

AIUM Practice Parameter for the Performance of Limited Obstetric Ultrasound Examinations by Advanced Clinical Providers

The American Institute of Ultrasound in Medicine (AIUM) is a multidisciplinary association dedicated to advancing the safe and effective use of ultrasound in medicine through professional and public education, research, development of practice parameters, and accreditation. Practice parameters of the AIUM are intended to provide the medical ultrasound community with recommendations for the performance and recording of high-quality ultrasound examinations.

To promote this mission, the AIUM is pleased to publish, in conjunction with the National Association of Nurse Practitioners in Women's Health (NPWH), Association of Physician Assistants in Obstetrics and Gynecology (APAOG), American College of Nurse-Midwives (ACNM), American College of Obstetricians and Gynecologists (ACOG), American College of Osteopathic Obstetricians and Gynecologists (ACOOG), and Society for Maternal-Fetal Medicine (SMFM) the *AIUM Practice Parameter for the Performance of Limited Obstetric Ultrasound Examinations by Advanced Clinical Providers*. This practice parameter has been developed for use by women's health nurse practitioners (WHNPs), physician assistants in obstetrics and gynecology (PAOGs), and certified nurse-midwives (CNMs)/certified midwives (CMs) performing and interpreting limited obstetric ultrasound studies within their scopes of practice.¹⁻³

Scope-of-practice laws and requirements that govern each health care provider's clinical activity vary by individual state, including requirements for physician consultation and supervision. Health care providers and interprofessional health care teams should understand their scopes of practice within the state where they are practicing.⁴

With respect to this *AIUM Practice Parameter for the Performance of Limited Obstetric Ultrasound Examinations by Advanced Clinical Providers*, when the imaging issue is outside of advanced clinical provider's education, experience, or scope of practice, or when a high-risk situation is identified, consultation should occur with a qualified physician who at minimum meets the *AIUM Training*

Guidelines for Physicians Who Evaluate and Interpret Diagnostic Obstetric Ultrasound Examinations in accordance with state law.^{1-3,5} A plan should be in place to address imaging concerns outside the advanced clinical provider's scope of practice.

This parameter reflects what the AIUM considers the minimum criteria for a limited obstetric ultrasound examination within the scopes of practice of advanced clinical providers in women's health. For the purpose of this document and the associated AIUM Training Guideline, "advanced clinical providers in women's health" refers specifically to WHNPs, PAOGs, and CNMs/CMs. It is not intended to establish a legal standard of care or to replace the performance of a clinically indicated standard diagnostic^{6,7} or detailed⁸ obstetric ultrasound examination. If not previously performed during the index pregnancy, a standard diagnostic or detailed obstetric ultrasound examination should be performed as soon as reasonably possible after the limited ultrasound examination.

A limited obstetric ultrasound examination may be performed in an acute clinical situation when an immediate impact on management is anticipated: for example, evaluation of cardiac activity or fetal presentation in a laboring patient. A limited obstetric ultrasound examination may also be performed in patients requiring serial examinations in which a subsequent anatomic evaluation may be unnecessary or impractical.

When a patient undergoes a limited ultrasound examination, it is important that she understands why a limited scan is being done and that she has appropriate expectations regarding the information being sought.

Clinical judgment should be used to determine the proper type of ultrasound examination performed.

I. Introduction

The clinical aspects contained in specific sections of this parameter (Introduction, Classification of Fetal Sonographic Examinations, Specifications of the Examination,

Equipment Specifications, and Fetal Safety) are based on the *AIUM Practice Guideline for the Performance of Obstetric Ultrasound Examinations*⁶ and the American College of Obstetricians and Gynecologists *Practice Bulletin No. 175: Ultrasound in Pregnancy*.⁷

Obstetric ultrasound examinations should only be performed when there is a valid medical reason, and the lowest possible ultrasonic exposure settings should be used to gain the necessary diagnostic information.^{9–12}

Relevant AIUM Statements:

As Low as Reasonably Achievable (ALARA)

Principle

*Recommended Maximum Scanning Times
for Displayed Thermal Index (TI)
Values*

*Statement on Measurement of Fetal Heart
Rate*

*Statement on the Safe Use of Doppler
Ultrasound*

*During 11–14 Week Scans (or earlier in
pregnancy)*

Prudent Use in Pregnancy

*Conclusions Regarding Epidemiology for
Obstetric Ultrasound*

Keepsake Fetal Imaging

This practice parameter describes the elements of a limited obstetric ultrasound examination within the scope of practice of advanced clinical providers in women's health. The practice parameter is limited to singleton pregnancies. If a multiple gestation is unexpectedly identified, membrane characteristics should be recorded with representative images and the patient should be referred for a standard diagnostic or detailed ultrasound evaluation.^{6–8}

Incidental findings of potential clinical significance should prompt consultation with a physician who at minimum meets the AIUM Official Statement *Training Guidelines for Physicians Who Evaluate and Interpret Diagnostic Obstetric Ultrasound Examinations*.

II. Classification of Fetal Ultrasound Examinations Within the Scope of Practice for Advanced Clinical Providers

A. Limited First-Trimester Examination (up to 13 6/7 Weeks)

A limited obstetric ultrasound examination in the first trimester includes evaluation of the presence, size,

location, and number of gestational sac(s). The gestational sac is examined for the presence of a yolk sac and embryo/fetus. When an embryo/fetus is detected, the crown-rump length (CRL) should be measured and cardiac activity recorded by M-mode imaging or a 2-dimensional (2D) video clip. Pulsed Doppler ultrasound should not be used in the first trimester to “hear” the embryonic heartbeat.

The uterus, cervix, adnexa, and cul-de-sac region should be examined.

B. Limited Second- or Third-Trimester Examination

A limited obstetric ultrasound examination in the second or third trimester may be performed to answer a specific clinical question: for example, cardiac activity or fetal presentation. A limited obstetric ultrasound examination may also be performed in patients requiring serial examinations in which a subsequent anatomic evaluation may be unnecessary or impractical. A limited obstetric ultrasound examination does not include an evaluation of fetal anatomy, and in almost all cases, a standard diagnostic or detailed anatomic evaluation of the fetus has been or will be performed during the index pregnancy.

A limited second- or third-trimester ultrasound examination includes an evaluation of fetal number, cardiac activity, presentation, placental location with respect to the internal cervical os, and amniotic fluid volume. If requested, a limited obstetric ultrasound examination may include fetal biometry. Reliable fetal biometric measurements require anatomic familiarity with the midline falx, thalami, cavum septi pellucidi, columns of the fornix, cerebellum, stomach, umbilical vein as it courses through the liver, and femoral diaphysis.

C. Specialized Obstetric Ultrasounds

A biophysical profile (BPP) may be performed to assess fetal well-being.¹³ The ultrasound component monitors fetal movement, fetal tone, fetal breathing movements, and amniotic fluid volume. This study may be done in conjunction with fetal heart rate monitoring.

Other specialized examinations such as transvaginal cervical length measurement for risk stratification with respect to preterm delivery may be performed if the advanced clinical provider has attained additional education and competency qualifications and participates in ongoing quality monitoring if required.^{14–16}

III. Qualifications and Responsibilities of Personnel

Women's Health Nurse Practitioners, PAOGs, and CMNs/CMs who perform and interpret limited obstetric ultrasound examinations must meet the *AIUM Training Guidelines for Advanced Clinical Providers in Women's Health Performing Limited Obstetric Ultrasound Examinations*.

IV. Written Request for the Examination

An appropriately licensed advanced clinical provider, physician, or other health care provider under that provider's direction must originate the request for the examination. Clinical judgment should be used to determine the proper type of ultrasound examination performed. The written or electronic request for an ultrasound examination should provide sufficient information to allow for the appropriate performance and interpretation of the examination. The accompanying clinical information should be provided by a health care professional familiar with the patient's clinical situation and should be consistent with relevant legal and local health care facility requirements.

V. Specifications of the Examination

A. Limited First-Trimester Ultrasound Examination (Table 1)

T1

1. Indications

Indications for first-trimester ultrasound include but are not limited to:

- Confirmation of the presence of an intrauterine pregnancy;
- Confirmation of cardiac activity;
- Estimation of gestational age; and
- Adjunct ultrasound guidance for chorionic villus sampling, embryo transfer, and localization and removal of an intrauterine contraceptive device.

2. Imaging Parameters

Scanning in the first trimester may be performed either transabdominally or transvaginally. If a transabdominal examination is not definitive, a transvaginal scan is recommended. In some cases, a transabdominal examination may be needed if a transvaginal scan is not definitive.

- The uterus (including the cervix) should be evaluated for the presence of a gestational sac. If a gestational sac is seen, its location should be documented. The gestational sac should be

evaluated for the presence or absence of a yolk sac and embryo. If an embryo or fetus is identified, the CRL should be measured.¹⁷

Comment:

A definitive diagnosis of intrauterine pregnancy can be made when an intrauterine gestational sac containing a yolk sac or embryo/fetus with cardiac activity is visualized.

A small intrauterine fluid collection with an echogenic rim can be seen in the decidualized endometrium, before the yolk sac and embryo. In the absence of ultrasound signs of ectopic pregnancy, such a fluid collection is highly likely (>99.5%) to represent an intrauterine gestational sac.^{18,19} A follow-up ultrasound examination and/or serial determination of maternal serum human chorionic gonadotropin levels are appropriate in pregnancies of undetermined location to avoid inappropriate intervention in a potentially viable early pregnancy.^{18–21} Although unlikely, an intrauterine fluid collection could represent a “pseudo-gestational sac” associated with an ectopic pregnancy. If an intrauterine pregnancy is not definitively identified, consultation with a physician provider who at minimum meets the AIUM Official Statement *Training Guidelines for Physicians Who Evaluate and Interpret Diagnostic Obstetric Ultrasound Examinations* is recommended.

The mean gestational sac diameter is not recommended for estimating a due date.⁷ The CRL is a more accurate indicator of gestational age than is the mean gestational sac diameter. The CRL should be measured in a standardized manner with the

Table 1. Components of a Limited First-Trimester Obstetric Ultrasound Examination of a Singleton Fetus

Presence and location of gestational sac
Presence or absence of yolk sac
Presence or absence of embryo/fetus: singleton
Presence or absence of cardiac activity (record by M-mode or video clip)
If embryo or fetus present, CRL
Cervix
Cul-de-sac
Uterus
Adnexa

ALARA: TIS at less than 10 weeks' gestational age; TIB at 10 weeks' gestation or greater (ratio <0.7).

embryo/fetus filling most of the image space. In the later first trimester, the fetus should be in a neutral midsagittal position with the entire CRL shown. The ultrasound beam should be perpendicular to the embryo/fetus, and the calipers should be placed on the outer border of the skin from the head to the rump.²²

T2

Guidelines for redating a pregnancy based on ultrasound are shown in Table 2. Once gestational age has been established based on the last menstrual period (LMP) and first accurate ultrasound evaluation, an estimated due date should be determined. Subsequent changes should be carefully considered and reserved for unusual circumstances.²³

- b. The presence or absence of cardiac activity should be documented with M-mode imaging or a 2D video clip. Pulsed Doppler ultrasound should not be used in the first trimester to “hear” the heartbeat.

Comment:

With transvaginal imaging, cardiac motion is usually observed when the embryo is 2 mm or greater in length. If an embryo less than 7 mm in length is seen without cardiac activity, a subsequent scan in 1 week is recommended to determine viability.^{6,18,19}

- c. Fetal number should be documented.

If a multiple gestation is unexpectedly identified, membrane characteristics should be recorded with representative images, and the patient should be referred for a standard diagnostic or detailed ultrasound evaluation.^{6–8}

- d. The uterus, including the cervix, adnexal region, and cul-de-sac, should be evaluated.

Comment:

The presence, location, appearance, and size of adnexal findings should be documented. The cul-de-sac should be evaluated for the presence or absence of fluid.

B. Limited and Specialized Second- or Third-Trimester Ultrasound Examination (Table 3)

T3

1. Indications

Indications for a second- or third-trimester limited obstetric ultrasound examination include but are not limited to:

- a. Confirmation of cardiac activity;
- b. Estimation of gestational age;
- c. Determination of fetal presentation;
- d. Evaluation of amniotic fluid volume;
- e. Evaluation of fetal growth, size/date discrepancy;
- f. Evaluation of fetal well-being;
- g. Evaluation of placental location, including relationship with the internal cervical os;
- h. Adjunct ultrasound guidance for amniocentesis, external cephalic version, or other procedure; and
- i. Cervical length assessment (requires additional specialized education, training, and credentialing).^{14,15}

2. Imaging Parameters for a Limited and Specialized Second- or Third-Trimester Fetal Examination

- a. Fetal number, cardiac activity, and presentation should be documented.

Comment:

If an abnormal heart rate and/or rhythm is identified or a multiple gestation is noted, referral to a qualified physician provider who at minimum meets the AIUM Official Statement *Training Guidelines for Physicians Who Evaluate and Interpret Diagnostic Obstetric Ultrasound Examinations* is recommended.

- b. A semiquantitative estimate of amniotic fluid volume (single deepest vertical pocket [DVP] or 4-quadrant amniotic fluid index [AFI]) should be documented.

Table 2. Guidelines for Redating Based on Ultrasound²³

Gestational Age Range (Based on LMP), wk	Method of Measurement	Discrepancy Between Ultrasound Dating and LMP Dating That Supports Redating, d
<13 6/7	CRL	>5
<8 6/7		>7
9 0/7–13 6/7		
14 0/7–15 6/7	BPD, HC, AC, FL	>7
16 0/7–21 6/7	BPD, HC, AC, FL	>10
22 0/7–27 6/7	BPD, HC, AC, FL	>14
≥28 0/7 ^a	BPD, HC, AC, FL	>21

^aBecause of the risk of redating a small fetus who may be growth restricted, management decisions based on third-trimester ultrasound alone are especially problematic and need to be guided by careful consideration of the entire clinical picture and close surveillance.

Comment:

The pocket of amniotic fluid should not include fetal parts or the umbilical cord and must be at least 1 cm in width.^{24–27}

Oligohydramnios is defined as a DVP less than 2 cm or AFI of 5 cm or less. The single DVP is the preferred method of assessment for oligohydramnios, as it is associated with fewer obstetric interventions without a significant difference in the perinatal outcome.^{24–27} Polyhydramnios is defined as a single DVP of 8 cm or greater or AFI of 24 cm or greater.²⁶

- c. The placental location, appearance, and relationship with the internal cervical os should be documented.

Comment:

It is recognized that the apparent placental position early in pregnancy may not correlate well with its location at the time of delivery. Transvaginal (or transperineal) ultrasound is recommended if the relationship of the edge of the placenta with the internal cervical os is uncertain or cannot be adequately visualized during the transabdominal ultrasound examination.

For pregnancies beyond 16 weeks, if the placental edge is 2 cm or greater away from the internal os, the placental location should be reported as normal. If the placental edge is less than 2 cm from the internal os but not covering the internal os, it should be labeled as low lying, and a follow-up ultrasound examination is recommended at 32 weeks' gestation. If the placental edge covers the internal cervical os, the placenta should be labeled as a placenta previa, and a follow-up

ultrasound examination is recommended at 32 weeks' gestation. At the follow-up examination at 32 weeks, if the placental edge is still less than 2 cm from the internal os (low lying) or covering the cervical os (placenta previa), follow-up transvaginal imaging at 36 weeks' gestation is recommended. These recommendations are for asymptomatic women. Earlier follow-up may be appropriate in women who are bleeding.²⁶

Comment:

When following up placental location, the evaluation of the relationship of the placenta with the internal cervical os must include an evaluation for residual vessels that may cross the internal os (vasa previa), a condition associated with high fetal mortality if not diagnosed before labor.^{28–30} Color flow imaging to assess vasa previa should be performed.³⁰

- d. Gestational age assessment

First-trimester crown-rump measurement is the most accurate means for ultrasound dating of pregnancy. Beyond this period, a variety of ultrasound parameters such as biparietal diameter (BPD), abdominal circumference (AC), and femoral diaphysis length (FL) can be used to estimate gestational age. The variability of gestational age estimation, however, increases with advancing pregnancy.³¹

Significant discrepancies between gestational age and fetal measurements may suggest the possibility of a fetal growth abnormality, intrauterine growth restriction, or macrosomia.^{31–33}

Comment:

The pregnancy should not be redated after an accurate earlier scan has been performed and is available for comparison.²³

- i. The BPD is measured at the level of the thalami and cavum septi pellucidum or columns of the fornix. The cerebellar hemispheres should not be visible in this scanning plane. The measurement is taken from the outer edge of the proximal skull to the inner edge of the distal skull.

Comment:

The head shape may be elongated (dolichocephaly) or rounded (brachycephaly) as a normal variant.

Table 3. Components of a Limited Second- or Third-Trimester Ultrasound Examination of a Singleton Fetus

Fetal cardiac activity (M-mode or video clip)
Fetal number: singleton
Fetal presentation
Amniotic fluid volume
Placental location with respect to internal cervical os
Cervix ^a
Fetal biometry if requested:
BPD and/or HC
Abdominal diameter or AC, if estimating fetal weight
FL
Uterus, adnexa
BPP (if requested)

ALARA: TIB (ratio <0.7)

^aTransvaginal cervical length assessment requires additional education and assessment.

Under these circumstances, certain variants of normal fetal head development may make measurement of the head circumference (HC) more reliable than BPD for estimating gestational age.

- ii. The HC is measured at the same level as the BPD. Head circumference is measured along the outer perimeter of the bony calvarium, excluding the soft tissue. This measurement is not affected by head shape.
- iii. The FL can be reliably used after 14 weeks' gestational age. The long axis of the femoral shaft is most accurately measured with the beam of insonation being perpendicular to the shaft, excluding the distal femoral epiphysis. Calipers are placed at the end of the ossified diaphysis.
- iv. The AC or average abdominal diameter should be determined at the skin line on a true transverse view at the level of the junction of the umbilical vein, portal sinus, and fetal stomach when visible.

e. Fetal weight estimation

Fetal weight can be estimated from measurements such as the BPD, HC, AC or average abdominal diameter, and FL. Results from various prediction models can be subsequently compared to fetal weight percentiles from published normograms.^{31–33}

Comment:

If previous studies have been performed, appropriateness of growth should also be documented. Scans for growth evaluation can typically be performed at least 3 weeks apart. A shorter scan interval may result in confusion as to whether measurement changes are truly due to growth as opposed to variations in the technique itself.³⁴

Currently, even the best fetal weight prediction methods can yield errors as high as $\pm 15\%$. This variability can be influenced by factors such as the nature of the patient population, the number and types of anatomic parameters being measured, technical factors that affect the resolution of ultrasound images, and the weight range being studied.

f. Maternal anatomy

Evaluation of the uterus, cervix, and adnexa should be performed when appropriate.

If the cervix is not adequately visualized or appears abnormal (shortened or funneled) on a transabdominal examination, a transvaginal (or transperineal) ultrasound examination is recommended when evaluation of the cervix is needed.

If a referring health provider desires a precise cervical length measurement for risk stratification with respect to preterm delivery, a transvaginal measurement of the cervix should be performed in accordance with current education and imaging guidelines (Figure 1 and Table 4). An advanced clinical provider who chooses to perform ultrasound measurements of the cervical length should have additional specialized education, training, and credentialing in this technique. Organizations currently providing education and competency assessment include the Cervical Length Education Review Program (CLEAR) sponsored by the Perinatal Quality Foundation (www.perinatal-quality.org) and the Fetal Medicine Foundation (www.fetalmedicine.org).^{14,15}

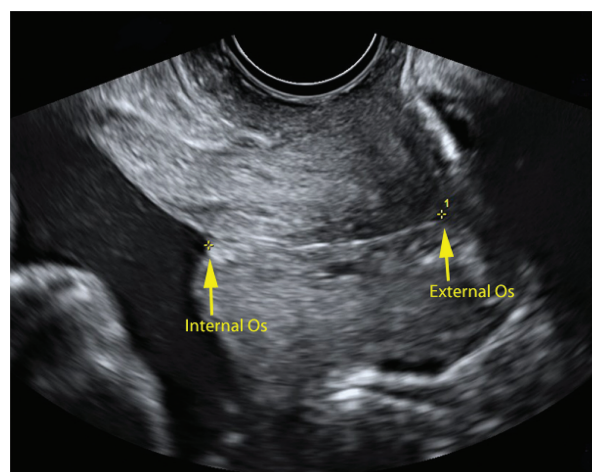
F1
T4

C. Biophysical Profile for Fetal Well-being: Ultrasound Criteria¹³

A biophysical profile (BPP) may be done to assess fetal well-being. This examination is generally performed in the later second or third trimester in patients at increased risk for antepartum stillbirth:

Figure 1.

A contraction in the lower uterine segment that meets in the midline may obscure the internal os, giving the false impression of a longer endocervical canal. Excessive pressure against the cervix with the ultrasound transducer may also falsely elongate the cervix.



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1. Fetal breathing movements—at least 1 episode of rhythmic fetal breathing of 30 seconds or longer within 30 minutes;
2. Fetal body movements—at least 3 discrete body or limb movements within 30 minutes;
3. Fetal tone—at least 1 episode of extension of a fetal extremity with return to flexion or opening and closing of a hand; and
4. Amniotic fluid volume—a single DVP of fluid that does not include the cord or fetal parts (extremities), measuring at least 2 cm in depth and 1 cm in horizontal width.

Each of the 4 areas is given a score of 2 points if the above criteria are met or a score of 0 if the criteria are not met, for a possible total of 8 points. A score of 8 is reassuring. A score of 6 is equivocal (neither reassuring nor nonreassuring). A score of 4 or less is abnormal. Regardless of the BPP score, an inadequate amount of amniotic fluid (single DVP $< 2 \times 1$ cm without fetal parts) requires further evaluation.¹² Clinical management depends on gestational age and obstetric circumstances.

VI. Documentation

Adequate documentation is essential for high-quality patient care. There should be a permanent record of the limited obstetric ultrasound examination and its interpretation. Image documentation, image retention, and reporting of the limited obstetric ultrasound examination should be in accordance with the *AIUM Practice Parameter for Documentation of an Ultrasound Examination*.

Table 4. Criteria for Standardized Transvaginal Cervical Length Assessment

Bladder empty: transvaginal scan
Cervix occupies 75% of available image space
Anterior and posterior cervixes are of equal thickness
Internal and external cervical os are seen
Endocervical canal is seen throughout
Calipers placed at the internal and external os where the anterior and posterior walls of the cervix meet; if the endocervical canal curves, $>$ linear measurements should be used and added together to obtain the cervical length
Dynamic cervical shortening: exam time 3–5 minutes and/or suprapubic/fundal pressure
Record shortest best measurement

Adapted from the Perinatal Quality Foundation.¹⁴

VII. Equipment Specifications

Limited obstetric ultrasound examinations should be conducted in real time, using a transabdominal and/or transvaginal approach. A transducer of the appropriate frequency should be used.

The choice of the transducer frequency is a trade-off between beam penetration and resolution. With modern equipment, 3- to 5-MHz abdominal transducers allow sufficient penetration in most patients while providing adequate resolution. During early pregnancy, transvaginal ultrasound may provide superior resolution while still allowing adequate penetration.

VIII. Fetal Safety and ALARA

Diagnostic ultrasound studies of the fetus are generally considered safe during pregnancy. The potential benefits and risks of each examination should be considered. This diagnostic procedure should be performed only when there is a valid medical indication. The ALARA principle (as low as reasonably achievable) should be observed when adjusting controls that affect the acoustic output and by considering transducer dwell times. The lowest possible ultrasonic exposure setting should be used to gain the necessary diagnostic information.^{9–11}

A thermal index for soft tissue (TIS) should be used at earlier than 10 weeks' gestation, and a thermal index for bone (TIB) should be used at 10 weeks' gestation or later when bone ossification is evident. A ratio of less than 0.7 is considered appropriate. In keeping with the ALARA principle, M-mode imaging or a 2D video clip should be used for documentation of cardiac activity. Pulsed Doppler ultrasound is discouraged.^{9–11}

Obstetric ultrasound examinations should only be performed when there is a valid medical reason. The use of ultrasound to solely determine fetal sex is inappropriate. The promotion, selling, or leasing of ultrasound equipment for making “keepsake fetal videos” is considered by the US Food and Drug Administration to be an unapproved use of a medical device. Use of a diagnostic ultrasound system for these purposes may be in violation of state laws or regulations.¹²

IX. Quality Control and Improvement, Safety, Infection Control, and Patient Education

Policies and procedures related to quality control, patient education, infection control, and safety should be

developed and implemented in accordance with the *AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices*.

Any transducer that is in direct contact with body fluids or mucosa must be covered with a single-use protective sheath before use. All transducers must be cleaned after each examination by removing the transducer cover (if applicable) and manually/mechanically removing any residual gel and organic debris. The transducer should be wiped down with soap and water or quaternary ammonium (a low-level disinfectant) sprays or wipes. It should then be rinsed with water and dried. In addition, any transducer in contact with body fluids or mucosa (eg, endocavitary/transperineal) must undergo high-level disinfection. The type of solution and the time for cleaning depend on the manufacturer and infectious disease recommendations. Protocols for transducer cleaning and safe handling of ultrasound coupling gel are available in the *AIUM Official Statement Cleaning and Preparing External- and Internal-Use Ultrasound Probes Between Patients & Safe Handling and Use of Ultrasound Coupling Gel*.

Ongoing quality of imaging studies and provider performance should be monitored in a quality assurance program. Ultrasound equipment must meet all state and federal guidelines. The equipment used for limited obstetric ultrasound examinations must be maintained in good operating condition and undergo routine quality assurance at least once a year in accordance with the *AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices*.

Acknowledgments

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Members represent their societies in the initial version and final revision of this parameter.

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