Using Interventional Radiology to Treat Postpartum Hemorrhage

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ABSTRACT
Postpartum hemorrhage (PPH) is a serious complication of giving birth that can result in death. Interventional radiology allows for the use of uterine artery embolization and transcatheter arterial embolization to prevent and treat PPH. These procedures are minimally invasive options that use the uterine or internal iliac arteries to place either a balloon or embolic material to stop the bleeding. These techniques also can be used as a preventive treatment for women with known placental abnormalities who are at an increased risk of hemorrhaging. This article discusses causes, early recognition, and treatment of PPH. It also discusses nursing care for patients with PPH and presents a case report describing the use of interventional radiology before cesarean delivery for a patient with placenta accreta.

Key words: postpartum hemorrhage (PPH), transcatheter arterial embolism (TAE), uterine artery embolization (UAE), interventional radiology (IR).

Postpartum hemorrhage (PPH) accounted for approximately 25% of maternal morbidity worldwide in 2012. The incidence of PPH in the United States is increasing, although PPH deaths usually are considered preventable. Although definitions of PPH have varied in the past and lacked standardization, health care providers have traditionally defined it as blood loss exceeding 500 mL for a vaginal delivery or 1,000 mL for a cesarean delivery. In October 2017, the American College of Obstetricians and Gynecologists defined PPH as a cumulative blood loss of more than or equal to 1,000 mL within 24 hours after giving birth, regardless of the route of delivery and despite the use of uterotonic agents (ie, medications that contract the uterus or help to increase uterine tone) and uterine massage. Postpartum hemorrhage is identified as either primary or secondary. Primary PPH occurs within the first 24 hours of delivery. Secondary PPH occurs after the initial 24 hours; the onset usually is between 7 and 14 days after delivery but can occur up to 12 weeks post partum.

The most common cause of secondary PPH is endometritis. Women who have had a prolonged labor, multiple pregnancies, or polyhydramnios (ie, excessive amniotic fluid); have given birth to a large fetus (eg, greater than 4,000 g); are of an advanced maternal age (ie, more than 35 years of age); are obese (ie, body mass index greater than 30); or have experienced pyrexia during labor are at increased risk for PPH. Uterine inversion and placenta percreta (ie, the placenta has grown through the uterine wall and has the potential to attach to nearby organs) are less common causes of PPH. Causes of PPH can be categorized into the four Ts: tone, trauma, tissue, and thrombin.

• Tone refers to the failure of the uterus to contract adequately after delivery of the placenta. Lack of uterine tone is the primary cause of PPH in approximately 70% of cases.
• Trauma to the genital tract or uterus causes approximately 20% of PPH cases. Trauma can include perineal, cervical, and vaginal lacerations, and uterine rupture,
which may be the result of using forceps or a vacuum during delivery.\textsuperscript{6}

- **Tissue causes** include a retained placenta and abnormal placental implantation, which contribute to approximately 10\% of PPH cases.\textsuperscript{6}
- **Thrombin** refers to patients with inherited or acquired coagulation disorders that cause approximately 1\% of PPH cases.\textsuperscript{6}

Placenta previa and placenta accreta (eg, tissue causes) are defined as abnormal implantations of the placenta to the uterine wall.\textsuperscript{10,11} Placenta previa occurs when the placenta partially or completely covers the cervix, rendering a vaginal delivery impossible because of the risk of severe bleeding before and during delivery.\textsuperscript{11} Placenta accreta occurs when placental tissue grows into the myometrium (ie, first layer of the uterine lining) rather than attaching to it.\textsuperscript{10} Upon delivery of the placenta, the uterine wall containing the placental tissue will continue to bleed.

**PPH PREVENTION**

Prevention of PPH begins with accurate and frequent postpartum assessments. At our institution, the labor and delivery (L&D) nurse assesses the patient every 10 to 15 minutes while the patient is in the postanesthesia care phase. After the patient is transferred to a room, the postpartum nurse conducts an assessment every shift or more frequently based on the patient’s status.

**Prevention of postpartum hemorrhage begins with accurate and frequent postpartum assessments.**

A complete assessment includes an evaluation of fundal height, tone, and location by palpation. Ideally the fundus will be firm, midline, and at the level of the umbilicus. Any variations in the results of this assessment could be because of a full bladder, which could displace the uterus to the right and elevate the fundus above the level of the umbilicus; uterine atony; or the uterus filling with blood. The nurse completing the assessment describes the fundus as being firm or boggy. A firm fundus feels like a ball in the abdomen and a boggy fundus feels like a sponge. A boggy fundus is caused by uterine atony.\textsuperscript{12} The first step in caring for a boggy fundus is to provide fundal massage by placing one hand above the symphysis pubis to support the lower segment of the uterus and simultaneously placing the fingers of the other hand on the fundus. The nurse or other health care provider performs gentle massage of the fundus in a circular motion until the uterus becomes firm. The patient then requires continued close observation for the return of decreased uterine tone.\textsuperscript{12} A laceration of or tear in the uterine wall and the retention of a small piece of placenta in the uterus may cause blood to fill the uterus.

The L&D nurse also should assess the patient’s lochia (ie, postdelivery vaginal discharge). Lochia is comprised of endometrial tissue, bacteria, blood, and amniotic fluid. It is called rubra in the first few days post partum.\textsuperscript{12} It should be bright red and moderate in amount after delivery. The amount of lochia is described by the following measurements: scant is less than 2.5 cm on a menstrual pad in one hour; light is more than 2.5 cm but less than 10 cm; moderate is more than 10 cm but less than 15 cm; heavy is a saturated pad in one hour; and excessive is a menstrual pad that is saturated in 15 minutes by visual estimate. An increase in the amount of lochia or the presence of large clots may indicate PPH.\textsuperscript{12}

During the patient assessment, current recommendations emphasize paying attention to symptoms such as light-headedness, weakness, palpitations, diaphoresis, restlessness, confusion, air hunger, oliguria, and syncope.\textsuperscript{13} Patients may have already lost 20\% of their blood volume before the health care provider notices a change in their vital signs.\textsuperscript{14} An Association of Women’s Health, Obstetric and Neonatal Nurses PPH project noted that between 53\% and 93\% of PPH is preventable.\textsuperscript{15} The factors identified most frequently in the prevention of PPH are early recognition of the signs and symptoms and administration of blood products.\textsuperscript{16} Recognizing signs and symptoms is especially important because many women with more than 1,000 mL of blood loss do not present with any risk factors for PPH.\textsuperscript{17} Early recognition can lead to prompt intervention, and early treatment is vital to the success of controlling blood loss and preventing severe hemorrhaging and death.

**PPH TREATMENT**

The initial treatment for women experiencing PPH is pharmacologic and includes several options (Table 1). When
pharmacologic treatments fail, health care providers may consider the following interventions:

- examination under anesthesia to determine the source of the bleeding;
- insertion of a uterine balloon that is inflated with normal saline to create pressure on the uterine wall, which compresses the vessels and controls bleeding;\(^{18}\)
- dilation and curettage for removal of retained placental products;\(^{19}\)
- total abdominal hysterectomy; or
- interventional radiology (IR).\(^{4}\)

The most aggressive approach for life-threatening PPH emergencies is a total abdominal hysterectomy.\(^{20}\) Historically, providers have performed uterine massage, administered oxytocin, replaced fluids with an IV catheter, inserted an intrauterine balloon to perform uterine tamponade, manually compressed the uterus internally, or used circumferential B-Lynch uterine suture (ie, brace suture) to provide external uterine compression to stop bleeding and keep the patient alive.\(^{4}\) Some of these interventions may be used as temporary solutions until practitioners can stabilize the patient and transport her to the IR department.

### Interventional Radiology

The search for new technologies to control PPH resulted in the development of IR procedures that use imaging to perform life-saving interventions and preserve patients’ fertility.\(^{4}\) An interventional radiologist can perform a transcatheter arterial embolization (TAE) or insert a temporary balloon to occlude the artery (ie, uterine artery embolization [UAE]). The interventional radiologist uses fluoroscopy, ultrasound, and a contrast agent introduced via the femoral artery to perform these procedures.\(^{4}\) Transcatheter arterial embolization transports embolic material (eg, absorbable gelatin sponge, polyvinyl alcohol, coils) to the target artery via a catheter. Uterine arteries and internal iliac arteries or their branches are common sites for TAE.\(^{4}\) Some embolic materials are permanent and some are temporary. The interventional radiologist decides what type of embolic material to use based on the patient’s condition, age, and desire to preserve fertility. Although several embolic agents are available, interventional radiologists often use an absorbable gelatin sponge because the patient’s body absorbs it and it eventually dissolves.\(^{21}\)

Uterine artery embolization stops the bleeding after a balloon catheter is inflated at a site proximal to the bleeding

### Table 1. Pharmacologic Options for Treatment of Postpartum Hemorrhage\(^{1}\)

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
<th>Route</th>
<th>Action</th>
<th>Contraindications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxytocin</td>
<td>10-40 units</td>
<td>• IV</td>
<td>Stimulates uterine contractions by increasing local</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Intramuscular if IV is not available</td>
<td>prostaglandin production</td>
<td></td>
</tr>
<tr>
<td>Methylergonovine</td>
<td>0.2 mg</td>
<td>• Intramuscular</td>
<td>Increases tone, rate, and amplitude of contractions of the smooth muscle of the uterus</td>
<td>• Hypertension () • Heart disease () • Pre-eclampsia</td>
</tr>
<tr>
<td>Misoprostol</td>
<td>600-800 mcg</td>
<td>• PO • Sublingual • Rectal</td>
<td>Synthetic prostaglandin that induces uterine contractions by replacing the protective prostaglandins</td>
<td>None</td>
</tr>
<tr>
<td>Carboprost tromethamine</td>
<td>250 mcg</td>
<td>• Intramuscular • Intramyometrial</td>
<td>Produces myometrial contractions that lead to hemostasis of placentaion site</td>
<td>• Active cardiac, pulmonary, renal, or hepatic disease () • Asthma () • Hypertension</td>
</tr>
<tr>
<td>Tranexamic acid</td>
<td>1 g in 50 mL of normal saline or 5% dextrose in water</td>
<td>• IV piggyback for a minimum of 10 min to avoid hypotension</td>
<td>Displaces plasminogen from fibrin resulting in inhibition of fibrinolysis</td>
<td>• Active thromboembolic/embolic disorders</td>
</tr>
</tbody>
</table>

mcg = micrograms.
Reference
The closer the balloon is to the site of bleeding, the higher the chance the procedure will be successful. The benefits of performing TAE or UAE include avoiding the use of general anesthesia, stopping the bleeding immediately, and having the ability to repeat the procedure as necessary.

Preventing hemorrhage in high-risk pregnant women may require an IR procedure before delivery. Interventional radiologists can perform a UAE prophylactically in pregnant women to prevent PPH in known or suspected cases of placenta previa or placenta accreta. The interventional radiologist inserts sheaths into both femoral arteries to deploy a deflated occlusion balloon into each of the internal iliac arteries. He or she then removes the sheaths and the deflated balloons remain in place until after delivery. After the patient has undergone a cesarean delivery, the interventional radiologist will inflate the balloons if needed based on the amount of bleeding. If he or she postpones inflating the balloons, the balloons may remain in place for up to a few days until the patient’s providers are certain she will not begin to bleed again; then they can remove the balloons.

There are few major complications associated with TAE for PPH. Complications that may occur include maternal thromboembolic events leading to acute lower limb ischemia, which can result in the need for an arterial bypass procedure or a surgical thromboembolectomy. Arterial pseudoaneurysm formations and arterial dissection or rupture also may occur. Additionally, obstetric (OB) providers have expressed concerns about maternal and fetal exposure to radiation during an IR procedure. The patient and her provider should consider the benefits versus the risks of these procedures. Interventional radiology nurses can perform interventions to minimize the patient’s exposure to radiation, such as placing a lead apron on her. Additionally, the patient’s condition may prohibit her from undergoing an IR procedure; patients who are hemodynamically unstable or exhibit signs and symptoms of disseminated intravascular coagulation are not suitable candidates for an elective IR procedure with regional anesthesia. The obstetrician may perform a more traditional treatment such as a hysterectomy or uterine artery ligation for patients with these conditions.

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Facility leaders should provide educational resources, protocols, and proper equipment in the interventional radiology department for personnel caring for obstetric patients to safely manage postpartum hemorrhage.

Obstetric practitioners expect some blood loss at delivery; however, this may desensitize them to hemorrhage and lead to a delay in the recognition and diagnosis of PPH. It is important for L&D and postpartum nurses to be able to recognize heavier-than-normal bleeding. They should be aware that heavier-than-normal bleeding may present as a gush of blood or a slow, steady trickle or may consist of the passage of one or more large clots or several small clots. Performing uterine massage every 10 minutes for the first 60 minutes after delivery may reduce blood loss and the need for uterotonic.

Several organizations, including the California Maternal Quality Care Collaborative, offer recommendations for OB units to prepare for PPH, including the following:

- establish a written PPH protocol;
- implement the use of risk assessment tools;
- have PPH medications readily available on the unit and maintain them at the appropriate temperature (eg, methylergonovine requires refrigeration).
Key Takeaways

• Postpartum hemorrhage (PPH) is a serious complication of childbirth that can cause morbidity and mortality. The precise definition of PPH varies; however, it was recently defined as a cumulative blood loss of more than or equal to 1,000 mL within 24 hours after giving birth.

• Causes of PPH include lack of uterine tone, trauma to the genital tract, uterine rupture, retained placenta, abnormal placental implantation, and endometritis.

• The first-line treatment for PPH is pharmacologic intervention. Other treatments include dilation and curettage and hysterectomy. New treatments via interventional radiology include transcatheter arterial embolization and uterine artery embolization.

• Nurses who work on labor and delivery and postpartum units, in interventional radiology departments, and in the OR should all work together to care for patients experiencing PPH to deliver high-quality coordinated care.

- create a PPH cart that contains blood draw supplies, IV supplies, fluids, vaginal packing, an inflatable uterine balloon, disposable bed underpads, sanitary pads, and commonly requested instruments (eg, Sims retractor, weighted speculum, Gelpi retractor, sponge sticks, Allis clamp); and
- have a calibrated underdrape and scale available for the OB nurse to quantify PPH blood loss by weighing all blood-stained or blood-soaked materials (eg, underpads, gowns, sheets, drapes, radiopaque laparotomy sponges) after delivery of the newborn and subtracting the dry weight. For the difference between the dry (ie, before delivery) and wet (ie, after delivery) weights, 1 g is equivalent to 1 mL of blood. This method is more objective and accurate than a visual estimate.16,17

CASE REPORT

A 36-year-old primigravida patient was scheduled for a primary cesarean delivery at 34 weeks' gestation because of placenta accreta. She had a history of fibroid growths in her uterus that required a myomectomy, cystoscopy, and reconstruction of the uterus two years before her current pregnancy. An ultrasound performed at 28 weeks' gestation revealed an anterior uterine mass that was likely the regrowth of a fibroid, and placenta accreta. The patient's OB provider confirmed this diagnosis with magnetic resonance imaging.

The perinatologist's recommendation to the obstetrician was to deliver the infant between 34 and 35 weeks' gestation because of the placenta accreta and subsequent risk to both the mother and the fetus. The obstetrician consulted with the interventional radiologist upon diagnosis of placenta accreta. They developed a plan of care that included inserting balloons into the patient's uterine arteries in the IR department on the day of the cesarean delivery and transferring her directly to the OR in a supine position to prevent movement of the balloons. The OB team planned to perform the cesarean delivery in the OR rather than on the L&D unit in case it became necessary to perform an immediate hysterectomy. The patient, her husband, and other family members discussed placental implantation issues and possible outcomes with her obstetrician and agreed to the plan of care.

Two weeks before the scheduled delivery date, the patient came to the L&D unit and the L&D nurse administered 12 mg of betamethasone intramuscularly. The medication was given for two doses 24 hours apart to enhance fetal lung maturity. A second regimen was given 24 and 48 hours before the patient was admitted for the cesarean delivery. The OB nurse worked closely with the RN circulator to make sure the necessary supplies, equipment, and personnel were available in the OR. Labor and delivery staff members transferred specialized maternal and infant equipment and supplies to the OR.

After the patient was admitted to the L&D unit, personnel drew blood from her for laboratory studies, and four units of packed red blood cells were placed on hold for her in the blood bank. The L&D nurse obtained IV access at two sites with large-bore angiocatheters to allow for blood administration as needed. The L&D nurse also monitored the fetal heart rate and uterine activity with an external fetal monitor for 30 minutes before transferring the patient to the IR department. In the IR department, the interventional radiologist administered a local anesthetic.
He then placed balloon occlusion catheters in the bilateral hypogastric arteries. The balloons were sutured in place and left deflated. The IR nurse monitored the maternal vital signs and the L&D nurse assessed the fetal heart rate intermittently throughout the procedure.

The patient was then transferred to the OR for a primary cesarean delivery under epidural anesthesia. After anesthetic medications were administered through the epidural catheter, the L&D nurse used a doppler to auscultate and verify the fetal heart rate. Shortly after the obstetrician made the incision, he delivered a female infant from a breech presentation. During the procedure, it became necessary to inflate the balloons that had been placed in the IR department to occlude blood flow in the hypogastric arteries and control bleeding. The anesthesia professional also administered 500 mL of albumin intraoperatively. A neonatologist and a nurse from the special care nursery (SCN) immediately attended to the newborn. After both parents saw the infant, she was transferred to the SCN for monitoring and observation because of her gestational age.

The obstetrician removed the placenta, which had grown through the myometrium and was diagnosed as a placenta percreta. The obstetrician discovered a degenerating myoma during uterine closure and performed a left cornual resection, lysis of adhesions, omentectomy, and excision of a right paratubal cyst.

Postoperative laboratory testing showed that the patient's hemoglobin had dropped from 11.3 g/dL to 6 g/dL because of a 1,500-mL blood loss during the surgical procedure. After receiving four units of packed red blood cells and four units of fresh frozen plasma, the patient's hemoglobin increased to 10.1 g/dL with a hematocrit of 29%.

After spending five to six hours in the postanesthesia care unit, the patient was transferred to the intensive care unit for continuous monitoring. After an additional 24 hours in the intensive care unit, the interventional radiologist deflated the balloons halfway and the critical care nurses monitored the patient for any additional bleeding. Her condition remained stable, and she was transferred to the postpartum unit approximately 36 hours postoperatively. The patient continued to improve, and no additional bleeding was noted. Her complete blood count was monitored throughout her stay; her hemoglobin and hematocrit values remained stable at 10.1 g/dL and 29%, respectively. She was discharged from the hospital in stable condition. The newborn remained under the care of the SCN nurses and physicians for several weeks. The consensus among the health care team was that without the involvement of the IR team, the patient probably would have required a hysterectomy.

**CONCLUSION**

Interventional radiology may be indicated for the prevention and treatment of PPH either before delivery in cases of known placental abnormalities and implantation or after delivery when the patient is hemorrhaging. Obstetric nurses should maintain strong assessment skills and a thorough understanding of life-saving interventions needed for PPH. Being prepared to intervene when PPH occurs can improve patient outcomes and quality of care. Obstetric organizations are setting standards that encourage L&D nurses and physicians to work collaboratively with IR personnel and perioperative services. Effective communication and interdisciplinary care can help ensure prompt recognition of and timely intervention for patients with PPH.

**REFERENCES**


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