

**American College of Radiology
ACR Appropriateness Criteria®
Postpartum Hemorrhage**

Variant: 1 Postpartum hemorrhage. Early (within first 24 hours) after cesarean delivery. Initial Imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler pelvis	Usually Appropriate	○
US pelvis transabdominal	Usually Appropriate	○
US pelvis transvaginal	Usually Appropriate	○
CT abdomen and pelvis with IV contrast	May Be Appropriate	⦿⦿⦿
CT abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	⦿⦿⦿⦿
CTA abdomen and pelvis with IV contrast	May Be Appropriate	⦿⦿⦿⦿
MRI pelvis without and with IV contrast	Usually Not Appropriate	○
MRI pelvis without IV contrast	Usually Not Appropriate	○
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⦿⦿⦿

Variant: 2 Postpartum hemorrhage. Early (within first 24 hours) after vaginal delivery. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler pelvis	Usually Appropriate	○
US pelvis transabdominal	Usually Appropriate	○
US pelvis transvaginal	Usually Appropriate	○
CT abdomen and pelvis with IV contrast	May Be Appropriate	⦿⦿⦿
CT abdomen and pelvis without IV contrast	May Be Appropriate	⦿⦿⦿
CT abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	⦿⦿⦿⦿
CTA abdomen and pelvis with IV contrast	May Be Appropriate	⦿⦿⦿⦿
MRI pelvis without and with IV contrast	Usually Not Appropriate	○
MRI pelvis without IV contrast	Usually Not Appropriate	○

Variant: 3 Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after caesarian delivery. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler pelvis	Usually Appropriate	○
US pelvis transabdominal	Usually Appropriate	○
US pelvis transvaginal	Usually Appropriate	○
MRI pelvis without and with IV contrast	May Be Appropriate	○
MRI pelvis without IV contrast	May Be Appropriate (Disagreement)	○
CT abdomen and pelvis with IV contrast	May Be Appropriate	⦿⦿⦿
CT abdomen and pelvis without IV contrast	May Be Appropriate	⦿⦿⦿
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	⦿⦿⦿⦿
CTA abdomen and pelvis with IV contrast	May Be Appropriate	⦿⦿⦿⦿

Variant: 4 Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after vaginal

delivery. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler pelvis	Usually Appropriate	○
US pelvis transabdominal	Usually Appropriate	○
US pelvis transvaginal	Usually Appropriate	○
MRI pelvis without and with IV contrast	May Be Appropriate (Disagreement)	○
MRI pelvis without IV contrast	May Be Appropriate (Disagreement)	○
CT abdomen and pelvis with IV contrast	May Be Appropriate	☼☼☼
CT abdomen and pelvis without IV contrast	May Be Appropriate	☼☼☼
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☼☼☼☼
CTA abdomen and pelvis with IV contrast	May Be Appropriate	☼☼☼☼

Panel Members

Jennifer W. Uyeda, MD^a; Elizabeth George, MD^b; Caroline Reinhold, MD^c; Esma A. Akin, MD^d; Susan M. Ascher, MD^e; Olga R. Brook, MD^f; Tara L. Henrichsen, MD^g; Patricia C. Henwood, MD^h; Lee A. Learman, MD, PhDⁱ; Katherine E. Maturen, MD, MS^j; Michael N. Patlas, MD^k; Jessica B. Robbins, MD^l; Elizabeth A. Sadowski, MD^m; Carl Saphier, MDⁿ; Darci J. Wall, MD^o; Phyllis Glanc, MD.^p

Summary of Literature Review

Introduction/Background

Postpartum hemorrhage (PPH) is among the top three causes of maternal death in the United States and accounts for 27% of all maternal deaths worldwide [1,2]. PPH affects 1% to 5% of all deliveries and may be life-threatening. PPH in the first 24 hours after delivery is termed primary or early PPH, whereas after 24 hours to 6 weeks it is termed secondary, late, or delayed PPH. Although classically, PPH has referred to pregnancies delivered beyond 20 weeks of gestation, the definition may be expanded to include hemorrhage post terminations or early pregnancy loss [3]. PPH is defined as any hemorrhage associated with signs or symptoms of hypovolemia within 24 hours of delivery, regardless of the type of delivery [4].

Many of the causes of primary PPH are diagnosed clinically, such as uterine atony, lower genital tract laceration with palpable perineal or vaginal hematomas, and coagulopathy. However, imaging plays a crucial role in the diagnosis of many other causes of primary PPH such as adherent placenta, retained products of conception (RPOC) with or without superimposed infection, bladder flap hematoma, subfascial/prevesical hematoma (secondary to epigastric vessel injury or direct tear of the rectus muscle), uterine rupture/scar dehiscence, and vascular uterine anomalies (VUA). Causes of secondary PPH include uterine atony, VUA, placental attachment disorders (please see the ACR Appropriateness Criteria[®] topic on "[Placenta Accreta Spectrum Disorder](#)" [5]), and rarely gestational trophoblastic disease (please see the ACR Appropriateness Criteria[®] topic on "[Gestational Trophoblastic Disease](#)" [6] for further guidance).

Conservative measures such as uterine tamponade with either packing or balloon catheter and massage, uterotonic medications, and correction of coagulopathies are the first line of treatment.

Once a specific diagnosis has been identified, tailored intervention such as curettage for RPOC, embolization for VUA, antibiotics for infection, evacuation of large bladder hematoma, or surgical repair for uterine rupture can be performed. Uterine artery embolization, surgical ligation of uterine/internal iliac arteries, or hysterectomy may be necessary if these measures fail. Of special note is the evolving diagnosis and management of VUA. Myometrial VUA are believed to represent subinvolution of the placental bed, may be associated with RPOC, and will resolve either with removal of RPOC or expectant management in most patients. Timmerman et al [7] has reported an increased risk of significant PPH in those areas of intense myometrial vascularity with peak systolic velocity >83 cm/s. A subsequent report by the same group indicated surgical removal of RPOC would also result in almost immediate resolution of these areas of intense myometrial vascularity [8,9]. Multidisciplinary consultation may aid in optimal management protocols in this group of patients with VUAs, RPOC, and PPH.

Special Imaging Considerations

For the purposes of distinguishing between CT and CT angiography (CTA), ACR Appropriateness Criteria topics use the definition in the [ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography \(CTA\)](#) [10]:

"CTA uses a thin-section CT acquisition that is timed to coincide with peak arterial or venous enhancement. The resultant volumetric dataset is interpreted using primary transverse reconstructions as well as multiplanar reformations and 3-D renderings."

All elements are essential: 1) timing, 2) reconstructions/reformats, and 3) 3-D renderings. Standard CTs with contrast also include timing issues and recons/reformats. Only in CTA, however, is 3-D rendering a **required** element. This corresponds to the definitions that the CMS has applied to the Current Procedural Terminology codes.

Pelvic angiography has not been included in this document because the clinical utility of pelvic angiography has a very limited role as an isolated diagnostic imaging study. Pelvic angiography in the setting of PPH is primarily used to perform therapeutic interventions, which is not within the scope of this document.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Postpartum hemorrhage. Early (within first 24 hours) after cesarean delivery. Initial Imaging.

The most common cause of early PPH is related to uterine atony or lack of effective uterine contraction after delivery and is typically a clinical diagnosis in >75% of patients. It is initially treated by uterine massage and uterotonic drugs such as oxytocin, and the majority of patients respond well to these treatments. In the setting of cesarean section, because the abdomen is already open, surgical procedures to control intraoperative and immediate hemorrhage such as uterine or ovarian artery ligation or uterine compression sutures may be utilized. If there is no response, additional considerations would include associated RPOC, adherent placentation, or even uterine inversion, and in these situations, imaging may be helpful. About 1% of third trimester deliveries are complicated by RPOC [11] and is the second most common etiology for PPH after uterine atony; although, this is typically seen in the delayed PPH population. The diagnosis of RPOC is helpful to the clinician in determining whether surgical intervention is warranted. Trauma-related hemorrhage may be due to lacerations, uterine rupture, or incision extensions. Imaging may be helpful to delineate the extent of intra-abdominal hemorrhage, whereas infralevator or perineal hemorrhage may be evaluated on visual inspection. Coagulopathy, either inherited or acute related to amniotic fluid embolism, placental abruption, severe pre-eclampsia or hemolysis, elevated liver enzymes, and low platelet count (HELLP) syndrome, is less common but potentially life threatening. There is a long list of risk factors associated with uterine atony, which is not within the scope of this document.

Variant 1: Postpartum hemorrhage. Early (within first 24 hours) after cesarean delivery. Initial Imaging.

A. CT Abdomen and Pelvis

In the setting of hemorrhage, the primary role of CT is to determine whether active ongoing hemorrhage is present, to localize the bleeding, and to identify the source, which is best accomplished with a CT with intravenous (IV) contrast. There is little clinical utility in a noncontrast CT or CT with and without IV contrast in the setting of active ongoing hemorrhage. In hemodynamically stable patients when conventional medical treatment has been unsuccessful in terminating hemorrhage, further evaluation with CT can be considered, particularly in suspected intra-abdominal hemorrhage or postsurgical complications [12]. CT has a role in identifying surgical causes of PPH, which will not benefit from empiric embolization such as uterine rupture and genital tract laceration.

Although uterine atony is a clinical diagnosis, CT can be helpful by detecting a hematoma within the cavity of an enlarged uterus [13] and excluding other causes of PPH. However, it can be difficult to differentiate blood products from RPOC [12].

CT can detect vascular complications such as bladder flap, subfascial, or perivaginal space hematoma and delineate relationship to adjacent organs (supralevator versus infralevator location in the perivaginal space) [14,15]. Small (<4 cm) subfascial and bladder flap hematomas may not be clinically significant [15]. A >5 cm bladder flap hematoma should raise suspicion for uterine dehiscence, characterized by disruption of the endometrial and myometrial layers with an intact serosal layer [15,16]. Low correlation between clinical and radiologic findings of dehiscence have been noted, and it is important not to interpret hypodense edema at the cesarean incision site as dehiscence in the first postpartum week [15]. Presence of gas in the myometrial defect extending

from the endometrium to the parametrial tissue along with hemoperitoneum are findings suggestive of uterine rupture [15].

Variant 1: Postpartum hemorrhage. Early (within first 24 hours) after cesarean delivery. Initial Imaging.

B. CTA Abdomen and Pelvis

Persistent hemorrhage after empiric embolization is an indication for CTA [12]. Active extravasation is seen in 41% to 74% cases of PPH on CTA [17] and multiphasic CT, including a noncontrast arterial and portal venous phases, has excellent accuracy of 97% [18] for detection of the site of active extravasation, similar to that of gastrointestinal hemorrhage [17,18]. CTA can be falsely positive because of dilated tortuous hypertrophic uterine arteries mimicking extravasation and be falsely negative in atony because of slow intermittent hemorrhage [12,18]. CTA also enables comprehensive evaluation of abdominopelvic vasculature, including vessels not often evaluated on routine angiography such as the ovarian and inferior epigastric arteries [18].

Serpiginous myometrial vessels and prominent parametrial vessels can be a sign of VUA [19], whereas the presence of a pseudoaneurysmal sac is a more specific finding [14,20,21]. CTA can also identify and localize the feeding arteries of arteriovenous malformation (AVM) for treatment planning [14]. However, CTA cannot reliably distinguish acquired VUA from failure of obliteration/subinvolution of the placental bed vessels, assess its severity, or need for intervention [19].

Variant 1: Postpartum hemorrhage. Early (within first 24 hours) after cesarean delivery. Initial Imaging.

C. MRI Pelvis

MRI is not commonly used in significant life-threatening early PPH as CT, in part related to access and time required to perform the study in an acute setting. MRI has an important role to play in distinguishing and/or confirming uterine dehiscence versus rupture, in particular when it is confusing on ultrasound (US) or CT.

Although RPOC can be seen as an intracavitary mass with variable signal characteristics, distinction from blood products is limited in the absence of contrast administration. MRI is better than CT and US in detecting the myometrial defect with intact serosal layer in uterine dehiscence because of superior soft-tissue contrast [14,15]. However, in the immediate postpartum period, the cesarean section incision can be T1 and T2 hyperintense and may mimic a dehiscence [22].

Noncontrast MRI can be used to identify bladder flap, subfascial, and deep-seated pelvic hematomas, which depending on the time since delivery may demonstrate variable T1 and T2 signal characteristics [14,23]. The superior spatial resolution of MRI compared to US enables localization of the hematoma (eg, supralelevator versus infralevator location in the perivaginal space) for potential targeted intervention [23].

On MRI fast-spin echo sequences, AVM demonstrates serpiginous signal voids with prominent parametrial vessels and focal disruption of the junctional zone [14]. VUA can also be seen on MRI fast-spin echo sequence as serpiginous signal voids with prominent parametrial vessels, whereas the presence of a pseudoaneurysm sac is more specific [14,20]. Failure of obliteration of the placental bed vessels after pregnancy cannot be reliably distinguished from acquired VUA on MRI [19].

Variant 1: Postpartum hemorrhage. Early (within first 24 hours) after cesarean delivery.

Initial Imaging.

D. US Duplex Doppler Pelvis

Transabdominal US is often performed in conjunction with transvaginal US and color or power Doppler and should be considered a single examination. Color and spectral Doppler are commonly employed in pelvic sonography to detect the presence of vascular flow in normal anatomic structures as well as various pathologic lesions. In women with PPH, Doppler improves the specificity and negative predictive value of detecting RPOC by detecting vascularity within a thickened endometrial echo complex [24]. When a pseudoaneurysm is suspected, color and spectral Doppler can detect swirling or yin-yang pattern of blood flow within a hypoanechoic structure [14,20].

Pitfalls in assessment include that absence of vascularity could represent an avascular RPOC [12] and marked vascularity can mimic a pseudoaneurysm, although RPOC generally extends to the endometrium, whereas pseudoaneurysm is restricted to the myometrium [25]. However, it can be difficult to distinguish acquired VUA from subinvolution of the placental bed [19,26] or to assess its severity or need for intervention on US [19]. Although high peak systolic velocities have been used to predict need for intervention, there is considerable overlap [7].

Variant 1: Postpartum hemorrhage. Early (within first 24 hours) after cesarean delivery.

Initial Imaging.

E. US Pelvis Transabdominal

A combined transabdominal and transvaginal approach is usually used in pelvic imaging. The transabdominal approach lends an anatomic overview whereas the transvaginal approach has greater contrast and spatial resolution. See the "US Pelvis Transvaginal" section below for further detail.

Variant 1: Postpartum hemorrhage. Early (within first 24 hours) after cesarean delivery.

Initial Imaging.

F. US Pelvis Transvaginal

A combined transabdominal and transvaginal approach is the primary modality of choice for the investigation of early PPH not responsive to initial conservative measures. Although transvaginal US detection of an echogenic endometrial mass has the highest sensitivity for the detection of RPOC, this is a nonspecific finding that overlaps with the normal postpartum appearance [14]. The most diagnostic combination of US findings is an echogenic endometrial mass that is vascular [27]. The presence of debris and gas is relatively common in the early postpartum period, in as much as 20% to 25%. Thickened endometrial echo complex, up to 2 to 2.5 cm in diameter, is nonspecific in this early postpartum period [28].

US can be used in this setting to assess for coexisting pathology and complications, such as RPOC or hematoma. US can detect most pelvic hematomas [13], including bladder flap hematomas [14,15]. Although uterine scar dehiscence may be seen on US as an irregular thinned uterine wall or a myometrial defect [14], differentiation from the normal appearance of the cesarean section scar can be difficult.

VUA, including uterine artery pseudoaneurysm, are a relatively rare cause of early PPH, occurring particularly in the traumatic setting [19,20], and most commonly arise from the uterine artery. VUA appear as hypoechoic tortuous channels or masses in the myometrium with characteristic Doppler

findings [14,19] with turbulent flow on color Doppler and high-velocity and low-resistance flow on spectral analysis and may be associated with a peripheral echogenic hematoma [20].

It can be difficult to distinguish acquired VUA from subinvolution of the placental bed [19,26] or to assess its severity or need for intervention on US [19]. A dilated vessel in the myometrium may suggest the diagnosis of pseudoaneurysm.

Variant 2: Postpartum hemorrhage. Early (within first 24 hours) after vaginal delivery. Initial imaging.

The most common cause of early PPH is related to uterine atony or lack of effective uterine contraction after delivery and is typically a clinical diagnosis in >75% of patients. It is initially treated by uterine massage and uterotonic drugs such as oxytocin, and the majority of patients respond well to these treatments. If there is no response, additional considerations would include associated RPOC, adherent placentation, or even uterine inversion, and in these situations, imaging may be helpful. About 1% of third trimester deliveries are complicated by RPOC [11] and is the second most common etiology for PPH after uterine atony; although, this is typically seen in the delayed PPH population. The diagnosis of RPOC is helpful to the clinician in determining whether surgical intervention is warranted. Trauma-related hemorrhage may be due to lacerations, uterine rupture, or incision extensions. Imaging may be helpful to delineate the extent of intra-abdominal hemorrhage, whereas infralevator or perineal hemorrhage may be evaluated on visual inspection. Coagulopathy, either inherited or acute related to amniotic fluid embolism, placental abruption, severe pre-eclampsia or HELLP syndrome, is less common but potentially life threatening. There is a long list of risk factors associated with uterine atony, which is not within the scope of this document.

Variant 2: Postpartum hemorrhage. Early (within first 24 hours) after vaginal delivery. Initial imaging.

A. CT Abdomen and Pelvis

In the setting of hemorrhage, the primary role of CT is to determine whether active ongoing hemorrhage is present, to localize the bleeding, and to identify the source, which is best accomplished with a CT with IV contrast. There is little clinical utility in a noncontrast CT or CT with and without IV contrast in the setting of active ongoing hemorrhage. In hemodynamically stable patients, when conventional medical treatment has been unsuccessful in terminating hemorrhage, multiphasic CT can be useful in localizing the source of extravasation for targeted therapy [12,29], particularly in suspected intra-abdominal hemorrhage [12].

Although uterine atony is a clinical diagnosis, CT can be helpful by detecting focal or diffuse arterial or venous oozing and/or hematoma within the cavity of an enlarged uterus [13]. RPOC can be difficult to differentiate from blood products even on multiphase CT [12]. Endometritis is a clinical diagnosis with a nonspecific CT appearance of a thickened heterogeneous endometrium with fluid, gas, and debris within the cavity [15].

CT can detect vascular complications such as supraumbilical and perivaginal space hematoma and delineate the relationship to adjacent organs (supralevator versus infralevator location in the perivaginal space) for targeted intervention [12,14,15,30].

Variant 2: Postpartum hemorrhage. Early (within first 24 hours) after vaginal delivery. Initial imaging.

B. CTA Abdomen and Pelvis

Persistent hemorrhage after empiric embolization is an indication for CTA [12]. Active extravasation is seen in 41% to 74% cases of PPH on CTA [17] and multiphasic CT, including a noncontrast, arterial, and portal venous phases, has excellent accuracy of 97% [18] for detection of the site of active extravasation, similar to that of gastrointestinal hemorrhage [17,18]. CTA can be falsely positive because of dilated tortuous hypertrophic uterine arteries mimicking extravasation and be falsely negative in atony because of slow intermittent hemorrhage [12,18].

Serpiginous myometrial vessels and prominent parametrial vessels can be a sign of VUA [19], whereas the presence of a pseudoaneurysmal sac is a more specific finding [14,20,21]. CTA can also identify and localize the feeding arteries of AVM for treatment planning [14]. However, CTA cannot reliably distinguish acquired VUA from failure of obliteration or subinvolution of the placental bed vessels, assess its severity, or need for intervention [19].

Variant 2: Postpartum hemorrhage. Early (within first 24 hours) after vaginal delivery. Initial imaging.

C. MRI Pelvis

MRI is not as commonly used in significant life-threatening early PPH as CT, in part related to access and to time required to perform the study in an acute setting. MRI has an important role to play in distinguishing and/or confirming uterine dehiscence versus rupture, in particular when it is confusing on US or CT. RPOC can be seen as a variably enhancing intracavitary mass with variable degree of myometrial thinning [13,14].

Patients with difficult vaginal deliveries without large palpable hematomas may benefit from noncontrast MRI to identify deep-seated pelvic hematomas, which, depending on the time since delivery, may demonstrate variable T1 and T2 signal characteristics [14,23]. The superior spatial resolution of MRI compared to US enables localization of hematomas (eg, supralelevator versus infralevator location in perivaginal space) for potential targeted intervention [23].

VUA can be seen on MRI fast-spin echo sequence as serpiginous signal voids with prominent parametrial vessels, whereas the presence of a pseudoaneurysm sac is more specific [14,20]. Failure of obliteration of the placental bed vessels after pregnancy cannot be reliably distinguished from acquired VUA on MRI [19].

Variant 2: Postpartum hemorrhage. Early (within first 24 hours) after vaginal delivery. Initial imaging.

D. US Duplex Doppler Pelvis

Transabdominal US is often performed in conjunction with transvaginal US and color or power Doppler and should be considered a single examination. Color and spectral Doppler are commonly employed in pelvic sonography to detect the presence of vascular flow in normal anatomic structures as well as various pathologic lesions. In women with PPH, Doppler improves the specificity and negative predictive value of detecting RPOC by detecting vascularity within a thickened endometrial echo complex [24]. When a pseudoaneurysm is suspected, color and spectral Doppler can detect swirling or yin-yang pattern of blood flow within a hypoanechoic structure [14,20].

Pitfalls in assessment include that absence of vascularity could represent an avascular RPOC [12] and marked vascularity can mimic a pseudoaneurysm, although RPOC generally extends to the endometrium, whereas pseudoaneurysm is restricted to the myometrium [25]. However, it can be

difficult to distinguish acquired VUA from subinvolution of the placental bed [19,26] or to assess its severity or need for intervention on US [19]. Although high peak systolic velocities have been used to predict need for intervention, there is considerable overlap [7].

Variant 2: Postpartum hemorrhage. Early (within first 24 hours) after vaginal delivery. Initial imaging.

E. US Pelvis Transabdominal

A combined transabdominal and transvaginal approach is usually used in pelvic imaging. The transabdominal approach lends an anatomic overview whereas the transvaginal approach has greater contrast and spatial resolution. See the "US Pelvis Transvaginal" section below for further detail.

Variant 2: Postpartum hemorrhage. Early (within first 24 hours) after vaginal delivery. Initial imaging.

F. US Pelvis Transvaginal

A combined transabdominal and transvaginal approach is the primary modality of choice for the investigation of early PPH not responsive to initial conservative measures. Although transvaginal US detection of an echogenic endometrial mass has the highest sensitivity for the detection of RPOC, this is a nonspecific finding that overlaps with the normal postpartum appearance [14]. The most diagnostic combination of US findings is an echogenic endometrial mass that is vascular [27]. The presence of debris and gas is relatively common in the early postpartum period, in as much as 20% to 25%. Thickened endometrial echo complex, up to 2 to 2.5 cm in diameter, is nonspecific in this early postpartum period [28].

US can detect most pelvic hematomas [13-15]. Rarely, US may demonstrate ovarian vein thrombosis as an echogenic mass within an enlarged ovarian vein [14].

Variant 3: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after caesarian delivery. Initial imaging.

Secondary or late PPH is typically defined as any significant uterine hemorrhage occurring between 24 hours to 6 weeks postpartum. The most common etiologies are RPOC, subinvolution of the placental bed, or infection. RPOCs are more likely after vaginal delivery, whereas postpartum endometritis is more common after cesarean. Less common causes include, but are not limited to, coagulopathy, pseudoaneurysm or AVMs, dehiscent cesarean scar, or gestational trophoblast disease (GTD). Primary PPH is considered a risk factor for secondary PPH.

Variant 3: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after caesarian delivery. Initial imaging.

A. CT Abdomen and Pelvis

In the setting of hemorrhage, the primary role of CT is to determine whether active ongoing hemorrhage is present, to localize the bleeding, and to identify the source, which is best accomplished with a CT with IV contrast. There is little clinical utility in a noncontrast CT or CT with and without IV contrast in the setting of active ongoing hemorrhage. In hemodynamically stable patients, when conventional medical treatment has been unsuccessful in terminating hemorrhage, multiphasic CT can be useful in localizing the source of extravasation for targeted therapy [12,29], particularly in suspected intra-abdominal hemorrhage [12].

CT can detect vascular complications such as bladder flap, subfascial, or perivaginal space

hematoma and delineate relationship to adjacent organs (supralevator versus infralevator location in the perivaginal space) [14,15]. Small (<4 cm) subfascial and bladder flap hematomas may not be clinically significant [15]. A >5 cm bladder flap hematoma should raise suspicion for uterine dehiscence, characterized by disruption of the endometrial and myometrial layers with an intact serosal layer [15,16]. Low correlation between clinical and radiologic findings of dehiscence have been noted, and it is important not to interpret hypodense edema at the cesarean incision site as dehiscence in the first postpartum week [15]. Presence of gas in the myometrial defect extending from the endometrium to the parametrial tissue along with hemoperitoneum are findings suggestive of uterine rupture [15].

RPOC can be difficult to differentiate from blood products even on multiphase CT [12]. Endometritis is a clinical diagnosis with a nonspecific CT appearance of a thickened heterogeneous endometrium with fluid, gas, and debris within the cavity [15]. Superimposed parametrial abscess or infected hematoma and other complications such as ovarian vein thrombosis [14,15] can be detected on CT.

GTD (most commonly choriocarcinoma after third trimester delivery) is a rare cause of delayed PPH and appears as a heterogeneous hypervascular intrauterine mass, often with central necrosis, indistinguishable from RPOC, except in cases of invasion of adjacent organs or distant metastasis [14].

Variant 3: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after caesarian delivery. Initial imaging.

B. CTA Abdomen and Pelvis

Persistent hemorrhage after empiric embolization is an indication for CTA [12]. Active extravasation is seen in 41% to 74% cases of PPH on CTA [17] and multiphasic CT, including a noncontrast, arterial, and portal venous phases, has excellent accuracy of 97% [18] for detection of the site of active extravasation, similar to that of gastrointestinal hemorrhage [17,18]. CTA can be falsely positive because of dilated tortuous hypertrophic uterine arteries mimicking extravasation and be falsely negative in atony because of slow intermittent hemorrhage [12,18].

Serpiginous myometrial vessels and prominent parametrial vessels can be a sign of VUA [19], whereas the presence of a pseudoaneurysmal sac is a more specific finding [14,20,21]. CTA can also identify and localize the feeding arteries of AVM for treatment planning [14]. However, CTA cannot reliably distinguish acquired VUA from failure of obliteration/subinvolution of the placental bed vessels, assess its severity, or need for intervention [19].

Variant 3: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after caesarian delivery. Initial imaging.

C. MRI Pelvis

In clinically suspected endometritis, MRI can identify associated findings such as abscess or infected hematoma that may require drainage and other complications such as ovarian vein thrombosis [14]. RPOC can be seen as a variably enhancing intracavitary mass with variable degree of myometrial thinning [13,14]. MRI is superior to CT and US in detecting the myometrial defect with intact serosal layer in uterine dehiscence because of superior soft-tissue contrast [14,15]. However, in the immediate postpartum period, the cesarean section incision can be T1 and T2 hyperintense and may mimic a dehiscence [22].

Noncontrast MRI can be used to identify bladder flap, subfascial, and deep-seated pelvic hematomas, which depending on the time since delivery, may demonstrate variable T1 and T2 signal characteristics [14,23] and a low T2 signal rim after >2 weeks due to hemosiderin deposition. The superior spatial resolution of MRI compared to US enables localization of hematoma (eg, supralelevator versus infralevator location in perivaginal space) for potential targeted intervention [23].

VUA can be seen on MRI fast-spin echo sequence as serpiginous signal voids with prominent parametrial vessels, whereas the presence of a pseudoaneurysm sac is more specific [14,20]. Failure of obliteration of the placental bed vessels after pregnancy cannot be reliably distinguished from acquired VUA on MRI [19].

GTD is a rare cause of delayed PPH and appears as a heterogeneous hypervascular intrauterine mass, often with central necrosis, indistinguishable from RPOC, except in cases of invasion of adjacent organs or distant metastasis [14].

Variant 3: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after caesarian delivery. Initial imaging.

D. US Duplex Doppler Pelvis

Transabdominal US is often performed in conjunction with transvaginal US and color or power Doppler and should be considered a single examination. Color and spectral Doppler are commonly employed in pelvic sonography to detect the presence of vascular flow in normal anatomic structures as well as various pathologic lesions. In women with PPH, Doppler improves the specificity and negative predictive value of detecting RPOC by detecting vascularity within a thickened endometrial echo complex [24]. When a pseudoaneurysm is suspected, color and spectral Doppler can detect swirling or yin-yang pattern of blood flow within a hypoanechoic structure [14,20].

Pitfalls in assessment include that absence of vascularity could represent an avascular RPOC [12] and marked vascularity can mimic a pseudoaneurysm, although RPOC generally extends to the endometrium, whereas pseudoaneurysm is restricted to the myometrium [25]. However, it can be difficult to distinguish acquired VUA from subinvolution of the placental bed [19,26] or to assess its severity or need for intervention on US [19]. Although high peak systolic velocities have been used to predict need for intervention, there is considerable overlap [7].

Variant 3: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after caesarian delivery. Initial imaging.

E. US Pelvis Transabdominal

A combined transabdominal and transvaginal approach is usually used in pelvic imaging. The transabdominal approach lends an anatomic overview whereas the transvaginal approach has greater contrast and spatial resolution. See the "US Pelvis Transvaginal" section below for further detail.

Variant 3: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after caesarian delivery. Initial imaging.

F. US Pelvis Transvaginal

Pelvic US using a combined transvaginal and transabdominal approach is the primary modality of choice for the investigation of late PPH as RPOC with or without endometritis is one of the major

causes of secondary or late PPH. Although detection of an echogenic or mixed-echo pattern endometrial mass has the highest sensitivity for the detection of RPOC, this is a nonspecific finding that overlaps with the normal postpartum appearance [14,31]. The most specific finding is a vascular echogenic mass, although flow may not be identified in all RPOC. Another US finding in RPOC is a thickened endometrial echo complex with a variable cutoff of 8 to 13 mm [25,32]. US can be used in this setting to assess for coexisting pathology and complications, such as RPOC, hematoma, or abscess.

US can detect most pelvic hematomas [13], including bladder flap hematomas [14,15] with superimposed echogenic foci of air suggesting infection [15]. Although uterine scar dehiscence may be seen on US as an irregular thinned uterine wall or a myometrial defect [14], differentiation from the normal appearance of the cesarean section scar can be difficult.

VUA, including uterine artery pseudoaneurysms, are a relatively rare cause of PPH [19,20] and most commonly arise from the uterine artery. VUA appear as hypoechoic tortuous channels or masses in the myometrium with turbulent flow on color Doppler and high-velocity and low-resistance flow on spectral analysis.

It can be difficult to distinguish acquired VUA from subinvolution of the placental bed [19,26] or to assess its severity or need for intervention on US [19]. A dilated vessel in the myometrium may suggest the diagnosis of pseudoaneurysm.

GTD, a rare cause of delayed/secondary PPH, is seen as an echogenic mass in the uterine cavity with possible invasion into the myometrium and even adjacent organs. Because of the associated elevated HCG, multiple theca lutein cysts may develop leading to ovarian enlargement. GTD is difficult to distinguish from RPOC, except in cases in which myometrial/adjacent organ invasion is seen and correlation with β -HCG is useful [14]. Please see the ACR Appropriateness Criteria[®] topic on "[Gestational Trophoblastic Disease](#)" [6] for further guidance.

Variant 4: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after vaginal delivery. Initial imaging.

Secondary or late PPH is typically defined as any significant uterine hemorrhage occurring between 24 hours to 6 weeks postpartum. The most common etiologies are RPOC, subinvolution of the placental bed, or infection. RPOC are more likely after vaginal delivery, whereas postpartum endometritis is more common after cesarean. Less common causes include, but are not limited to, coagulopathy, pseudoaneurysm or AVMs, dehiscent cesarean scar, or GTD. Primary PPH is considered a risk factor for secondary PPH.

Variant 4: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after vaginal delivery. Initial imaging.

A. CT Abdomen and Pelvis

In the setting of hemorrhage, the primary role of CT is to determine whether active ongoing hemorrhage is present, to localize the bleeding, and to identify the source, which is best accomplished with a CT with IV contrast. There is little clinical utility in a noncontrast CT or CT with and without IV contrast in the setting of active ongoing hemorrhage. In hemodynamically stable patients with delayed PPH, multiphasic CTA can be useful in localizing the source of extravasation for targeted therapy [12,29], particularly in suspected intra-abdominal hemorrhage [12].

CT can detect vascular complications such as supraumbilical and perivaginal space hematoma and delineate the relationship to adjacent organs (supralevator versus infralevator location in the perivaginal space) [12,14,15]. Although the diagnosis of complete uterine inversion is made clinically, subacute partial uterine inversions may be detected as a concavity of the uterine fundus in CT [12].

RPOC can be difficult to differentiate from blood products even on multiphase CT [12]. Endometritis is a clinical diagnosis with a nonspecific CT appearance of a thickened heterogeneous endometrium with fluid, gas, and debris within the cavity [15]. Superimposed parametrial abscess or infected hematoma and other complications such as ovarian vein thrombosis [14,15] can be detected on CT.

GTD (most commonly choriocarcinoma after third trimester delivery) is a rare cause of delayed PPH and appears as a heterogeneous hypervascular intrauterine mass, often with central necrosis, indistinguishable from RPOC, except in cases of invasion of adjacent organs or distant metastasis [14].

Variant 4: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after vaginal delivery. Initial imaging.

B. CTA Abdomen and Pelvis

Persistent hemorrhage after empiric embolization is an indication for CTA [12]. Active extravasation is seen in 41% to 74% cases of PPH on CTA [17] and multiphasic CT, including a noncontrast, arterial, and portal venous phases, has excellent accuracy of 97% [18] for detection of the site of active extravasation, similar to that of gastrointestinal hemorrhage [17,18]. CTA can be falsely positive because of dilated tortuous hypertrophic uterine arteries mimicking extravasation and be falsely negative in atony because of slow intermittent hemorrhage [12,18].

Serpiginous myometrial vessels and prominent parametrial vessels can be a sign of VUA [19], whereas the presence of a pseudoaneurysmal sac is a more specific finding [14,20,21]. CTA can also identify and localize the feeding arteries of AVM for treatment planning [14]. However, CTA cannot reliably distinguish acquired VUA from failure of obliteration/subinvolution of the placental bed vessels, assess its severity, or need for intervention [19].

Variant 4: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after vaginal delivery. Initial imaging.

C. MRI Pelvis

In clinically suspected endometritis, MRI can identify associated findings such as abscess or infected hematoma that may require drainage and other complications such as ovarian vein thrombosis [14]. RPOC can be seen as a variably enhancing intracavitary mass with variable degree of myometrial thinning [13,14].

Patients with difficult vaginal delivery without large palpable hematoma may benefit from noncontrast MRI to identify deep-seated pelvic hematomas, which depending on the time since delivery may demonstrate variable T1 and T2 signal characteristics [14,23] and a low T2 signal rim after >2 weeks because of hemosiderin deposition. The superior spatial resolution of MRI compared to US enables localization of hematoma (eg, supralevator versus infralevator location in perivaginal space) for potential targeted intervention [23].

VUA can be seen on MRI fast-spin echo sequence as serpiginous signal voids with prominent parametrial vessels, whereas the presence of a pseudoaneurysm sac is more specific [14,20]. Failure of obliteration of the placental bed vessels after pregnancy cannot be reliably distinguished from acquired VUA on MRI [19].

GTD is a rare cause of delayed PPH and appears as a heterogeneous hypervascular intrauterine mass, often with central necrosis, indistinguishable from RPOC, except in cases of invasion of adjacent organs or distant metastasis [14].

Variant 4: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after vaginal delivery. Initial imaging.

D. US Duplex Doppler Pelvis

Transabdominal US is often performed in conjunction with transvaginal US and color or power Doppler and should be considered a single examination. Color and spectral Doppler are commonly employed in pelvic sonography to detect the presence of vascular flow in normal anatomic structures as well as various pathologic lesions. In women with PPH, Doppler improves the specificity and negative predictive value of detecting RPOC by detecting vascularity within a thickened endometrial echo complex [24]. When a pseudoaneurysm is suspected, color and spectral Doppler can detect swirling or yin-yang pattern of blood flow within a hypoanechoic structure [14,20].

Pitfalls in assessment include that absence of vascularity could represent an avascular RPOC [12], and marked vascularity can mimic a pseudoaneurysm, although RPOC generally extends to the endometrium, whereas pseudoaneurysm is restricted to the myometrium [25]. However, it can be difficult to distinguish acquired VUA from subinvolution of the placental bed [19,26] or to assess its severity or need for intervention on US [19]. Although high peak systolic velocities have been used to predict need for intervention, there is considerable overlap [7].

Variant 4: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after vaginal delivery. Initial imaging.

E. US Pelvis Transabdominal

A combined transabdominal and transvaginal approach is usually used in pelvic imaging. The transabdominal approach lends an anatomic overview whereas the transvaginal approach has greater contrast and spatial resolution. See the "US Pelvis Transvaginal" section below for further detail.

Variant 4: Postpartum hemorrhage. Late (greater than 24 hours to 6 weeks) after vaginal delivery. Initial imaging.

F. US Pelvis Transvaginal

A combined transabdominal and transvaginal approach is the primary modality of choice as RPOC with or without endometritis is one of the major causes of secondary or late PPH. Although transvaginal US detection of an echogenic endometrial mass has the highest sensitivity for the detection of RPOC, this is a nonspecific finding that can overlap with the normal postpartum appearance [14,31]. Another US finding in RPOC is a thickened endometrial echo complex with a variable cutoff of 8 to 13 mm [25,32]. Endometritis, on the other hand, is a clinical diagnosis that has a nonspecific US appearance of a thick heterogeneous endometrium, with fluid and air within the cavity [14,33,34]. US can be used in this setting to assess for coexisting pathology and complications, such as RPOC, hematoma, or abscess. US can detect most pelvic hematomas [13-

[15\]](#) with superimposed echogenic foci of air suggesting infection [\[15\]](#).

GTD, a rare cause of delayed/secondary PPH, is seen as an echogenic mass in the uterine cavity with possible invasion into the myometrium and even adjacent organs. Because of the associated elevated HCG, multiple theca lutein cysts may develop leading to ovarian enlargement. GTD is difficult to distinguish from RPOC, except in cases in which myometrial/adjacent organ invasion is seen and correlation with β -HCG is useful [\[14\]](#). Please see the ACR Appropriateness Criteria[®] topic on "[Gestational Trophoblastic Disease](#)" [\[6\]](#) for further guidance.

Summary of Recommendations

- **Variant 1:** US duplex Doppler pelvis, US pelvis transabdominal, and US transvaginal are usually appropriate for the initial imaging for early PPH (within first 24 hours) after cesarean delivery. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care.) The panel did not agree on recommending CT abdomen and pelvis without and with IV contrast for patients in this clinical scenario. There is insufficient medical literature to conclude whether or not these patients would benefit from this procedure. Imaging with this procedure is controversial but may be appropriate.
- **Variant 2:** US duplex Doppler pelvis, US pelvis transabdominal, and US transvaginal are usually appropriate for the initial imaging for early PPH (within first 24 hours) after vaginal delivery. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care.) The panel did not agree on recommending CT abdomen and pelvis without and with IV contrast for patients in this clinical scenario. There is insufficient medical literature to conclude whether or not these patients would benefit from this procedure. Imaging with this procedure is controversial but may be appropriate.
- **Variant 3:** US duplex Doppler pelvis, US pelvis transabdominal, and US transvaginal are usually appropriate for the initial imaging for late PPH (greater than 24 hours to 6 weeks) after cesarean delivery. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care.) The panel did not agree on recommending MRI pelvis without IV contrast for patients in this clinical scenario. There is insufficient medical literature to conclude whether or not these patients would benefit from this procedure. Imaging with this procedure is controversial but may be appropriate.
- **Variant 4:** US transvaginal, US duplex Doppler pelvis, and US pelvis transabdominal are usually appropriate for the initial imaging for late PPH (greater than 24 hours to 6 weeks) after vaginal delivery. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care.) The panel did not agree on recommending MRI pelvis without and with IV contrast and MRI pelvis without IV contrast for patients in this clinical scenario. There is insufficient medical literature to conclude whether or not these patients would benefit from these procedures. Imaging with these procedures is controversial but may be appropriate.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at <https://acsearch.acr.org/list>. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at <https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria>.


Appropriateness Category Names and Definitions





Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
0	0 mSv	0 mSv
	<0.1 mSv	<0.03 mSv

	0.1-1 mSv	0.03-0.3 mSv
	1-10 mSv	0.3-3 mSv
	10-30 mSv	3-10 mSv
	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”

References

1. Clark SL, Belfort MA, Dildy GA, Herbst MA, Meyers JA, Hankins GD. Maternal death in the 21st century: causes, prevention, and relationship to cesarean delivery. *Am J Obstet Gynecol*. 2008;199(1):36 e31-35; discussion 91-32 e37-11.
2. Say L, Chou D, Gemmill A, et al. Global causes of maternal death: a WHO systematic analysis. *Lancet Glob Health*. 2014;2(6):e323-333.
3. Sheldon WR, Blum J, Vogel JP, et al. Postpartum haemorrhage management, risks, and maternal outcomes: findings from the World Health Organization Multicountry Survey on Maternal and Newborn Health. *BJOG* 2014;121 Suppl 1:5-13.
4. Committee on Practice B-O. Practice Bulletin No. 183: Postpartum Hemorrhage. *Obstet Gynecol* 2017;130:e168-e86.
5. American College of Radiology. ACR Appropriateness Criteria®: Suspected Placenta Accreta Spectrum Disorder. Available at: <https://acsearch.acr.org/docs/3102403/Narrative/>.
6. Dudiak KM, Maturen KE, Akin EA, et al. ACR Appropriateness Criteria® Gestational Trophoblastic Disease. *J Am Coll Radiol* 2019;16:S348-S63.
7. Timmerman D, Wauters J, Van Calenbergh S, et al. Color Doppler imaging is a valuable tool for the diagnosis and management of uterine vascular malformations. *Ultrasound Obstet Gynecol*. 2003;21(6):570-577.
8. Van den Bosch T, Van Schoubroeck D, Timmerman D. Maximum Peak Systolic Velocity and Management of Highly Vascularized Retained Products of Conception. *Journal of ultrasound in medicine : official journal of the American Institute of Ultrasound in Medicine* 2015;34:1577-82.
9. Groszmann YS, Healy Murphy AL, Benacerraf BR. Diagnosis and management of patients with enhanced myometrial vascularity associated with retained products of conception. *Ultrasound in obstetrics & gynecology : the official journal of the International Society of Ultrasound in Obstetrics and Gynecology* 2018;52:396-99.
10. American College of Radiology. ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA). Available at: <https://gravitas.acr.org/PPTS/GetDocumentView?docId=164+&releaseId=2>.
11. Wolman I, Altman E, Fait G, et al. Evacuating retained products of conception in the setting of an ultrasound unit. *Fertil Steril*. 2009;91(4 Suppl):1586-1588.
12. Sierra A, Burrell M, Sebastia C, et al. Utility of multidetector CT in severe postpartum hemorrhage. *Radiographics*. 2012;32(5):1463-1481.
13. Lee NK, Kim S, Lee JW, et al. Postpartum hemorrhage: Clinical and radiologic aspects. *Eur J*

Radiol. 2010;74(1):50-59.

- 14.** Laifer-Narin SL, Kwak E, Kim H, Hecht EM, Newhouse JH. Multimodality imaging of the postpartum or posttermination uterus: evaluation using ultrasound, computed tomography, and magnetic resonance imaging. *Curr Probl Diagn Radiol*. 2014;43(6):374-385.
- 15.** Rodgers SK, Kirby CL, Smith RJ, Horrow MM. Imaging after cesarean delivery: acute and chronic complications. *Radiographics*. 2012;32(6):1693-1712.
- 16.** Shanbhogue AK, Menias CO, Lalwani N, Lall C, Khandelwal A, Nagar A. Obstetric (nonfetal) complications. *Radiol Clin North Am*. 2013;51(6):983-1004.
- 17.** Takeda A, Koike W, Imoto S, Nakamura H. Three-dimensional computerized tomographic angiography for diagnosis and management of intractable postpartum hemorrhage. *Eur J Obstet Gynecol Reprod Biol*. 176:104-11, 2014 May.
- 18.** Lee NK, Kim S, Kim CW, Lee JW, Jeon UB, Suh DS. Identification of bleeding sites in patients with postpartum hemorrhage: MDCT compared with angiography. *AJR Am J Roentgenol*. 194(2):383-90, 2010 Feb.
- 19.** Hugues C, Le Bras Y, Coatleven F, et al. Vascular uterine abnormalities: Comparison of imaging findings and clinical outcomes. *Eur J Radiol*. 84(12):2485-91, 2015 Dec.
- 20.** Baba Y, Matsubara S, Kuwata T, et al. Uterine artery pseudoaneurysm: not a rare condition occurring after non-traumatic delivery or non-traumatic abortion. *Arch Gynecol Obstet*. 2014;290(3):435-440.
- 21.** Yi SW, Lee JH. Uterine pseudoaneurysm leakage may cause delayed postpartum haemorrhage: multidetector CT with angiography and transcatheter uterine arterial embolisation. *J Obstet Gynaecol*. 2012;32(6):552-555.
- 22.** Leyendecker JR, Gorengaut V, Brown JJ. MR imaging of maternal diseases of the abdomen and pelvis during pregnancy and the immediate postpartum period. *Radiographics*. 2004;24(5):1301-1316.
- 23.** Jain KA, Olcott EW. Magnetic resonance imaging of postpartum pelvic hematomas: early experience in diagnosis and treatment planning. *Magn Reson Imaging*. 1999;17(7):973-977.
- 24.** Matijevic R, Knezevic M, Grgic O, Zlodi-Hrsak L. Diagnostic accuracy of sonographic and clinical parameters in the prediction of retained products of conception. *J Ultrasound Med*. 2009;28(3):295-299.
- 25.** Sellmyer MA, Dessler TS, Maturen KE, Jeffrey RB, Jr., Kamaya A. Physiologic, histologic, and imaging features of retained products of conception. *Radiographics* 2013;33:781-96.
- 26.** Maleux G, Timmerman D, Heye S, Wilms G. Acquired uterine vascular malformations: radiological and clinical outcome after transcatheter embolotherapy. *Eur Radiol*. 2006;16(2):299-306.
- 27.** van den Bosch T, Daemen A, Van Schoubroeck D, Pochet N, De Moor B, Timmerman D. Occurrence and outcome of residual trophoblastic tissue: a prospective study. *Journal of ultrasound in medicine : official journal of the American Institute of Ultrasound in Medicine* 2008;27:357-61.
- 28.** Van Schoubroeck D, Van den Bosch T, Scharpe K, Lu C, Van Huffel S, Timmerman D. Prospective evaluation of blood flow in the myometrium and uterine arteries in the puerperium. *Ultrasound in obstetrics & gynecology : the official journal of the International*

Society of Ultrasound in Obstetrics and Gynecology 2004;23:378-81.

29. Kawamura Y, Kondoh E, Hamanishi J, et al. Treatment decision-making for post-partum hemorrhage using dynamic contrast-enhanced computed tomography. *J Obstet Gynaecol Res.* 40(1):67-74, 2014 Jan.
30. Yamashita Y, Torashima M, Harada M, Yamamoto H, Takahashi M. Postpartum extraperitoneal pelvic hematoma: imaging findings. *AJR Am J Roentgenol.* 1993;161(4):805-808.
31. Belachew J, Axelsson O, Eurenus K, Mulic-Lutvica A. Three-dimensional ultrasound does not improve diagnosis of retained placental tissue compared to two-dimensional ultrasound. *Acta Obstet Gynecol Scand.* 2015;94(1):112-116.
32. Cosmi E, Saccardi C, Litta P, Nardelli GB, Dessole S. Transvaginal ultrasound and sonohysterography for assessment of postpartum residual trophoblastic tissue. *Int J Gynaecol Obstet.* 2010;110(3):262-264.
33. Nalaboff KM, Pellerito JS, Ben-Levi E. Imaging the endometrium: disease and normal variants. *Radiographics.* 2001;21(6):1409-1424.
34. Zuckerman J, Levine D, McNicholas MM, et al. Imaging of pelvic postpartum complications. *AJR Am J Roentgenol.* 1997;168(3):663-668.
35. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: <https://edge.sitecorecloud.io/americancoldf5f-acrorgf92a-productioncb02-3650/media/ACR/Files/Clinical/Appropriateness-Criteria/ACR-Appropriateness-Criteria-Radiation-Dose-Assessment-Introduction.pdf>.

Disclaimer

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

^aBrigham & Women's Hospital, Boston, Massachusetts; Committee on Emergency Radiology-GSER.

^bResearch Author, Brigham & Women's Hospital & Harvard Medical School, Boston, Massachusetts. ^cPanel Chair, McGill University, Montreal, Quebec, Canada. ^dGeorge Washington University Hospital, Washington, District of Columbia; Commission on Nuclear Medicine and Molecular Imaging. ^eGeorgetown University Hospital, Washington, District of Columbia. ^fBeth Israel Deaconess Medical Center, Boston, Massachusetts.

⁹Mayo Clinic, Rochester, Minnesota. ^hBrigham & Women's Hospital & Harvard Medical School, Boston, Massachusetts; American College of Emergency Physicians. ⁱVirginia Tech Carilion School of Medicine, Roanoke, Virginia; American College of Obstetricians and Gynecologists. ^jUniversity of Michigan, Ann Arbor, Michigan. ^kMcMaster University, Hamilton, Ontario, Canada. ^lUniversity of Wisconsin, Madison, Wisconsin. ^mUniversity of Wisconsin, Madison, Wisconsin. ⁿWomen's Ultrasound, LLC, Englewood, New Jersey; American College of Obstetricians and Gynecologists. ^oMayo Clinic, Rochester, Minnesota. ^pSpecialty Chair, University of Toronto and Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada.