

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

**Clinical Condition:** Abnormal Vaginal Bleeding

**Variant 1:** Postmenopausal vaginal bleeding, First study. (Endometrial sampling may also be performed initially followed by imaging if results are inconclusive or symptoms persist despite negative findings.)

Radiologic Procedure	Rating	Comments	RRL*
US pelvis transvaginal	9		O
US pelvis transabdominal	8		O
US hysterosonogram	6	3D imaging may be a useful adjunct to standard 2D imaging if intracavitary abnormality is suspected.	O
US pelvis with Doppler	4		O
CT pelvis with contrast	2		☼ ☼ ☼
MRI pelvis without and with contrast	2		O
CT pelvis without contrast	1		☼ ☼ ☼
CT pelvis without and with contrast	1		☼ ☼ ☼ ☼
MRI pelvis without contrast	1		O
<b><u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate</b>			<b>*Relative Radiation Level</b>

**Variant 2:** Postmenopausal vaginal bleeding, endometrium ≤5 mm by transvaginal ultrasound. (Some centers may choose to use ≤4 mm rather than ≤5mm. Please see narrative.)

Radiologic Procedure	Rating	Comments	RRL*
US pelvis transabdominal	4		O
US hysterosonogram	2		O
US pelvis with Doppler	2		O
CT pelvis with contrast	2		☼ ☼ ☼
MRI pelvis without and with contrast	2		O
CT pelvis without contrast	1		☼ ☼ ☼
CT pelvis without and with contrast	1		☼ ☼ ☼ ☼
MRI pelvis without contrast	1		O
<b><u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate</b>			<b>*Relative Radiation Level</b>

**Clinical Condition:****Abnormal Vaginal Bleeding****Variant 3:**

**Postmenopausal vaginal bleeding, endometrium >5 mm by transvaginal ultrasound. (Endometrial sampling would also be warranted in this clinical setting to evaluate for malignancy.) (Some centers may choose to use >4 mm. Please see narrative.)**

<b>Radiologic Procedure</b>	<b>Rating</b>	<b>Comments</b>	<b><u>RRL*</u></b>
US hysterosonogram	8	3D imaging may be a useful adjunct to standard 2D imaging if intracavitary abnormality is suspected.	O
MRI pelvis without and with contrast	5	When hysterosonography is not feasible or to define extent of disease with endometrial cancer. See statement regarding contrast in text under "Anticipated Exceptions."	O
US pelvis transabdominal	4		O
US pelvis with Doppler	4		O
MRI pelvis without contrast	2		O
CT pelvis with contrast	2		☼ ☼ ☼
CT pelvis without contrast	1		☼ ☼ ☼
CT pelvis without and with contrast	1		☼ ☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 4:****Premenopausal vaginal bleeding. First study.**

<b>Radiologic Procedure</b>	<b>Rating</b>	<b>Comments</b>	<b><u>RRL*</u></b>
US pelvis transvaginal	9		O
US pelvis transabdominal	8		O
US hysterosonogram	4		O
US pelvis with Doppler	2		O
CT pelvis with contrast	2		☼ ☼ ☼
MRI pelvis without and with contrast	2		O
CT pelvis without contrast	1		☼ ☼ ☼
CT pelvis without and with contrast	1		☼ ☼ ☼ ☼
MRI pelvis without contrast	1		O
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Clinical Condition:** Abnormal Vaginal Bleeding

**VARIANT 5:** Premenopausal vaginal bleeding, endometrium <16 mm by transvaginal ultrasound. Follow-up study.

Radiologic Procedure	Rating	Comments	RRL*
US hysterosonogram	6		O
US pelvis with Doppler	5		O
US pelvis transabdominal	4		O
CT pelvis with contrast	2		☼ ☼ ☼
MRI pelvis without and with contrast	2		O
CT pelvis without contrast	1		☼ ☼ ☼
CT pelvis without and with contrast	1		☼ ☼ ☼ ☼
MRI pelvis without contrast	1		O
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

**VARIANT 6:** Premenopausal vaginal bleeding, endometrium ≥16 mm by transvaginal ultrasound. Follow-up study. (Endometrial sampling may also be warranted in this clinical setting depending on patient risk factors for malignancy.)

Radiologic Procedure	Rating	Comments	RRL*
US pelvis transvaginal	8	Follow-up study performed in the early proliferative phase of the menstrual cycle or following administration of progesterone.	O
US hysterosonogram	7		O
US pelvis with Doppler	5		O
MRI pelvis without and with contrast	5	See statement regarding contrast in text under “Anticipated Exceptions.”	O
US pelvis transabdominal	4	May be helpful if uterus is in neutral position or if uterine penetration by TVUS is poor.	O
MRI pelvis without contrast	3		O
CT pelvis with contrast	2		☼ ☼ ☼
CT pelvis without contrast	1		☼ ☼ ☼
CT pelvis without and with contrast	1		☼ ☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

**Clinical Condition:****Abnormal Vaginal Bleeding****Variant 7:****Heterogeneous endometrium or suspected focal abnormality at transvaginal ultrasound.**

<b>Radiologic Procedure</b>	<b>Rating</b>	<b>Comments</b>	<b><u>RRL*</u></b>
US hysterosonogram	8		O
US pelvis with Doppler	7	Evaluate for vascular pedicle flow or irregular vessels in endometrial cavity.	O
MRI pelvis without and with contrast	5	If hysterosonogram is not feasible. See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI pelvis without contrast	4		O
US pelvis transabdominal	4	May be helpful if uterus is in neutral position or if uterine penetration by TVUS is poor.	O
CT pelvis with contrast	2		☼ ☼ ☼
CT pelvis without contrast	1		☼ ☼ ☼
CT pelvis without and with contrast	1		☼ ☼ ☼ ☼
<b><u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate</b>			<b>*Relative Radiation Level</b>

**Variant 8:****Endometrium not adequately visualized at transvaginal ultrasound.**

<b>Radiologic Procedure</b>	<b>Rating</b>	<b>Comments</b>	<b><u>RRL*</u></b>
US hysterosonogram	8		O
US pelvis transabdominal	6		O
MRI pelvis without and with contrast	6	If hysterosonogram is not feasible. Would be preferred if underlying malignancy is suspected. See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI pelvis without contrast	4		O
US pelvis with Doppler	3		O
CT pelvis with contrast	2		☼ ☼ ☼
CT pelvis without contrast	1		☼ ☼ ☼
CT pelvis without and with contrast	1		☼ ☼ ☼ ☼
<b><u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate</b>			<b>*Relative Radiation Level</b>

## ABNORMAL VAGINAL BLEEDING

Expert Panel on Women's Imaging: Genevieve L. Bennett, MD<sup>1</sup>; Rochelle F. Andreotti, MD<sup>2</sup>; Susanna I. Lee MD, PhD<sup>3</sup>; Sandra O. DeJesus Allison, MD<sup>4</sup>; Douglas L. Brown, MD<sup>5</sup>; Theodore Dubinsky, MD<sup>6</sup>; Phyllis Glanc, MD<sup>7</sup>; Donald G. Mitchell, MD<sup>8</sup>; Ann E. Podrasky, MD<sup>9</sup>; Thomas D. Shipp, MD<sup>10</sup>; Cary Lynn Siegel, MD<sup>11</sup>; Jade J. Wong-You-Cheong, MD<sup>12</sup>; Carolyn M. Zelop, MD.<sup>13</sup>

### **Summary of Literature Review**

Virtually every woman will at some point in her lifetime experience episodes of vaginal bleeding that will be perceived as abnormal. Menses begins at puberty and extends to menopause. The average menstrual cycle is 29 days long, with a range of 23-39 days [1]. Overall, the length of the menstrual cycle remains relatively constant throughout the reproductive years, but as a woman approaches menopause the cycle gradually shortens. Although blood loss is difficult to quantify, most loss occurs in the first few days of menses, and bleeding generally lasts from 2 to 7 days. The cycle length and the volume and duration of bleeding remain fairly constant for a woman throughout her reproductive years. After menopause, bleeding ceases completely. Abnormal vaginal bleeding may include noncyclic, excessive, or prolonged bleeding in the premenopausal patient or any vaginal bleeding in the postmenopausal patient. Differential considerations vary with patient age, hormonal status, and risk factors for endometrial carcinoma [2-3]. The perimenopausal patient with abnormal bleeding is a special clinical challenge since menstrual bleeding is less predictable in this age group. Hematuria, which occasionally may be misinterpreted as abnormal vaginal bleeding, should be excluded by clinical history and physical examination.

Endometrial carcinoma is the most common gynecologic cancer in the United States, with a mean age at diagnosis of 60 years [4]. Abnormal uterine bleeding is the most common clinical presentation, with only about 15% of

cancers occurring in women without bleeding [5-6]. Appropriate evaluation of the patient with abnormal vaginal bleeding will allow for early diagnosis of endometrial carcinoma and the best opportunity for cure. Therefore, endometrial carcinoma should be rigorously excluded in any postmenopausal or perimenopausal patient with abnormal bleeding as well as in younger patients with significant risk factors, such as obesity and anovulation. However, even in the postmenopausal patient, endometrial cancer accounts for only up to 10% of uterine bleeding, with endometrial atrophy being the most common etiology [7].

Anovulatory bleeding is the most common etiology of abnormal bleeding in the premenopausal patient [8]. However, anatomic abnormalities such as endometrial and cervical polyps and submucosal fibroids may also be a cause and are found in up to 40% of premenopausal patients evaluated for this symptom [9]. Other abnormalities that may cause abnormal bleeding include endometrial hyperplasia, fibroids, adenomyosis, cervical and vaginal neoplasia, and other less common uterine tumors and coagulopathies. Pregnancy-related complications should always be excluded in any woman of reproductive age with abnormal bleeding.

In the premenopausal patient without risk factors for endometrial carcinoma, a trial of medical therapy may initially be undertaken if anovulatory cycles are suspected. In the postmenopausal patient or if bleeding persists despite medical therapy in the premenopausal patient, endometrial sampling or imaging is warranted. Although imaging procedures cannot replace definitive histologic diagnosis, they play an important role in screening, characterizing anatomic abnormalities, and directing appropriate patient care, often preventing unnecessary diagnostic procedures. Imaging is often essential for further evaluation of the patient with inconclusive biopsy results or persistent bleeding despite negative findings.

In the setting of abnormal vaginal bleeding, office endometrial sampling now has largely replaced dilatation and curettage (D&C); however, issues of access to the endometrial cavity and sampling error limit the clinical value of a negative result. Furthermore, only about 60% of the endometrial cavity is curetted with D&C, and many focal lesions may be missed, making the detection of focal structural causes for bleeding a vital role of imaging in this clinical setting [10].

### **Transvaginal Ultrasound**

Transvaginal ultrasound (TVUS) is generally the initial imaging procedure of choice for evaluating abnormal vaginal bleeding due to its ability to depict endometrial pathology, its widespread availability, and its excellent safety profile and cost effectiveness [11-15]. In the postmenopausal patient, endometrial thickness is a well-established predictor of endometrial disease, and TVUS is the mainstay in detecting and characterizing abnormal

<sup>1</sup>Principal Author, New York University Medical Center, New York, New York.

<sup>2</sup>Panel Chair, Vanderbilt University Medical Center, Nashville, Tennessee.

<sup>3</sup>Panel Vice-chair, Massachusetts General Hospital, Boston, Massachusetts.

<sup>4</sup>Georgetown University Hospital, Washington, District of Columbia.

<sup>5</sup>Mayo Clinic, Rochester, Minnesota.

<sup>6</sup>University of Washington School of Medicine, Seattle, Washington.

<sup>7</sup>Sunnybrook Health Sciences Centre, Bayview Campus, Toronto, Ontario, Canada.

<sup>8</sup>Thomas Jefferson University Hospital, Philadelphia, Pennsylvania.

<sup>9</sup>Baptist Hospital of Miami/South Miami Center for Women and Infants, Miami, Florida.

<sup>10</sup>Diagnostic Ultrasound Associates, P.C., Brookline, Massachusetts, American College of Obstetrics and Gynecology.

<sup>11</sup>Mallinckrodt Institute of Radiology, St. Louis, Missouri.

<sup>12</sup>University of Maryland School of Medicine, Baltimore, Maryland.

<sup>13</sup>University of Connecticut, School of Medicine, Farmington, Connecticut, American College of Obstetrics and Gynecology.

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Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

endometrial thickening with highly reproducible measurements [16-18]. Endometrial thickness refers to the double thickness measurement (sum of the thickness of the two endometrial layers excluding any intracavitary fluid). If an abnormally thickened endometrium is identified, nonfocal endometrial biopsy is generally advocated as the next diagnostic step to exclude diffuse endometrial pathology, including carcinoma and hyperplasia [19-20].

In a meta-analysis of 35 studies including 5,892 postmenopausal women, using 5 mm as the upper threshold for normal endometrial thickness, the sensitivity of TVUS for detecting endometrial cancer was 96% [15]. An endometrial thickness of  $\leq 5$  mm was associated with a less than 1% probability of endometrial cancer. Sensitivity for the detection of cancer did not differ for women taking hormone replacement therapy (HRT) compared to those not taking HRT. Many additional studies have further demonstrated that with an endometrial thickness of  $< 5$  mm, the risk of endometrial cancer is very low [18,21-22]. An expert panel for the evaluation of postmenopausal bleeding concluded that if US shows a normal-appearing endometrium with a double thickness measurement of  $\leq 5$  mm, the test can be considered negative for endometrial carcinoma [23]. A similar criterion can be used for women taking HRT, tamoxifen, or other selective estrogen receptor modulator therapy. Recent guidelines from the American College of Obstetrics and Gynecology (ACOG) advocate using 4 mm as the endometrial thickness cutoff that reasonably excludes endometrial carcinoma [24]. However, this threshold may be associated with lower specificity and more false positive US examinations [15].

In the asymptomatic postmenopausal patient without bleeding, the clinical usefulness of screening with TVUS remains a subject of debate. There is lack of consensus regarding what endometrial thickness best separates those with from those without endometrial pathology, and further validation is necessary. Upper threshold values ranging from 4 to 11 mm have been suggested [6,25-26]. In addition to endometrial thickness, individual patient parameters such as age, hormonal therapy, and other risk factors for endometrial carcinoma must also be considered in patient management decisions.

The value of endometrial thickness as an indicator for endometrial pathology in the premenopausal patient is controversial, as it may vary widely depending on phase of menstrual cycle. The optimum threshold level of endometrial thickness that should prompt further evaluation in this age group remains the subject of debate. The examination should ideally be performed during the early proliferative phase of the menstrual cycle when the endometrium is at its thinnest. A thickness  $> 16$  mm in a symptomatic premenopausal patient may be considered abnormal but with suboptimal sensitivity (67%) and specificity (75%) [13]. A recent study suggests that an endometrial thickness of 8 mm yields a higher sensitivity of 83.6% but with lower specificity of 56.4% [27]. Focal heterogeneity or eccentric thickening of the endometrium

detected at TVUS should always be further investigated irrespective of endometrial thickness to exclude endometrial pathology [23]. TVUS can help to identify focal lesions within the endometrium such as polyps and submucosal fibroids which may lead to sampling error and a negative biopsy result.

Abnormalities within the myometrium such as fibroids and adenomyosis may also be a cause of abnormal vaginal bleeding. Fibroids are readily demonstrated at sonography and can be characterized as submucosal, intramural, or subserosal in location [28]. The reported sensitivity and specificity of TVUS for detecting adenomyosis are 53%-89% and 65%-98%, respectively [29-33]. However, detection of adenomyosis at TVUS may be limited if there is coexisting uterine pathology, such as fibroids. In one study, the sensitivity and specificity of TVUS for diagnosing adenomyosis in patients with and without fibroids were 33.3% and 78% and 97.8% and 97.1%, respectively [31].

### **Hysterosonography**

Hysterosonography (also referred to as sonohysterography or saline infusion sonohysterography [SIS]) consists of the instillation of sterile saline into the uterine cavity via a small catheter under TVUS guidance. This allows for better delineation of the endometrial lining when it is not clearly delineated on TVUS, which may occur in 5%-10% of patients [34]. This technique also allows for differentiation of focal lesions such as polyps from diffuse abnormalities such as endometrial hyperplasia. Hysterosonography and hysteroscopy show similar performance characteristics, with sensitivity of 95%-96% and specificity of 88%-90% for detecting characterizing focal endometrial abnormalities [35-36]. Hysterosonography has the advantages of being less invasive, less expensive, and well-tolerated by patients; however, a specific histologic diagnosis cannot be made, and identification of a focal mass prompts triage to a hysteroscopically directed biopsy procedure. Hysterosonography may also be used to further evaluate the endometrium in patients with negative TVUS and biopsy with persistent bleeding, allowing for detection of small intracavitary abnormalities, such as polyps or focal hyperplasia, not detectable by TVUS [9,37]. In a study by Erdem et al [38] the sensitivity and specificity of sonohysterography were 97.7% and 82.4%, respectively versus 83.0% and 70.6%, respectively for TVUS for detection of endometrial abnormalities such as polyps, submucosal fibroids, and endometrial hyperplasia in patients with abnormal vaginal bleeding. Differentiation of endometrial from subendometrial abnormalities, particularly in patients treated with tamoxifen, is also an important role for this technique with significant implications for patient management [39-40].

### **Transabdominal Ultrasound**

Transabdominal pelvic US is usually performed in conjunction with TVUS, and the two techniques are complementary. Transabdominal scanning offers a wider field of view, increased depth of penetration, and an

ability to evaluate adjacent organs. A transabdominal approach is particularly helpful for evaluating a markedly enlarged fibroid uterus, especially if there is extension of subserosal or pedunculated fibroids out of the pelvis. However, optimum evaluation of the endometrium generally requires TVUS, which allows for higher-resolution imaging [17,41]. If the transvaginal probe cannot be tolerated, as is often the case in a prepubertal or virginal patient, transabdominal US using the urinary bladder as an acoustic window becomes essential.

### **Doppler Ultrasound**

Color and pulsed Doppler US allows for the assessment of uterine and endometrial vascularization and may be of added value in further characterizing an endometrial abnormality detected at TVUS. Demonstration of blood flow in an intracavitary lesion excludes the possibility of a retained blood clot. Endometrial polyps often demonstrate a feeding vessel, which can aid in detection at TVUS [42]. However, resistive indices and Doppler flow patterns are variable and generally do not help to differentiate benign from malignant processes [43-45]. The added value of power Doppler imaging for analysis of vascular patterns with the use of blood vessel mapping is currently under investigation, but it is not in routine clinical use [46].

### **Three-Dimensional Sonography**

Three-dimensional sonography can be a useful adjunct to TVUS and hysterosonography in the characterization of abnormalities within the endometrial cavity, including localization of focal abnormalities prior to directed biopsy. It allows the ability to reconstruct any plane of section, in orientations that cannot be obtained directly using standard 2D sonography and hysterosonography [47-48]. In a study by Benacerraf et al [49] three-dimensional coronal view of the uterus was of added value to the standard 2D pelvic sonogram in 24% of all patients referred for gynecologic sonography and in up to 39% of patients with an endometrial thickness  $\geq 5$  mm. Recently, three-dimensional power Doppler angiography combined with 3D TVUS has become a new diagnostic tool to evaluate vascular patterns in the abnormal endometrium and endometrial volume, potentially allowing for differentiation between benign and malignant causes of a thickened endometrium [50-51]. However, this technique remains investigational, and its role in general clinical practice has not yet been determined.

### **Magnetic Resonance Imaging**

Magnetic resonance imaging (MRI) of the pelvis may be a useful problem-solving tool when US findings are not definitive. Uterine anatomy is well-delineated at MRI secondary to inherent soft-tissue contrast of uterine tissues. Although not a first-line test, MRI may be considered for evaluating the endometrium when TVUS is not possible or when the endometrium cannot be well visualized due to uterine orientation or coexisting abnormalities such as adenomyosis or leiomyomas. MRI may provide additional important information regarding fibroid number, size, and location prior to intervention

such as embolization or myomectomy [52]. MRI may also help to confirm the diagnosis of adenomyosis, which may be difficult at TVUS when there are coexisting fibroids with reported sensitivity of 70%-88% and specificity of 67%-93% [30-33].

In a woman with an enlarging or an abnormally enlarged uterus where underlying malignancy is a concern and US does not delineate the endometrium, MRI serves as a useful problem-solving tool. MRI-detected features of benign endometrial polyps overlap with those of carcinoma, so histologic confirmation remains necessary when an endometrial mass is identified at MRI [53]. However, evidence of an endometrial lesion invading the myometrium confirms a diagnosis of malignancy. Also, demonstration of enhancement of an intracavitary abnormality with gadolinium contrast agents confirms the presence of a mass and excludes the possibility of a retained blood clot or debris. Results of initial studies investigating the added value of diffusion weighted imaging in differentiating benign from malignant endometrial lesions show promise, but further investigation is necessary before this technique can be applied to clinical practice [54-55].

### **Computed Tomography**

Computed tomography (CT) is generally not warranted for evaluating vaginal bleeding since uterine anatomy is not well characterized due to limited soft-tissue contrast resolution. For detection of endometrial thickening using TVUS as the reference standard, the sensitivity, specificity, and positive and negative predictive values of MDCT were 53.1%, 93.5%, 66.7%, and 89.1%, respectively, in one recent study [56]. Multiplanar reformation may be a helpful addition to standard axial images when evaluating the endometrium at multidetector CT [57]. However, an abnormal endometrium incidentally detected at CT should be referred to TVUS for further evaluation.

### **Positron Emission Tomography/Computed Tomography**

Positron emission tomography (PET) with CT (PET/CT) is not warranted for evaluating vaginal bleeding. In premenopausal patients, normal endometrial uptake of fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG) changes cyclically, increasing during the ovulatory and menstrual phases. This variation requires that the evaluation of the endometrium be correlated with the menstrual history. In postmenopausal women, increased tracer uptake is considered abnormal [58]. Neither use of contraceptives nor hormonal therapy is associated with a significant increase in endometrial tracer uptake. Abnormal endometrial tracer uptake incidentally detected on PET should be referred for TVUS evaluation.

### **Summary**

- Imaging procedures cannot replace definitive histologic diagnosis, and tissue sampling may be the most appropriate initial step in evaluating a woman with abnormal vaginal bleeding depending on the clinical situation. However, imaging can play an

important role in screening, characterization of structural abnormalities, and directing appropriate patient care, often preventing inappropriate diagnostic procedures.

- TVUS is generally the initial imaging procedure of choice for evaluating abnormal vaginal bleeding, and endometrial thickness is a well-established predictor of endometrial disease in postmenopausal women. Endometrial thickness measurements of  $\leq 5$  mm and  $\leq 4$  mm have been advocated as appropriate threshold values to reasonably exclude endometrial carcinoma in the postmenopausal age group [15,18,21-24]. However, the most appropriate value for upper limits normal for the asymptomatic postmenopausal patient without bleeding remains the subject of debate. An upper threshold value of 16 mm has been suggested for the premenopausal patient with abnormal bleeding, although it remains controversial as endometrial thickness varies greatly in this patient age group [13,27].
- Transabdominal US is generally an adjunct to TVUS and is most helpful when TVUS cannot be performed or when there is poor visualization of the endometrium secondary to uterine position or poor penetration due to associated uterine pathology such as fibroids or adenomyosis.
- Hysterosonography is often a valuable next step after TVUS, allowing for identification of focal abnormalities within the endometrial cavity, which may then lead to hysteroscopically guided biopsy or resection [35-36]. This procedure may also help to better delineate the endometrium when it cannot be well-visualized at TVUS [34].
- Color and pulsed Doppler allows for assessment of uterine and endometrial vascularization and may be of added value in further characterizing an endometrial abnormality detected at TVUS. Endometrial polyps will often have a feeding vessel, which aids in their detection [42].
- Pelvic MRI is an important problem-solving tool and adjunct to TVUS, particularly when hysterosonography cannot be performed for technical reasons or to better define extent of disease if endometrial carcinoma is suspected.
- CT is generally not warranted for evaluating a patient with abnormal vaginal bleeding. An abnormal endometrium incidentally detected at CT should be referred to TVUS for further evaluation.

### Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie,  $<30$  mL/min/1.73m<sup>2</sup>), and almost never in other

patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates  $<30$  mL/min/1.73m<sup>2</sup>. For more information, please see the [ACR Manual on Contrast Media](#) [59].

### 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, both because of 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 to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria<sup>®</sup> [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	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 (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).		

### Supporting Document(s)

- [ACR Appropriateness Criteria<sup>®</sup> Overview](#)
- [Procedure Information](#)
- [Evidence Table](#)

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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.