

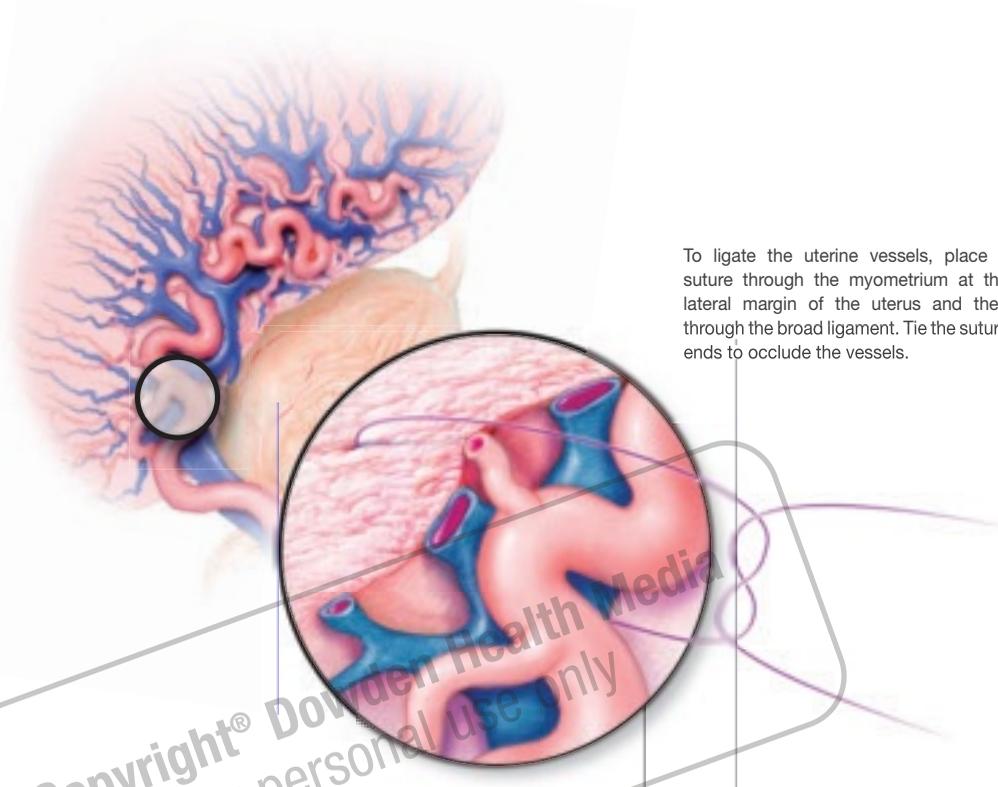
Michael L. Stitely, MD

Assistant Professor,
Department of Obstetrics and
Gynecology, West Virginia University
School of Medicine, Morgantown, WVa

Robert B. Gherman, MD

Director of Maternal-Fetal Medicine,
Prince George's Hospital Center,
Cheverly, Md

*The authors report no financial
relationships relevant to this article.*



To ligate the uterine vessels, place a suture through the myometrium at the lateral margin of the uterus and then through the broad ligament. Tie the suture ends to occlude the vessels.

Obstetric emergencies

**Postpartum hemorrhage
Solutions to 2 intractable cases**

A stepwise approach to bleeding caused by persistent uterine atony and placental abnormalities

CASE 1 Uterine atony leads to heavy bleeding

A 21-year-old nulliparous patient at 41 weeks' gestation delivers vaginally after a prolonged second stage and chorioamnionitis. After placental separation, profound uterine atony is noted, and the patient begins to hemorrhage. The atony is unresponsive to bimanual massage, intravenous oxytocin, and intramuscular methylergonovine.

What can be done to stanch the flow?

Postpartum hemorrhage remains a leading cause of maternal death in the United States, and most cases are the direct con-

sequence of uterine atony. As such, they generally respond to the timely administration of IV oxytocin or uterotonics. In this article, we focus on uncommon aspects of postpartum hemorrhage—such as bleeding that persists despite these basic maneuvers, as happened in Case 1.

STEP 1 Identify source of bleeding, administer uterotonic drugs

Three prostaglandins are among the uterotonic drugs available to clinicians for treating uterine atony (TABLE 1):

Carboprost tromethamine, a synthetic

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derivative of prostaglandin F₂, acts as a smooth-muscle constrictor. It can be injected intramuscularly or directly into the myometrium. Avoid carboprost tromethamine in patients with reactive airway disease, because it can cause bronchial smooth muscle to constrict.

Prostaglandin E₂, also known as dinoprostone, is available as a 20-mg vaginal suppository that should be administered rectally for postpartum hemorrhage to prevent the dose from being washed away by excessive blood flow. Dinoprostone is approved by the Food and Drug Administration (FDA) as an abortifacient and works by causing contraction of the smooth muscle of the uterus. Limitations include its high prevalence of side effects, including nausea, vomiting, fever, and diarrhea.

Misoprostol, a synthetic analogue of prostaglandin E₁, is FDA-approved for prevention of gastric ulcers. It is highly potent, stable at room temperature, inexpensive, and rapidly absorbed through oral, vaginal, and rectal routes of administration.¹ For treatment of postpartum uterine atony, place a dose of 1,000 µg (five 200-µg tablets) rectally. Uterine tone should improve within 3 minutes.²

For a list of other drugs and devices recommended for the labor and delivery suite, see **TABLE 2**.

STEP 2 Apply direct pressure to the uterine cavity

If uterotonic medications fail to control bleeding and improve uterine tone, apply direct pressure to the uterine cavity by packing it with gauze^{3,4} or inserting a Bakri tamponade balloon device (*Cook Women's Health, Spencer, Ind*).⁵

Uterine packing. The goal is to place direct pressure on all surfaces of the uterine cavity. This can be accomplished easily when the cervix has been fully dilated after vaginal delivery. Unfurl multiple rolls of moistened Kerlix gauze and evenly pack and cover the entire uterine cavity.

TABLE 1

Uterotonic drugs: Instructions and cautions		
DRUG	DOSAGE AND ROUTE	PRECAUTIONS
Oxytocin	10 U IM or 10–40 U in 1,000 mL of a balanced salt solution by IV infusion	Avoid infusing large doses (10–20 mL/min) for long periods due to antidiuretic effects of oxytocin
Methylergonovine	0.2 mg IM	Avoid if hypertension is present Avoid IV administration
Carboprost tromethamine	0.25 mg IM	Avoid in patients with asthma, cardiac, renal, or hepatic disease
Dinoprostone	20 mg rectally or intravaginally	Avoid in patients with cardiac, renal, or hepatic disease
Misoprostol	1,000 µg rectally	Avoid in patients with renal or hepatic failure

TABLE 2

Tools for the well-prepared labor and delivery unit	
ITEM	APPLICATION
Uterotonic drugs (see TABLE 1)	Pharmacotherapy for uterine atony
Gauze rolls and sterile Mayo stand cover	Uterine packing
Bakri balloon	Intrauterine tamponade
Long size 1 chromic suture on larged curved needles	B-Lynch sutures (see FIGURE 1 , page 70)
Long straight free needles and size 0 chromic suture	Hemostatic square sutures (see FIGURE 2 , page 70)
Topical hemostatic agents: Gelfoam, thrombin, Tisseel, FloSeal	Topical hemostasis

Be sure to place the initial rolls of gauze high in the fundus, or blood may accumulate undetected behind the packing.

We begin by placing a sterile Mayo stand cover into the uterus, then apply packing inside the stand cover. This technique facilitates removal of the gauze and minimizes trauma to the endometrium (the packing does not stick to the uterine cavity when it is removed). Be sure to tie the ends of the gauze rolls together when using more than 1 roll.

CONTINUED

These 5 topical or systemic agents can control venous bleeding and oozing

Absorbable gelatin sponge

Venous bleeding or oozing from the uterine incision that is unresponsive to suturing can often be contained by placing a piece of absorbable gelatin sponge (Gelfoam; Pfizer, New York City) over the bleeding site. Cut the sponge to fit the size of the bleeding site and hold it in place for 10 to 15 seconds. Leave the sponge in place once bleeding is controlled.

Topical thrombin

When application of gelatin sponge alone does not bring about hemostasis, try topical thrombin (Thrombin-JMI; Jones Pharma, Bristol, Va). This product is supplied as a kit that includes the active ingredient in powder form plus a diluent. The powder is diluted at a strength of 1,000 U/mL, and the mixture is sprayed onto a gelatin sponge and placed at the site of the bleeding. Do not inject thrombin solution! Complete resorption of the gelatin sponge occurs in 4 to 6 weeks.

Gelatin matrix thrombin solution

Another useful topical agent is FloSeal (Baxter Healthcare, Deerfield, Ill), which is supplied as a bovine-derived gelatin matrix that is mixed with a bovine thrombin solution to create a foam matrix, which is then applied directly to the bleeding site. Unlike thrombin-soaked gelatin sponge, FloSeal can be applied directly to arterial bleed-

ing. Because this product requires the presence of fibrinogen within the patient's blood, its utility is limited in patients with hypofibrinogenemia.

Fibrin sealant

This topical agent (Tisseel; Baxter Healthcare) is useful even in patients with coagulopathy. It is a mixture of thrombin and concentrated fibrinogen. The product is packaged as 2 separate components with diluents. These diluted components are injected in a dual syringe device and mixed in a Y-connector tube and then applied in a thin layer directly to the site of bleeding. The mixture solidifies within 3 to 5 minutes after application. This product can also be used to reapproximate tissues.

Recombinant factor VIIa

This promising systemic agent (NovoSeven; Novo Nordisk US, Princeton, NJ) binds to tissue factors that are exposed at sites of vessel injury.¹⁵ It can be administered in cases of life-threatening hemorrhage and is helpful even in the presence of dilutional or consumptive coagulopathy. A dose of 70–90 µg/kg is administered IV and can be repeated in 10 to 15 minutes if bleeding is not controlled.¹⁶ The high cost of this potentially life-saving product may preclude community hospital blood banks from stocking it routinely.

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Recombinant factor VIIa can help control hemorrhage even in the presence of dilutional or consumptive coagulopathy

Remove the packing 24 to 36 hours after placement. We remove the gauze in an operating room in case additional maneuvers are needed to control recurrent hemorrhage.

The Bakri balloon is a large Silastic balloon with a capacity of 500 mL that is designed to provide intrauterine tamponade for bleeding caused by atony, placenta previa, or focal placenta accreta. It has also been used to control hemorrhage associated with cervical ectopic pregnancy.⁵

A port with a lumen on the device makes it possible to assess the state

of hemorrhage. The balloon is placed through the cervix and into the uterus after vaginal delivery, or in reverse fashion during cesarean delivery. It is then filled with saline to apply pressure to the bleeding surfaces of the endometrium.

Once the balloon is inflated, observe the catheter port for signs of continued hemorrhage. If bleeding remains brisk, further intervention will be necessary to control the hemorrhage. If bleeding slows appreciably, the balloon tamponade is likely to be successful and the patient can be observed.

CONTINUED

Leave the balloon in place for 24 to 36 hours, then deflate it incrementally. If bleeding recurs when you deflate the balloon, reinflate it and leave it in place longer.

STEP 3 Control the blood supply to the uterus

If packing or tamponade is unsuccessful, the next step is radiographic uterine artery embolization or surgical ligation of the uterine blood supply with O'Leary sutures,⁶ followed by utero-ovarian vessel ligation, if necessary.⁷

Uterine artery embolization is an effective method of decreasing blood flow to the uterus. Only facilities with readily available interventional radiology services can perform the procedure, however, and the patient must be stable enough for transfer to the radiology suite. Because most cases of postpartum hemorrhage involve profuse blood loss, radiographic embolization is limited to cases of slow but continuing uterine blood loss.

Surgical ligation of the uterine blood supply is particularly useful. It requires a laparotomy incision after vaginal delivery but is easily performed at the time of cesarean delivery:

1. Create the bladder flap and mobilize the bladder inferiorly
2. Place a suture approximately 1 to 2 cm inferior to the level at which a low transverse uterine incision would be placed during cesarean delivery. This is done by pulling the broad ligament laterally using the thumb and index and middle fingers, and placing size 0 chromic suture, anterior to posterior, through the myometrium at the lateral margin of the uterus
3. Pass the suture through the broad ligament, posterior to anterior, staying well medial to the course of the ureter
4. Tie the suture to occlude the uterine vessels
5. Repeat on the opposite side.

If this procedure does not reduce the hemorrhage substantially, perform a high uterine artery ligation. This technique is identical to the inferior vessel ligation, but is performed approximately 5 cm superior to the first ligation site.

If these steps fail to reduce bleeding significantly, ligate the utero-ovarian blood supply bilaterally in similar fashion.

STEP 4 Place uterine compression sutures

The uterus can be externally compressed by the strategic placement of sutures.

The B-Lynch technique⁸ begins with placement of a long size 1 chromic suture on a large curved needle through the anterior lateral aspect of the myometrium just below the repaired uterine incision during a cesarean delivery (**FIGURE 1**, page 70). (It is placed in the same anatomic location in the absence of a hysterotomy.) The suture then exits just above the uterine incision.

The suture is directed over the anterior surface of the myometrium, over the fundus, and down the posterior wall of the uterus, before reentering the myometrium at the inferior posterior lateral edge of the uterus and crossing horizontally to the opposite edge. The suture is then brought up over the posterior myometrium, over the fundus, and back across the anterior myometrium. It then reenters the anterior myometrium just above the uterine incision and exits just below it. The 2 free ends are tied together under tension while a surgical assistant manually compresses the uterus.

To determine the degree of blood loss, visually inspect the vagina. If the technique has been successful, close the abdomen and give the patient a uterotonic for 24 hours. Also, monitor urine output, hemoglobin, and hematocrit carefully and inspect the vagina frequently for blood loss.

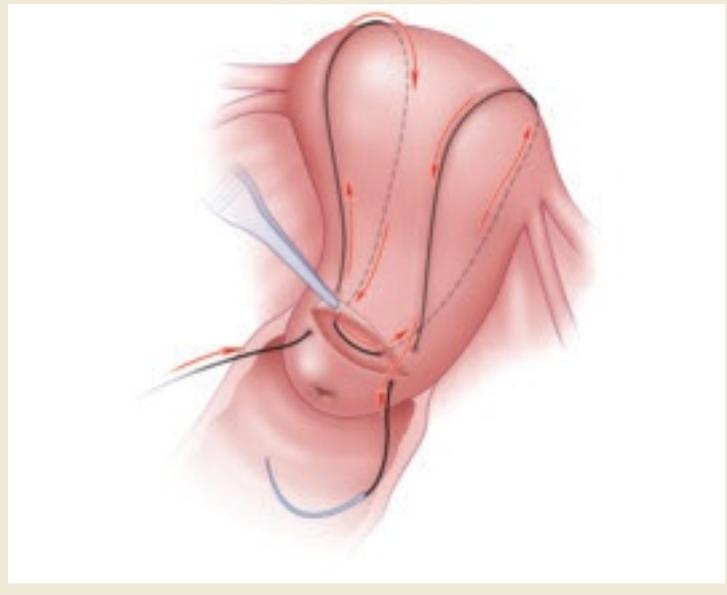
The square-suture technique, described by Cho and colleagues,⁹ is also useful

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Radiographic embolization of the uterine artery is best suited to cases of slow but continuing blood loss

FIGURE 1

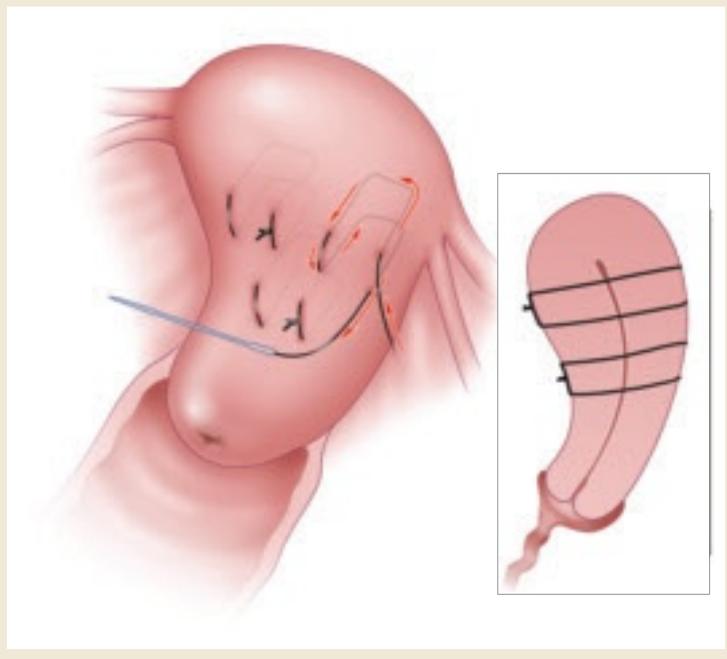
Compress the uterus with the B-Lynch technique



Pass long size 1 chromic suture through the anterior uterine wall just below and above the usual site of a low-transverse incision, wrap the suture around the anterior and posterior uterine walls, and pass through the posterior wall opposite the entry point. Wrap the suture again and finish near the entry point on the anterior wall. Tie the ends tightly with the uterus under compression.

FIGURE 2

**Compression option:
Square-suture technique**



Using size 1 chromic catgut suture on a free, long, straight Keith needle, stitch the anterior and posterior uterine walls together in 3 to 5 small squares. The ends of each square are then tied tightly while an assistant compresses the uterus from anterior to posterior.

(FIGURE 2). It involves placement of size 1 chromic catgut suture using a free, long, straight Keith needle in the following steps:

1. Pass the suture through the myometrium, anterior to posterior
2. Pass the suture through the myometrium again, posterior to anterior, approximately 4 to 6 cm medial to the exit point of the first pass
3. Place the suture 4 to 6 cm inferior and pass it through the myometrium yet again, anterior to posterior
4. Pass the suture through the myometrium, posterior to anterior, 4 to 6 cm lateral to the last exit point
5. Tie the 2 free ends together under tension while a surgical assistant compresses the uterus in the anterior-to-posterior direction.

Place 3 to 5 of these sutures across the surface of the uterus until the resulting compression relieves the hemorrhage. Before closing the abdomen, inspect the vagina carefully to confirm the success of the procedure.

Both the B-Lynch and square-suture techniques are intended to preserve the patient's fertility. If the patient has completed childbearing, consider prompt hysterectomy instead.

**STEP 5
Perform hysterectomy**

If compression sutures and devascularization of the uterus fail to control the hemorrhage, hysterectomy is the next step.

**CASE 2 Attached placenta
exacerbates bleeding**

A 36-year-old gravida 4 para 3 with 3 prior cesarean deliveries presents at 36 weeks' gestation with heavy vaginal bleeding. A sonogram performed earlier in the pregnancy revealed an anterior placenta previa. The patient undergoes emergent cesarean delivery for continued brisk bleeding, but the placenta fails to detach from the uterus.

How would you proceed?

Images: Rob Flewell

CONTINUED

Temporary abdominal closure is damage control for hemorrhagic catastrophes

Not all hospitals have the facilities or blood-bank capacity to manage hemorrhagic catastrophes, so temporizing measures to stabilize the patient may be necessary, followed by transfer to a tertiary center.

Temporary abdominal closure is a useful strategy for uncontrollable intra-abdominal hemorrhage or coagulopathy. It involves packing the bleeding site with sterile laparotomy pads and sealing it with an occlusive dressing.

To begin, place a sterile x-ray cassette cover into the peritoneal cavity to cover any exposed bowel. Then place moist sterile towels over the cassette cover and any exposed subcutaneous tissue. Place 2 suction drains on top of the towels. Cover the towels and drains with an occlusive adhesive dressing such as an Ioban (3M Healthcare, St Paul, Minn). Attach the drains to wall suction to achieve temporary abdominal closure (see photo).¹⁷

Transfer the patient to an intensive care unit for warming, fluid and blood replacement, and correc-

tion of acidosis and coagulopathy. Once the acidosis and coagulopathy are reversed, take the patient back to the operating room for removal of the packing and abdominal closure.

If intensive care facilities are unavailable, the patient can be transferred to a tertiary care center following temporary closure.



Photo courtesy Alison Wilson, MD

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If only a small area of the placenta is firmly adherent to the uterus, an attempt to remove or excise it is reasonable

STEP 1 Attempt to separate the placenta from the uterus

Gently attempt to manually develop a separation plane between the placenta and uterus. If this proves impossible at all surfaces of the placenta, the accreta is global, and hysterectomy is warranted in most cases.

If placenta accreta or percreta is strongly suspected before delivery, avoid attempts to deliver the placenta and proceed to hysterectomy or planned retention.

STEP 2 Perform hysterectomy or planned retention

If a separation plane can be developed between the placenta and uterus, and only a small area is firmly adherent, the accreta is focal. An attempt to remove or excise the focally adherent placenta is reasonable. The attachment site can be oversewn to control bleeding, and the

hemostatic square-suture technique or Bakri balloon may be helpful.

In a case series, Nishijima and colleagues¹⁰ described successful removal of the adherent placenta in 2 patients under direct visualization by inverting the uterus through a large midline uterine incision.

Kayem and colleagues¹¹ described ligation of the umbilical cord close to the placental insertion, with the placenta left in the uterus. They reviewed the records of all patients with the diagnosis of placenta accreta during 2 time frames:

- when management involved immediate hysterectomy
- when management was conservative with the placenta left in utero.

During conservative management, 3 of 20 patients underwent hysterectomy—1 at the patient's request, 1 at the time of delivery due to hemorrhage, and 1 for bleeding on postoperative day 26 due to endometritis. The rates of disseminated intravascular coagulation and transfusion

were lower during conservative management. Two women who underwent conservative management had subsequent successful pregnancies. One of these patients had 2 subsequent pregnancies, both complicated by placenta accreta that was again managed conservatively.

Long-term morbidity of conservative management is unclear

Because of the small number of cases reported, long-term morbidity and mortality rates due to hemorrhage or infection are unknown. Therefore, conservative management should be undertaken with extreme caution! Patients who have completed childbearing should be managed by hysterectomy.

In some cases, conservative management of placenta accreta may serve as a temporizing measure to allow for transfer to a higher level of care when immediate postpartum hysterectomy is not safe or feasible.

When the bladder is involved

When placenta percreta involves the urinary bladder, conservative management may be the only safe option because of the irreparable harm that could occur to the lower urinary tract during hysterectomy.¹² (Imagine the urinary tract injuries that could occur during hysterectomy for the patients in **FIGURE 3A and B!**)

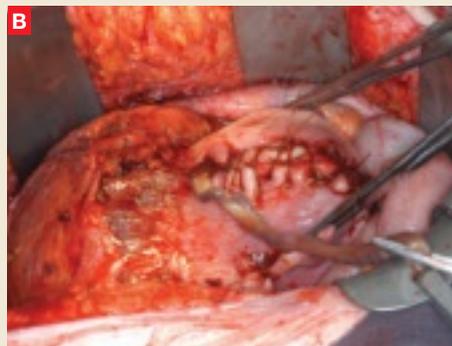
In these cases, conservative management involves delivering the fetus through a classical uterine incision, ligating the umbilical cord close to the placental insertion, and closing the uterine incision. Avoid attempts to remove the placenta. Give the patient a broad-spectrum prophylactic antibiotic such as amoxicillin/clavulanic acid for 10 days.¹¹ Assess the patient weekly for 6 weeks with ultrasonography, clinical examination, and a white blood cell count with differential (to assess for signs of infection). It may take 6 to 10 months for the placenta to be entirely reabsorbed.

FIGURE 3

Bladder wall involvement



This ultrasonographic image shows placenta percreta involving the posterior bladder wall.



Placenta percreta that has eroded through the entire lower uterine segment and into the bladder. Photo from Stoehr E, Stittely M. Placenta percreta diagnosed antenatally with magnetic resonance imaging. *The Female Patient*. 2005; 30:37-39. Used with permission.

Manage blood replacement

Few community hospitals keep a large reserve of blood products in stock. A massive obstetric hemorrhage can rapidly deplete blood-bank stores and necessitate transferring the patient or obtaining products from other hospitals or facilities. For this reason, the blood bank should be notified of postpartum hemorrhage as soon as possible, and the possibility of using emergency-release, type-specific blood should be discussed with blood-bank medical personnel.

When to transfuse red blood cells

Administer packed red blood cells (RBCs) if the hemorrhage is profuse and ongoing or if the patient is hemodynamically unstable. Each unit of packed RBCs increases the hematocrit by approximately

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When placenta percreta involves the bladder, retention of the placenta may be the only safe option

3% and raises the hemoglobin level by approximately 1 g.

If coagulopathy is suspected, or the patient has received more than 6 to 8 U of packed RBCs, consider transfusing fresh frozen plasma.

Blood studies are also indicated

Send blood to the laboratory for measurement of prothrombin time (PT), partial thromboplastin time (PTT), and fibrinogen. If the hospital is not equipped to measure fibrinogen, perform a rapid-clot observation test¹³ by filling a plain, red-top tube with blood and observing it for clotting. If a clot forms in 8 to 10 minutes and remains intact, the test is normal. When the fibrinogen level is less than 150 mg/dL, the blood will not clot or the clot will dissolve in 30 to 60 minutes.

This rapid test can guide the decision to infuse fresh frozen plasma. Each unit of fresh frozen plasma raises the fibrinogen level by 10 mg/dL. The goal is to keep the fibrinogen level above 100 mg/dL.

Platelet count often declines during hemorrhage

When blood loss is ongoing, try to keep the platelet count above $50 \times 10^3/\mu\text{L}$. Each unit of platelets will increase the platelet count by $5\text{--}10 \times 10^3/\mu\text{L}$. However, platelets are rapidly destroyed after transfusion, so continue to assess hemoglobin level, hematocrit, platelet count, and coagulation parameters. Also, check calcium and electrolyte levels, and correct levels after the transfusion of every 4 U of blood.

Cell-saver technology is an option for management of postpartum hemorrhage, once the surgical field has been cleared of amniotic fluid.¹⁴

Volume replacement can be accomplished with concurrent administration of crystalloid or other volume expanders, such as hetastarch (Hespan) or albumin.

Monitor urine output to gauge the adequacy of volume replenishment.

Consider contacting a referral center about patient transfer or additional blood products if bleeding is ongoing or coagulation defects persist. ■

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Each unit of packed red blood cells increases the hematocrit by about 3% and raises the hemoglobin level by about 1 g