared with other uterotonic agents, the data for misoprostol’s efficacy are more limited, and the optimal doses have not been established.

Recombinant Activated Factor VII

Recombinant activated factor VII (rFVIIa) is a vitamin K–dependent protein approved by the U.S. Food and Drug Administration for treatment of bleeding in individuals with hemophilia A and B, acquired inhibitor antibodies, and congenital factor VII deficiency. Factor VIIa promotes clotting through the extrinsic pathway by complexing to tissue factor. Factor VIIa also promotes activation of factor X to Xa, activation of factor IX to IXa, and formation of thrombin. Factor VIIa can then bind directly to platelets to achieve hemostasis. Administration of supraphysiologic doses of factor VIIa activates factor X directly on platelets, which results in thrombin and fibrin production and efficient crosslinking. This fibrin clot has a different architecture, which is stronger and more resistant to degradation.
Some expanded (off-label) uses of rFVIIa have included trauma cases and patients with thrombocytopenia. In addition, the obstetric literature includes case reports of the use of rFVIIa for treatment of PPH in patients with uterine atony, preeclampsia, accreta, uterine rupture, lacerations, multifetal gestations, and anaphylactoid syndrome of pregnancy (ASP). Most patients received only 1 dose, and the outcomes were generally described as successful, with hemostasis usually occurring less than 30 minutes after the dose was administered. McMorrow et al recently described a retrospective case-matched analysis of 28 cases of massive PPH (> 5 units of red blood cells [RBCs] transfused in 24 hours); in 6 of these cases, patients received rFVIIa. Between the 2 groups, there were no significant differences in the magnitude or absolute value of the PT. The authors concluded that routine use of rFVIIa was not supported based on their cases. Similarly, Ahonen et al reported their experience with 26 patients treated with rFVIIa for severe PPH. Approximately two thirds of patients who received rFVIIa experienced a good response to the product (defined as < 1000 mL of blood loss after administration of rFVIIa without the need for further interventions). However, failure likely occurred in some patients due to arterial bleeding.

rFVIIa is not considered a primary treatment modality for PPH, and conventional means to control bleeding are still recommended. One concern regarding the use of rFVIIa in PPH relates to hypercoagulation, as the levels of factor VIIa rise by more than 1000-fold with this treatment; however, increased thrombotic events have not been confirmed in randomized trials. In addition, the optimal dose and timing of rFVIIa treatment in PPH has not yet been determined. Current literature regarding rFVIIa use in obstetrics reflects individual institutional experience and protocols. If rFVIIa is considered for PPH, consultation with a hematologist is appropriate. rFVIIa might prevent hysterectomy and appear to reduce bleeding; however, randomized controlled trials are still needed to establish whether rFVIIa is a safe and effective treatment for PPH.

NONPHARMACOLOGIC INTERVENTIONS

Uterine Packing

Uterine packing for massive hemorrhage is an older, somewhat controversial concept that has fallen out of use due to concerns for concealing hemorrhage and potentially increasing risk for infection. However, packing the uterus can be another potentially life-saving measure in PPH. A uterine pack consists of a gauze roll tightly packed into the uterus to provide pressure directly on bleeding capillary/venous vessels or the bleeding decidua. The pack can also contain an x-ray cassette bag, filled with gauze rolls tied end to end, providing enough volume to fill the uterus.

Tamponade Balloons

Similarly, the purpose of tamponade balloons is to gain temporary control of or reduce uterine bleeding when conservative management is appropriate and medical therapy has failed. The Bakri tamponade balloon was specifically designed for uterine tamponade...
to control PPH. Its silicone balloon holds 500 mL of saline and has a drainage lumen that allows for blood loss monitoring. In a case series of 23 patients with PPH, the Bakri tamponade balloon was successful 90% of the time when placed properly and 100% of the time for cases of uterine atony. The Sengstaken-Blakemore tube (originally developed to temporarily manage bleeding esophageal varices) has a “stomach” portion that holds 300 mL of saline and allows for drainage of blood from sites proximal to the tube placement. In 17 cases of massive PPH, the Sengstaken-Blakemore tube reduced hemorrhage in 71% of cases and avoided further surgery in 88%. The Rüschi urologic balloon holds 400 to 500 mL of saline and has also been described for the treatment of PPH in 2 cases. A review of 9 studies evaluating conservative management of PPH with tamponade balloons of different types suggested an average success rate of 84% (range, 71%–100%) in 136 cases. Usually, these devices remain in place for approximately 24 hours. Parameters such as fluid input and output, fundal height, and vaginal blood loss are continuously monitored while the balloons are in place. Concomitant treatments include continuous oxytocin infusions and broad-spectrum antibiotics.

**INTERVENTIONAL RADIOLOGY**

Percutaneous transcatheter interventional procedures are becoming more common in the management of obstetric and gynecologic problems. If repair of lacerations, administration of uterotonic drugs, and correction of coagulopathies fail, these techniques are considered next for the treatment of PPH. Arterial embolization is an option after the initial resuscitation and stabilization and should be performed only in centers experienced with these procedures. Arterial embolization should be considered before surgery, as it cannot be performed after arterial ligation.

In a review of 14 studies using arterial embolization as a single modality for managing major PPH, the success rate was 90.7% (175/193 cases). Under fluoroscopic guidance, the catheter is passed into the anterior branch of the internal iliac artery or into the uterine artery. Occlusive materials such as absorbable gelatin sponges or acrylic microspheres are injected until arterial blood flow ceases. Absorbable materials are preferred over coils because they occlude the arteries temporarily, which allows for recanalization of blood flow within a couple weeks. Embolization is usually bilateral.

The time needed to institute the procedure has been previously cited as a concern, especially when a patient is actively bleeding. Decision making and mobilization of personnel and appropriate equipment require time and planning. In 1 study of 49 cases, the mean procedural duration was 45.6 ± 19.3 min (range, 20–120 min), and 34 cases (69%) were performed in less than 60 minutes. Complications from these procedures, although not common, are related to ischemia and thrombosis from the embolization, pelvic infection, and vessel injuries from the angiography itself. Transient fevers are the most common immediate complication. Because of the resultant ischemia to the uterus, concerns for future fertility as well as placental implantation problems and fetal growth are valid. However, these occurrences have not been extensively studied.

**SURGICAL APPROACHES**

**Vessel Ligation During Laparotomy**

Laparotomy via a midline incision is the standard approach to assessing and managing bleeding that is unresponsive to the previously described measures. Because 90% of the blood supply to the uterus comes from the uterine arteries, occluding the uterine arteries reduces the majority of the uterine blood flow. Bilateral uterine artery ligation, or the O’Leary suture (Figure 1), accomplishes this goal. This procedure is relatively quick and easy to perform because the uterine arteries are easily accessible. The technique uses a large curved needle with a No. 1 chromic or catgut suture directed from anterior to posterior through the myometrium, approximately 1 to 2 cm medial to the broad ligament. The suture then is directed posterior to anterior through an avascular space in the broad ligament, close to the lateral border of the uterus, and tied. This suture usually is placed at the level of the internal cervical os but can be placed higher or lower as needed for hemostasis. In the event that uterine artery ligation fails to achieve hemostasis, similar sutures can be placed across the vessels within the utero-ovarian ligaments.

AbdRabbo et al described a stepwise uterine devascularization procedure in 103 patients with PPH who were unresponsive to manual massage and medications. The sequence of steps included (1) a unilateral uterine vessel ligation, (2) bilateral uterine vessel ligation (O’Leary suture), (3) a low bilateral uterine artery ligation, (4) a unilateral ovarian vessel ligation, and (5) bilateral ovarian vessel ligation. The physicians managing these cases started with step 1 and proceeded with the subsequent steps when sufficient hemostasis did not occur. Success was achieved in 77 cases (74.8%) after the second step, and 81 patients (79%) received 3 to 4 units of RBCs. Of note, no patient required a hysterectomy. According to this report, the stepwise process is an effective, safe alternative to hysterectomy.
Of all the surgical techniques for hemostasis, physicians perform hypogastric artery ligation less frequently today. Its purpose is to diminish the pulse pressure of blood flowing to the uterus via the internal iliac (hypogastric) vessels. The procedure is likely less successful (40%) than previously thought. Other limitations include a dissection that is more complex and difficult to perform, leading to prolonged time until achieving hemostasis.

Uterine Compression Sutures

Uterine compression sutures, which simulate manual uterine compression, can also be used to treat PPH and reduce the need for hysterectomy. The principle is that a contracted uterus does not bleed. Several approaches have been described in the literature. The B-Lynch suture (Figure 2) is a uterine “brace” that compresses the uterus in a vertical accordion style. First, bimanual compression of the uterus is applied to determine if compression controls the bleeding. In its original report, a No. 1 Monocryl suture on a 70-mm blunt semicircular needle was used, but a No. 2 chromic or No. 1 Vicryl suture has also been described. The largest study of the use of the B-Lynch suture for PPH was a 7-year review of 28 cases at a single institution. All procedures were performed at the time of a cesarean delivery, and uterine atony was the underlying etiology in 25 cases (89.3%). The sutures failed to control the hemorrhage in 5 cases (17.9%). There were 7 subsequent pregnancies, which were uneventful and delivered by elective repeat cesarean at term. The B-Lynch approach also requires uterine exteriorization and an open uterine cavity. The Hayman procedure is a modification of the B-Lynch technique that does not require an open uterine incision. (For interested readers, a description of the B-Lynch suture as well as a brief video demonstration is available at www.cbl.uk.com.)

Square suturing (Figure 3) is another technique for achieving hemostasis. These sutures approximate the anterior and posterior uterine walls and consequently provide uterine compression. With square suturing, the uterus is sewn from front to back (serosa to serosa) using a No. 7 or 8 surgical straight needle with a No. 1 atraumatic chromic catgut suture. Placement of the sutures varies depending on the clinical situation (eg, in the cervicoisthmic area for cases of placenta previa or in isolated areas of bleeding). In the original report, 23 patients with PPH at cesarean delivery received this form of uterine compression; no hysterectomies were reported, and normal menstrual flow resumed after delivery. Reported complications include pyometra and uterine cavity synechiae.

Hysterectomy

Peripartum hysterectomy is usually reserved for cases of failed surgical or medical treatment. Peripartum hysterectomy is required in approximately 0.2 to 1.5 per 1000 deliveries, with the most common indications...
being abnormal placentation, uterine atony, and uterine rupture. The technique is similar to a standard hysterectomy, but there is an increased risk for injury to adjacent structures. Urinary tract injuries occur in 5% to 22% of peripartum hysterectomies, with the bladder being the most frequently involved organ.

**TRANSFUSION PRINCIPLES**

Postpartum transfusion rates vary between 0.4% and 6.4% for all deliveries. Given limitations of the various methods for determining whether the patient is hemorrhaging (EBL, hematocrit or hemoglobin concentrations, and presence of symptoms/signs of hemorrhage), it can be difficult to determine when blood product support should be instituted. There are no universally accepted guidelines for replacement of blood components in PPH. Blood products are transfused when blood loss is significant and ongoing, especially if the patient’s vital signs are unstable. RBCs restore oxygen-carrying capacity, which is important to ensure adequate tissue perfusion and to prevent acidosis, coagulopathy, and hypothermia, while clotting factors and platelets provide hemostasis. In 1 study, the incidence of myocardial ischemia was 50% in patients admitted to an intensive care unit for PPH and hypovolemic shock if they had a hemoglobin below 6.0 g/dL, systolic blood pressure of 88 mm Hg or less, a diastolic blood pressure of 50 mm Hg or less, and a heart rate exceeding 115 bpm.

**Blood Products**

In order to avoid dilutional coagulopathy, concurrent replacement of RBCs with coagulation factors and platelets is recommended. Recent experience from trauma centers recommends 1 unit of fresh frozen plasma (FFP) for every 1 to 2 units of RBCs until the patient’s clinical status stabilizes or the coagulopathy resolves. Another ratio of blood products is 6 units of RBCs, 4 units of plasma, and 1 unit of platelets. Results of laboratory testing can also guide transfusion practices. For example, a PT and PTT prolonged 1.5 times the normal, a platelet count below 25,000 cells/mL, and a fibrinogen level below 100 mg/dL should prompt further transfusion in the appropriate clinical setting. Table 4 lists the blood components, indications for transfusion, and hematologic effects. Platelets are usually available in

---

**Table 4**

<table>
<thead>
<tr>
<th>Blood Component</th>
<th>Indications</th>
<th>Hematologic Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBCs</td>
<td>Significant blood loss</td>
<td>Oxygen-carrying capacity restoration</td>
</tr>
<tr>
<td>FFP</td>
<td>Severe coagulopathy</td>
<td>Decrease in clotting factors</td>
</tr>
<tr>
<td>Plasma</td>
<td>Severe hypovolemia</td>
<td>Replacement of plasma volume</td>
</tr>
<tr>
<td>Platelets</td>
<td>Severe hemorrhage</td>
<td>Hemostasis</td>
</tr>
</tbody>
</table>

---

**Figure 2.** The B-Lynch procedure. (A) Suture on the anterior wall of the uterus. (B) Suture on the posterior wall of the uterus. (C) Relationship of the suture to the uterine incision and lateral borders of the uterus. (D) Final appearance of the uterus after closure. (Adapted with permission from B-Lynch C. Conservative surgical management. In: B-Lynch C, Keith LG, Lalonde AB, Karoshi M, editors. A textbook of postpartum hemorrhage. Duncow [UK]: Sapiens Publishing; 2006:289.)
Postpartum Hemorrhage

6 to 9 unit equivalents from apheresis or whole blood. FFP, collected from whole blood or plasma apheresis after removing platelets and cells, is stored between –18°C and –30°C and must be thawed, a process which takes approximately 20 to 30 minutes. Cryoprecipitate is extracted from slowly thawing FFP.

Autologous Transfusion

Autologous transfusion including donation, storage, and retransfusion has been shown to be safe in pregnancy.46,47 Benefits of autologous transfusion include decreased risk of autoimmunization, exposure to bloodborne pathogens, and immunologic complications. However, meeting the requirements for donation (hemoglobin > 11 g/dL at 32 weeks) is not always possible in the obstetric population given the physiologic anemia that occurs during pregnancy.48,49 Preparations for autologous transfusion are commenced in situations with a high chance of transfusion (eg, placenta percreta) or in patients with rare antibodies, for whom it may be challenging to find compatible blood. Acute normovolemic hemodilution involves the collection of autologous blood immediately before surgery or delivery. Fluid (colloid or crystalloid) is administered in an equivalent volume to the blood that is withdrawn. The principle behind the procedure is that there is an intentional dilution of the RBC concentration, and the RBC mass lost per mL of surgical blood loss is reduced.50 The collected blood is then transfused back into the patient after completion of the case. Advantages of acute normovolemic hemodilution include a reduction in subsequent blood transfusions, reduced blood viscosity, increased cardiac output while maintaining the patient’s heart rate during the procedure, and enhanced blood flow and oxygen delivery to tissues.

Cell-Saver Technology

Cell-saver technology has also been successful for patients undergoing cesarean delivery. Blood is suctioned from the operative field and then washed, suspended in saline, and reinfused into the patient. Separate suction devices, one for removing amniotic fluid and another for collecting the RBC product, are recommended. Pregnancy is thought to be a “relative contraindication” to cell-saver technology due to the increased risk for bacterial contamination and ASP. Rebarber et al51 reported on 139 patients treated with cell-saver technology during cesarean deliveries at 3 hospitals. The salvage began after delivery of the infant and removal of the amniotic fluid. There were no cases of ASP or ARDS. The cost per patient for the autotransfusor unit was $500 to $600 regardless of the number of units processed, which became cost-effective after 2 or more units of processed autologous blood were transfused. There is only 1 case report of a patient developing ASP after use of cell-saver technology.52 This patient developed hypoxia, cardiovascular collapse, and death minutes after infusion of cell-saver blood following cesarean delivery. The patient also had HELLP syndrome, so the exact cause of death was unclear.

SECONDARY PPH

The majority of cases of secondary PPH occur as a result of subinvolution of the uterus. Management is similar to that of primary PPH, with a focus on resuscitation, uterotonic agents, antibiotics for endometritis, and uterine evacuation. Choriocarcinoma and inherited coagulopathies can also present as secondary PPH. The management of these entities is beyond the scope of this review.

SPECIAL CONSIDERATIONS

ABNORMAL PLACENTATION

Abnormal placentation (including accreta, increta, and percreta) is becoming more common today, primarily due to the increased number of cesarean deliveries performed. Placenta accreta has become the leading cause of peripartum hysterectomies. The rate of placenta previa-accreta approaches 70% after 5 cesarean deliveries.53 Early diagnosis and preparation are critical in the management of patients with suspected placenta accreta, and a multidisciplinary approach is required. The blood bank should be notified about the potential need for multiple blood transfusions. Maternal mortality can be as high as 10% in cases of placenta accreta, and multiple transfusions are required in 90% of these patients.54 A
unique approach to treating uterine hemorrhage caused by a partial placenta accreta involves excising the implantation site and closing the uterine incision. In some cases, this procedure may avoid a hysterectomy.

**UTERINE INVERSION**

Uterine inversion is associated with massive hemorrhage. Repositioning of the uterus involves placing the palm of the hand against the fundus with the fingertips exerting upward pressure circumferentially. To return the uterus to its normal position, terbutaline, magnesium sulfate, halogenated general anesthetics, and/or nitroglycerin may be needed to relax the uterus. As such, immediate notification of an anesthesiologist is recommended. If manual repositioning is not successful, 2 options via a laparotomy have been described in the older literature. The Huntington procedure provides progressive upward traction on the inverted uterus using Babcock clamps or Allis forceps. In the Haultain procedure, the cervical ring is cut posteriorly, the inverted uterus is repositioned digitally, and the incision is repaired.

**ANAPHYLACTOID SYNDROME OF PREGNANCY**

ASP, formerly called amniotic fluid embolism, occurs in 7.7 per 100,000 deliveries and has a case fatality rate of 21.6%. Although the exact pathophysiology is unknown, exposure of the pulmonary system to amniotic fluid may result in vasospasm, acute pulmonary hypertension, and severe hypoxia. Patients usually present with cardiorespiratory collapse and cardiac arrest, but coagulopathy can occur soon after the initial presenting symptoms. PPH results from major coagulation deficiencies and is accompanied by uterine atony.

**REFUSAL OF BLOOD PRODUCTS**

Some patients may choose to refuse blood product support; this situation most commonly occurs in persons who ascribe to the faith known as Jehovah’s Witness. Of the approximately 1.3 million Jehovah’s Witnesses living in the United States, 71% are women, more than 50% of whom identify themselves as black (37%) or Hispanic (14%). In a study of 332 Jehovah’s Witnesses who underwent 328 vaginal and 63 cesarean deliveries, Jehovah’s Witnesses incurred an approximate 44-fold increased risk of death due to obstetric hemorrhage compared with the general obstetric population at the hospital. Patients who refuse blood products should be identified early in the pregnancy, ideally at the first prenatal visit. Patients should communicate which if any measures (ie, RBCs, platelets, plasma, cryoprecipitate, albumin, autologous transfusion, cell-saver transfusion, erythropoietin) they are willing to accept in the event of life-threatening hemorrhage. As part of the informed consent process, patient refusal of blood products should be thoroughly documented. Anesthesiologists are key participants in this process, as they need to be aware of the patient’s blood refusal status at the time of operative deliveries.

**PREVENTION**

**CHANGING THE SYSTEM**

PPH can occur without warning, and most women have no risk factors. The key to reducing maternal morbidity and mortality is a well-defined, multidisciplinary approach that acts efficiently and avoids conflicting strategies.

In a review of all pregnancy-related deaths in North Carolina from 1995 to 1999 (n = 108), 14% were attributed to hemorrhage; approximately 93% of these deaths were judged to have been potentially preventable through improved quality of care. Similarly, 2 maternal deaths related to hemorrhage in a New York hospital

---

**Table 4. Blood Components for Transfusion**

<table>
<thead>
<tr>
<th>Product</th>
<th>Volume (mL)</th>
<th>Expected Response</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packed red cells (RBCs, WBCs, plasma)</td>
<td>240</td>
<td>Increase hematocrit by 3%; improve oxygen carrying capacity</td>
<td>Consider for a hemoglobin &lt; 6 g/dL; type specific and crossmatched blood preferred</td>
</tr>
<tr>
<td>Platelets (platelets, RBCs, WBCs, plasma)</td>
<td>50</td>
<td>Increase platelet count 5000–10,000/mm³ per unit</td>
<td>Used for microvascular bleeding with platelet counts &lt; 50,000/mm³</td>
</tr>
<tr>
<td>Fresh frozen plasma (fibrinogen, antithrombin, factors V and VIII)</td>
<td>250</td>
<td>Increase fibrinogen by 10 mg/dL</td>
<td>Used for microvascular bleeding due to clotting factor deficiency, INR &gt; 2, or a PTT &gt; 1.5</td>
</tr>
<tr>
<td>Cryoprecipitate (fibrinogen, factors VIII and XIII, von Willebrand's factor)</td>
<td>40</td>
<td>Increase fibrinogen by 10 mg/dL</td>
<td>Used for microvascular bleeding due to fibrinogen deficiency or a fibrinogen level &lt; 100 mg/dL</td>
</tr>
</tbody>
</table>

INR = international normalized ratio; PTT = partial thromboplastin time; RBC = red blood cell; WBC = white blood cell. (Adapted from Fuller AJ, Bucklin B. Blood component therapy in obstetrics. Obstet Gynecol Clin North Am 2007;34:447. Copyright 2007, with permission from Elsevier.)

---

www.turner-white.com

Obstetrics and Gynecology Volume 11, Part 3
promoted the creation of a patient safety initiative to improve hospital systems caring for women at risk for major obstetric hemorrhage. This initiative included (1) a rapid response team (modeled after the cardiac arrest team) that undergoes quarterly mock drills on all shifts; (2) clinical pathways, guidelines, and protocols for early diagnosis of at-risk patients; (3) a review of the duties of on-call obstetricians; (4) involvement of senior members of the department in all cases of PPH; (5) weekly didactic sessions; and (6) involvement of the trauma team. After initiation of these systematic changes, outcomes including PPH and maternal death were compared pre- and postintervention; there were no maternal deaths attributed to hemorrhage after introduction of the new system. However, outcomes (eg, need for cesarean hysterectomy, transfusion volume, operative times) were not different. Although the educational efforts involved a substantial amount of time, thought, and teaching, the hospital system was thought to have improved patient safety overall.

According to another report, the availability of an obstetric hemorrhage equipment tray on the labor and delivery service also may facilitate prompt surgical management of severe obstetric hemorrhage as well as reduce the need for blood transfusion and hysterectomy. This tray contains supplies for tamponade (5-yard roll of packing, vaginal packs, balloon device), straight-eyed (10 cm) Keith needles and large curved-eyed needles for use with No. 1 suture, instruments for exposure (3 Heaney vaginal retractors, 4 sponge forceps), several different types of suture, and diagrams and instructions for the various types of compression sutures and tamponade techniques. The clinicians who reported experience with this tray found the ready availability of this rarely needed equipment to be useful in avoiding delays in the treatment of PPH.

The Joint Commission on Accreditation of Healthcare Organizations recommends that obstetric staff periodically conduct drills to help prepare for PPH, conduct debriefings to evaluate team performance, and identify areas for improvement. Other hospital committees and agencies have developed protocols that should be followed once PPH is recognized (see www.health.state.ny.us/professionals/protocols_and_guidelines/maternal_hemorrhage/docs/managing_maternal_hemorrhage_poster.pdf; also see www.sapienspublishing.com/pph_pdf/PPH-Guidelines.pdf). These protocols involve measures such as streamlined processes for true emergencies and diagrams posted in the operating room containing figures of operative techniques and medication dosages.

**STEPS FOR CLINICIANS**

With respect to the aforementioned protocols and interventions to reduce PPH or minimize its severity, clinicians should take additional steps to identify and treat patients at risk. At the first prenatal visit, a detailed history should determine individual risk factors for PPH, and those at risk should be scheduled to deliver in centers with capabilities for blood transfusion and trained birth attendants. Sending a blood type and screen upon admission for delivery is appropriate for patients at risk for PPH and usually takes 45 minutes for laboratory processing. Blood crossmatching takes approximately 15 to 45 additional minutes after the type and screen.

Other steps for those at risk include stopping or transitioning to more reversible anticoagulants for patients taking blood thinners and avoiding prolonged labor. Active management of the third stage of labor involves controlled traction on the umbilical cord, countertraction on the uterus just above the pubic symphysis, and administration of oxytocin to effect uterine contractions and placental expulsion. Active management reduces the amount of blood loss at vaginal deliveries and decreases the number of retained placentas. Oxytocin is routinely administered soon after delivery, which may be given at the time of delivery of the anterior shoulder of the fetus or, more commonly in the United States, following delivery of the placenta. At a cesarean delivery, spontaneous delivery of the placenta has been shown to decrease blood loss by 31% as compared with manual removal. Although a third stage of labor greater than 30 minutes has been considered abnormal and warrants manual placental extraction, recent evidence based on interpretation of receiver-operator curves suggests that if a placenta has not delivered by 18 minutes, it should be removed to reduce the incidence of PPH.

Early recognition of excessive bleeding is also critical to reduce morbidity and mortality. If the means are available to detect excessive blood loss more rapidly, earlier action can provide improved medical and/or surgical treatment. One study found that training health care personnel on estimating blood loss improved the accuracy of blood loss estimation. Another study comparing simulated EBL in calibrated and noncalibrated drapes demonstrated that calibration significantly improved the accuracy of EBL reporting, whereas the accuracy of EBL worsened with increasing blood volume in the noncalibrated drapes. Calibrated drapes with a funneled collection pouch have been described in studies on PPH and are currently in use in 13 countries.
UTEROTONIC DRUGS FOR PREVENTION

Given that uterine atony is the most common cause of PPH, a key aspect in the prevention of PPH is uterotonics therapy. Misoprostol has attracted widespread attention for the prevention of PPH because of its strong uterotonic effects and ease of administration (the drug does not require refrigeration and can be given orally, sublingually, or rectally). A systematic review of 37 misoprostol and 9 intramuscular prostaglandin trials that included 42,621 women assessed the routine use of these agents in the third stage of labor. Oral misoprostol reduced severe PPH (EBL > 1000 mL) and blood transfusion as compared with placebo (risk ratio [RR], 0.66 [95% CI, 0.45–0.98]) in 7 trials of 2849 women. When compared with conventional injectable uterotonics, however, oral misoprostol was associated with a higher risk of severe PPH (RR, 1.32 [95% CI, 1.16–1.51]) and the need for additional uterotonic drugs in 16 trials with a total of 29,042 patients. In summary, 600 mg misoprostol orally or sublingually is better than placebo in preventing PPH. However, the data regarding PPH risk and the greater incidence of side effects with misoprostol compared with oxytocin suggest that conventional injectable uterotonics are preferred for PPH prevention. The World Health Organization recommends oxytocin or 600 mg oral misoprostol for prevention of PPH in settings where active management of the third stage of labor is not practiced.

REFERENCES

33. Hayman RG, Arulkumaran S, Steer PJ. Uterine compression
Postpartum Hemorrhage