

Postpartum Hemorrhage and the National Partnership for Maternal Safety Hemorrhage Bundle

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The learner will: 1) Identify women at risk for major postpartum hemorrhage; 2) List options available to control and mitigate the consequences of obstetric hemorrhage; 3) Discuss how contemporary transfusion practices apply in the obstetric setting; and 4) Draw from published guidelines and protocols to inform both individual clinical practice and systems solutions to prepare for these emergencies.

Definitions

Postpartum hemorrhage is most commonly defined by estimated blood loss (EBL) ≥ 500 mL for vaginal delivery and ≥ 1000 mL for cesarean delivery. The risk for adverse health outcomes accumulates with **persistent postpartum hemorrhage**, when bleeding exceeds 1000 mL and persists despite the use of first-line uterotonics and uterine massage,¹ particularly if bleeding is accompanied by signs or symptoms of hypovolemia.² The National Partnership for Maternal Safety recently defined indicators of **severe maternal morbidity** as ICU admission or transfusion with 4 or more units of blood products, and recommended that women with these indicators receive multidisciplinary review for the purpose of identifying opportunities for systems improvement.³ Massive blood transfusion has been defined as >10 u blood products transfused during the hospitalization for delivery⁴ or as erythrocyte transfusion >3 u/hour.⁵

Etiology

Primary postpartum hemorrhage develops within 24 hours of delivery and is due to uterine atony, retained placenta, genital tract trauma, placenta accreta, increta and percreta, uterine inversion, or coagulopathy. Coagulopathy may be inherited or result from a range of disorders in pregnancy, with amniotic fluid embolism being the most severe.⁶ *Secondary postpartum hemorrhage* is relatively infrequent, develops over 24 hours after delivery, and is ascribed to subinvolution of the placental site, retained products of conception, infection, or inherited coagulation defects.

Epidemiology

Postpartum hemorrhage complicates at least 3% of all deliveries, and appears to be increasing in frequency.^{7,8} Approximately 3% of women receive any blood products. Hemorrhage accounts for close to half of obstetric intensive care unit admissions,⁹ and 38% of cardiac arrests during the hospitalization for delivery.¹⁰

Uterine atony underlies 80% of all cases of postpartum hemorrhage.⁷ Population-level factors driving the increasing frequency of uterine atony include: 1) increasing population prevalence of obesity, multiple gestation, and advanced maternal age; 2) increasing inductions of labor;¹¹ and 3) increasing cesarean deliveries, from 21% of all births in 1997 to 32.7% in 2013.¹² Unrelenting uterine atony leads one-third of all peripartum hysterectomies.¹³ Uteroplacental inflammation (e.g., chorioamnionitis, vasculitis, funisitis, endometritis, and cervicitis) appears to be a major contributor to uterine atony that is sufficiently severe to require peripartum hysterectomy.¹⁴

Placenta accreta with or without placenta previa is the leading cause of massive blood transfusion.⁴ Accreta leads to approximately half of all peripartum hysterectomies, and rates have increased in conjunction with the burgeoning population of pregnant women with prior cesarean deliveries.⁴

Historically, hemorrhage was the leading cause of maternal death in the United States, but accounts for 11% of the total, or 1.8 maternal deaths per 100,000 live births in the United States.¹⁵ The majority of hemorrhage-related deaths are preventable.¹⁶⁻¹⁹

Anticipated Postpartum Hemorrhage

Even with the physiologic anemia of pregnancy, a hematocrit less than 32% should be treated to reduce the risk of peripartum blood transfusion (e.g., oral or intravenous iron). In addition, three groups need special antenatal preparation: 1) women with abnormal placentation; 2) those with inherited coagulation disorders; and 3) those who refuse blood products.

Abnormal Placentation

With placenta accreta, the decidua basalis (i.e., the decidual basal plate) is absent, and the basal plate of the placenta adheres to a floor of uterine myometrium. With placenta increta, chorionic villi invade into the myometrium, and with percreta, the placenta penetrates the uterine serosa, and may even grow into other pelvic structures, most commonly the bladder. Prior cesarean delivery, other uterine surgery, placenta previa, and maternal age ≥ 35 years are important risk factors for placenta accreta. Placental location mediates the relationship between prior cesarean and risk of accreta. Among women with a known placenta previa, the incidence of a morbidly adherent placenta increases from 3% among primary cesarean deliveries, to 11%, 40% and $>60\%$ after one, two, and three or more prior cesarean deliveries, respectively.²⁰ Given the rising incidence and prevalence of cesarean birth, placenta accreta increased from 0.8 per 1000 deliveries in the 1980s to 3 per 1000 deliveries in the past decade.²¹

Intrapartum blood loss is difficult to predict, depends on the success of the surgeons in avoiding manipulation of the placental bed, and can be rapid.²² Antenatal recognition and controlled surgical delivery improve outcomes.²³⁻²⁶ The Society of Maternal-Fetal-Medicine recommends that “women with a suspected placenta accreta should be scheduled for delivery in an institution with appropriate surgical facilities and a blood bank that can facilitate transfusion of large amounts of various blood products.”²¹ Placenta accreta remains the leading indication for unplanned peripartum hysterectomy,²⁷ likely as a consequence of the limitations of diagnostic accuracy.

Ultrasonography to locate the placenta and evaluate for markers of placenta accreta is recommended for every woman who has undergone prior uterine surgery, or found to have a low-lying placenta on the routine first or second trimester ultrasound.^{21,28} Magnetic resonance imaging (MRI) may help to confirm the diagnosis when ultrasound is inconclusive, and define the extent of invasion into surrounding organs in the case of placenta percreta.²¹ Women with a diagnosis of abnormal placentation based on ultrasonography are more likely to require blood transfusion and peripartum hysterectomy, and require more units of blood products transfused, when compared with women without definitive ultrasound findings.^{22,29}

In cases of extensive accreta, optimal surgical management is directed towards delivering the neonate, then closing the uterus with the placenta left *in situ*, followed by planned peripartum hysterectomy.³⁰ For women who desire fertility preservation, prophylactic uterine and hypogastric artery balloon catheters, stepwise uterine devascularization, pelvic vessel ligation or embolization, uterine compression sutures, and/or postpartum methotrexate may facilitate hemostatic control and placental involution.³¹ Any these techniques may also be appropriate for women with non-resectable placenta percreta, in order to reduce uteroplacental vascularity in preparation for a subsequent hysterectomy that may be scheduled 1-4 weeks postpartum.

Optimal management by the anesthesiologist ensures sufficient intravenous access and blood products to respond to massive hemorrhage, hemodynamic and hemostatic monitoring capability (e.g., central venous and peripheral arterial access), sequential compression stockings to prevent venous thromboembolism, padding and positioning to prevent nerve compression injury, warming devices to ensure normothermia, standard preoperative antibiotic prophylaxis in the hour prior to surgical incision and repeated if surgery is prolonged (i.e., ≥ 3 hours) or if heavy bleeding occurs.²¹ Given inaccuracy of models to predict total blood loss in these cases, the total number of recommended blood products to prepare depends on institutional capacity to maintain ongoing supply in the face of massive hemorrhage.^{22,32} Aggressive uterotonic administration, cell-saver auto-transfusion, massive transfusion management, and electrolyte and hemostatic measurement and management are discussed below.

Combined spinal epidural (or standard epidural) anesthesia allows the mother to be awake for the delivery, and may be extended for prolonged surgery. On the other hand, general anesthesia is preferred for cases with massive transfusion in the event of airway edema, fluid overload with pulmonary edema, or transfusion associated lung injury (TRALI). The decision about the primary anesthetic technique will weigh the magnitude of anticipated blood loss, the extent of the operative plan, the availability of additional anesthesia staff to assist with an unplanned conversion to general anesthesia, and the anticipated risk of a difficult airway.

Prophylactic embolization catheters may be inserted preoperatively into the anterior internal iliac or uterine arteries to facilitate balloon inflation or embolization immediately following delivery of the infant.²¹ Success rates vary based on institutional experience; cesarean delivery in the interventional radiology suite may improve efficacy of intra-arterial occlusion by avoiding catheter dislodgement.³³ While these catheters may be indicated for women

who desire fertility preservation, and in women with extensive or unrespectable placenta percreta, routine use is not recommended by the Society for Maternal-Fetal-Medicine due to potential complications including insertion site hematoma, abscess, tissue infection and necrosis.²¹ Epidural anesthesia should be initiated prior to femoral sheath insertion, to facilitate optimal positioning for both procedures and patient comfort.

Inherited Coagulation Disorders

Von Willebrand disease, hemophilia A and B, and factor XI deficiency account for approximately 90% of inherited bleeding disorders.^{1,34,35} Inherited platelet disorders (e.g., Bernard Soulier Syndrome, Glanzmann thrombasthenia) are rare. Given the clinical heterogeneity within each diagnosis, consultation with a hematologist and blood bank personnel will help to clarify optimal management for each patient. Sixteen percent of women who have von Willebrand disease will experience PPH within 24 hours of delivery, and 29% will experience delayed postpartum bleeding.³⁶

Jehovah's Witnesses and other women who refuse blood products

Antepartum consultation should review a comprehensive list of blood products, alternatives, and blood conservation strategies to determine acceptability of each intervention for the patient.³⁷ Antepartum iron and erythropoietin are often acceptable ways to optimize hematocrit prior to delivery, aiming for a hematocrit >35%, and may be continued postpartum in the event of significant blood loss.^{38,39} Neuraxial anesthesia with a catheter-based technique may be considered for operative anesthesia because an awake patient may change her mind in the face of impending death. Prophylactic administration of tranexamic acid has not been shown to significantly change cumulative blood loss, but administration early in the event of hemorrhage may be beneficial.

Volume replacement with crystalloid or colloid can decrease viscosity of the blood and improve peripheral perfusion while maintaining oxygen delivery (by increasing oxygen extraction in the periphery), and minimizing cardiac work. However, excessive crystalloid resuscitation can contribute to dilutional coagulopathy and decreased oncotic pressure. Cell-saver autotransfusion is discussed below, and a continuous circuit technique is often acceptable for patients who would otherwise refuse blood products.^{39,40} In the event of massive blood loss and profound anemia (hgb \leq 4 g/dL) prolonged postoperative sedation, intubation, thermoregulation, and paralysis may be required to limit oxygen consumption while erythropoietin and iron are used to restore the patient's red cell mass. Erythropoietin requires 48-72 hours for a significant reticulocyte response in peripheral blood, and 10-14 days to increase hemoglobin levels. Laboratory testing should be minimized using pediatric tubes and finger-stick testing where possible.³⁸

Risk stratified blood product preparation

Blood transfusion is rare following elective cesarean delivery (<1%), but risk is increased among women with antenatal anemia, placenta previa, or multiple gestation pregnancy, particularly when multiple risk factors present in combination.⁴¹ Systems to collect a blood specimen 1-3 days prior to planned Cesarean delivery may reduce unnecessary surgical delays.^{42,43}

Risk factors for blood transfusion may be evident before delivery (e.g., previa), on admission to the labor and delivery unit (e.g., antenatal hemorrhage), later in labor (e.g., chorioamnionitis or prolonged labor), or on transfer to postpartum care. Active and ongoing surveillance is recommended throughout the peripartum period. Approximately 40% of postpartum hemorrhages occur in previously low-risk women.⁴⁴

Recommendations for blood product preparation in Table 1 synthesize algorithms from the California Maternal Quality Care Collaborative (CMQCC),^{45,46} Stanford University,⁴⁷ and the MFMU Network.³⁹

Table 1. Blood product preparation based on the level of risk for peripartum blood transfusion

Risk level AND Recommendations	Conditions
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Prepare ≥2 units PRBC Risk > 10%	<ul style="list-style-type: none"> • Severe anemia (antepartum Hct <25%) <ul style="list-style-type: none"> ○ Mild anemia (Hct 25.1-29.9%) + other risk factors ○ Thrombocytopenia (platelets <100k) + other risk factors ○ Multiple gestation + other risk factors • Active bleeding on admission • Coagulation disorder including HELLP • CD for placenta previa, IUFD, or chorioamnionitis
Antibody Screen +	<ul style="list-style-type: none"> • Positive antibodies on T&S (Anti-D is usually due to Rhogam[†]) • History of difficult crossmatch • Sickle cell disease requiring extended crossmatch
Type and crossmatch [‡] <ul style="list-style-type: none"> • 4-20 units PRBC • 4-20 units FFP • 1-4 platelets (5-pk) 	<ul style="list-style-type: none"> • Maternal history of ≥3 Cesarean deliveries AND a placenta overlying the uterine scar or placenta previa • Imaging indicates placenta accreta, increta, or percreta • Planned cesarean hysterectomy

CD = cesarean delivery; FFP = fresh frozen plasma; Hct = hematocrit; HELLP = hemolysis, elevated liver enzyme, low platelet syndrome; PRBC = packed red blood cells

[†] Extra time is needed to discriminate between anti-D antibodies due to RhoGAM[®] and any additional antibodies that could interfere with a type and crossmatch.⁴⁸

[‡]The exact number of units determined by a patient-specific assessment of risk for massive blood loss, and institutional resources to rapidly procure additional blood products.^{22,32}

Unanticipated Postpartum Hemorrhage

System Factors

Clear multidisciplinary guidelines and regular skills training (multidisciplinary drills) reduce the incidence of massive PPH,⁴⁹⁻⁵¹ and are recommended for all units by the National Partnership for Maternal Safety.⁴⁴ Simulation-based training for obstetric hemorrhage encounters can reveal specific management deficits, and thereby facilitate targeted quality improvement and staff education.⁵²

Accumulating evidence suggests treatment delays increase risk for severe obstetric hemorrhage and hemorrhage-related maternal death.^{16,53,54,55} Bundling personnel, equipment, and drug resources ensures rapid and reliable delivery to the bedside.⁴⁴ Group paging systems can simultaneously request an entire Obstetric Medical Emergency Team.⁵⁶ Likewise, an obstetric hemorrhage cart can be used to store essential equipment.⁵¹ An obstetric hemorrhage drug pack containing uterotonics allows for efficient retrieval in the event of an emergency. Hemorrhage drills may be used to measure the time interval from the request for uterotonic medication to administration.⁴⁴

Obstetric hemorrhage is noted to be a particularly traumatic birth complication, regardless of the clinical outcome.⁴⁴ Patient, family, and staff support both during and after a hemorrhagic event are increasingly recognized as critical for restoring well-being, and mitigating complications such as post-traumatic stress disorder.⁴⁴

The Staged Approach

A Unit-Wide stage-based obstetric hemorrhage emergency management plan is recommended by the National Partnership for Maternal Safety,⁴⁴ and is based on 4 stages of obstetric hemorrhage (0 through 4).

Stage 0

Stage 0 begins with all deliveries, and focuses on ongoing risk assessment and active management of the third stage of labor. Prophylactic oxytocin decreases postpartum blood loss, and the need for additional uterotonics;⁵⁷ controlled cord traction and uterine massage provide limited benefit above oxytocin alone.⁵⁸⁻⁶⁰ The dose required to initiate acceptable uterine tone following cesarean delivery (≤ 3 IU) is lower than previously assumed.^{61,62} An initial infusion of 18 IU/hour (e.g., 30 IU in 500 mL, infused at 300 mL/hour) is effective to achieve acceptable uterine tone within 5 minutes in 90% of women undergoing elective cesarean delivery.⁶³⁻⁶⁵ Alternatively, some authors

recommend a 3 IU loading bolus over 15 seconds.⁶⁶ In women undergoing cesarean delivery after oxytocin labor augmentation, the combination of oxytocin and ergometrine reduces the need for additional uterotonic agents when compared with oxytocin alone, but the addition of ergometrine increases nausea without reducing blood loss.⁶⁷

No study has demonstrated that a maintenance infusion decreases postpartum blood loss, but an infusion of 10 IU/hour over 4 hours has been shown to decrease the need for additional uterotonic agents.⁶⁸

The Association of Women's Health Obstetric and Neonatal Nurses (AWHONN) recommends universal serial assessments of cumulative blood loss, vital signs, fundal height, and uterine tone for all deliveries (<http://www.pphpproject.org/resources.asp>). Accurate blood loss estimation is improved by the use of calibrated drapes and formal staff training in blood loss estimation.^{69,70} Blood contained in absorbing materials (e.g., pads, sponges) can be quantified by weight, subtracting the dry weight of each item, assuming 1 gm weight = 1 mL blood.³⁷ Immediately following delivery, the team should routinely tabulate fluid volume in suction canisters, calibrated drapes, and absorbing materials; any subsequent volume can be assumed to be blood, not amniotic fluid.

Because hemorrhage is often concealed or underestimated, monitoring protocols with clear triggers to escalate care are essential.^{16,37} The Modified Early Obstetric Warning System is an aggregate weighted scoring system that centers in the UK use to identify women developing critical illness.^{71,72} The Maternal Early Warning System suggests close evaluation if the heart rate exceeds 120 beats per minute; late signs of hemorrhage include hypotension, narrow pulse pressure, pallor or mottled appearance, cold and clammy extremities, oliguria (<0.5mL/kg/hr), anxiety, restlessness, confusion, palpitations, dizziness, diaphoresis, and dyspnea or air hunger. An obstetric shock index (HR/SBP) >1 has high specificity for postpartum hemorrhage, and is associated with an increased risk of blood transfusion.^{73,74}

Stage 1: Postpartum Hemorrhage

EBL>1000, brisk gush or boggy uterus, or multiple clots AND vital signs stable. At this point, both the anesthesiologist and the obstetrician should be notified. Monitoring intensity of both vital signs and EBL should increase. Targeted therapy includes appropriate venous access, initial fluid resuscitation, uterotonics, and analgesia to facilitate initial obstetric interventions to investigate and control the source of bleeding. The diagnostic evaluation should address the five Ts: (1) **Tone**—uterine atony; (2) **Trauma**—lacerations or genital tract trauma; (3) **Tissue**—retained placenta; (4) **Thrombin**—abnormalities of coagulation; and (5) **Turned inside out**—uterine inversion.

Rapid intravenous infusion of oxytocin may cause peripheral vasodilation, hypotension, flushing, nausea, chest pain, myocardial ischemia, and in the face of substantial hemorrhage, cardiovascular collapse.⁶² Limiting the infusion rate to ≤60 IU/hour appears to minimize serious hypotensive and ischemic effects.⁷⁵ When bleeding persists despite this maximal oxytocin infusion, second-line agents are indicated, including: 1) methergine 200 mcg IM if the patient is not hypertensive, repeated once after 15 minutes; 2) misoprostol 800-1000 mcg rectally or buccally; or 3) prostaglandin F_{2α} 250 mcg IM every 15-20 minutes up to 8 total doses (avoided in women with asthma).

Stage 2: Continued bleeding despite stage 1 interventions AND <1500 mL cumulative blood loss.

With **persistant postpartum hemorrhage**, it becomes very important to mobilize a full team. The patient should be moved to an operating room, large bore venous access secured, and a full panel of laboratory values sent, hematocrit, platelets, PT, and fibrinogen. Cross-match of at least 2 units of erythrocytes is usually indicated, and protocols for emergency release of blood products are recommended.^{42,44} Fibrinogen <2 g/L is an early predictor of the severity of subsequent PPH.⁷⁶⁻⁷⁸ Ongoing uterotonics, thermoregulation, antibiotic coverage, and venous thromboembolism prophylaxis should be addressed. Decisions about transfusion, requesting additional blood products, activating a massive transfusion protocol, converting to general anesthesia, initiating cell salvage, and establishing invasive hemodynamic monitoring depend on the ongoing state of the patient, the rate of blood loss, and the degree to which obstetricians are effective in diagnosing and controlling the source of bleeding.

Stage 3: EBL>1500, >2 u PRBC given, vital sign instability, evidence of coagulopathy, or ongoing bleeding. Stage 3 qualifies as **major obstetric hemorrhage**. Following manual exploration and repair of lacerations, stepwise escalation of surgical therapy includes D&C, intrauterine balloon (e.g., Bakri balloon), and uterine compression suture (e.g., B-Lynch, O'Leary, multiple squares), selective embolization, peripartum hysterectomy, and abdominal packing. In some cases, intraoperative manual aortic compression or cross clamping may facilitate surgical control.⁷⁹ Uterine inversion requires anesthesia and uterine relaxation to facilitate manual replacement.

While a hemoglobin transfusion threshold of 7 g/dL is generally appropriate, laboratory results are inaccurate in the face of ongoing hemorrhage, and transfusion should proceed empirically without waiting for laboratory results. Failure to maintain adequate hematocrit during acute obstetric hemorrhage has been associated with end organ dysfunction.⁸⁰ Hemostatic resuscitation with low transfusion ratios (FFP: PRBC and Platelet: PRBC ratios of 1:1 to 1:2) may increase survival in massively transfused trauma victims,⁸¹ and may decrease the need for advanced interventional procedures in postpartum hemorrhage.⁸² However, this evidence base suffers from survival bias. In 2015, a prospective RCT in trauma patients was published, and demonstrated that early resuscitation with plasma, platelets, and erythrocytes in a 1:1:1 ratio, compared with a 1:1:2 ratio, did not improve overall survival, but did improve hemostasis and reduced death from exsanguination at 24 hours.⁸³ Caution is advised. Plasma and platelets are pro-inflammatory, and may increase risk of pulmonary injury (e.g., TRALI) among individuals who ultimately receive ≤ 4 -6 units of erythrocytes.⁸⁴⁻⁸⁶ On the other hand, according to the trauma literature, the beneficial effect of plasma appears to be concentrated in the first two hours of resuscitation.^{87,88}

Although massive transfusion protocols specifically for obstetric hemorrhage have been described,^{89,90} standard institutional protocols are generally appropriate, as long as the higher transfusion threshold for fibrinogen is noted (≥ 2 g/L). Effective protocols are activated by phone, allow for initial supply of uncross-matched products if necessary, and supply batches of blood products that approximate the recommended 1:1:1 ratio.⁸⁷ Subsequent matched blood products are continuously prepared to maintain blood product availability, and the protocol is automatically discontinued once additional blood products have not been requested for at least one hour.

Regardless, the full panel of laboratory values (i.e., hematocrit, platelets, ionized Ca, K, PT, fibrinogen, ABG) should be sent every 30-60 minutes to establish trends. Serial coagulation tests are more helpful than single time point measurements in assessing for development of coagulopathy.⁵ Additional FFP may be needed to maintain the PT ≤ 1.5 times normal, platelets to maintain the platelet count over 50×10^9 /L, and cryoprecipitate or fibrinogen concentrate 4 g to maintain the fibrinogen over 2 g/L.⁷⁶⁻⁷⁸ Central laboratory turn-around time within 20 minutes is possible,⁹¹ but centralized viscoelastic monitoring with point-of-care real time display is emerging as a preferred strategy to facilitate goal directed therapy.⁹²⁻⁹⁵

In the event of unanticipated massive hemorrhage, an interosseous needle may be rapidly inserted in the proximal humerus and used to initiate fluid resuscitation while additional intravenous access is established.⁹⁶ Temporizing maneuvers include leg elevation, manual compression of the aorta at the umbilicus, and non-pneumatic anti-shock garments.⁹⁷ Permissive hypotension (MAP 50 mmHg) may help to limit bleeding, but is not well studied in the postpartum patient.³⁸

Adjunctive agents: Cell salvage—Over 650 published cases of obstetric patients have described auto-transfusion with blood salvaged and processed from the surgical field. The technique is gaining acceptance as newer machines in combination with leukocyte reduction filters have demonstrated effective clearance of fetal squamous cells, phospholipid lamellar bodies, plasma heparin, cytokines, and other coagulopathic mediators. The use of a leukocyte depletion filter has been associated with acute hypotension at the time of transfusion of cell salvaged erythrocytes.⁹⁸ Cell-salvaged blood does contain up to 2% fetal red blood cells; Rhesus-negative women require dose-adjusted RhoGAM[®] administration. Emergency cell salvage may be most appropriate in institutions where cell saver devices are routinely used, and dedicated technicians are available to set up the equipment.⁹⁹ Some centers may elect to limit use for women with placenta accreta or those who refuse blood products.

The anti-fibrinolytic agent **tranexamic acid** (1 g over 10 minutes Q 4-8 hr) improved survival in an international randomized controlled trial of trauma patients with significant hemorrhage.¹⁰⁰ Although fibrinolysis may be less important in the pathophysiology of PPH, the WHO recommends tranexamic acid when PPH continues despite standard uterotonic agents.¹⁰¹ A large trial in postpartum hemorrhage patients is currently ongoing.¹⁰⁰

Lyophilized fibrinogen concentrate 2-4 g has been reported to be helpful in obstetric patients.^{102,103} Although derived from human serum, fibrinogen concentrate is pasteurized, available in a standard concentration, and may be reconstituted and administered rapidly in a low volume.¹⁰⁴ The optimal amount of FFP to administer with fibrinogen concentrate is unknown.

Registries of **recombinant factor VIIa** report an overall 80% success rate to control hemorrhage when other interventions have failed, with reported doses ≤ 90 mcg/kg.^{1,105} Temperature, acidosis, calcium, platelets and fibrinogen should be first optimized for maximal hemostatic effect. For women with refractory hemorrhage in the setting of amniotic fluid embolism, recombinant factor VIIa has been associated with a high rate of devastating thrombotic complications.¹⁰⁶

Reporting and Systems Learning: Post-event debriefs are short clinical team meetings conducted immediately after a patient safety event, designed to build teamwork and identify opportunities for improvement. In addition, formal in-depth multidisciplinary reviews of serious hemorrhages (≥ 4 units of erythrocytes transfused or ICU admission) are recommended by the Joint Commission and the National Partnership for Maternal Safety (www.safehealthcareforeverywoman.org).⁴⁴

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Disclosure

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