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PREGNANCY Society for Maternal-Fetal Medicine

SMFM SPECIAL STATEMENT

Developing an optimal maternal-fetal medicine ultrasound practice: A report and recommendations of the workshop of the Society for Maternal-Fetal Medicine

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[Correction added 13 June 2025, after first online publication: Juliana G. Martins has been added to the byline and Jean L. Spitz's name has been corrected in this version.]

Abstract

This article is a report of a 2-day workshop titled "Developing an Optimal Maternal-Fetal Medicine Ultrasound Practice," held during the Society for Maternal-Fetal Medicine's 2023 Annual Pregnancy Meeting. Participants' fields of expertise included obstetrics and gynecology, sonography, maternal-fetal medicine, genetics, and genetic counseling. The American College of Obstetricians and Gynecologists, American Institute of Ultrasound in Medicine, American Registry for Diagnostic Medical Sonography, International Society of Ultrasound in Obstetrics and Gynecology, Gottesfeld-Hohler Memorial Foundation, and Perinatal Quality Foundation cosponsored the workshop. The workshop included presentations and small group discussions, and its goals were to accomplish the following:

1. Review best practices and emerging technologies for designing and running an efficient obstetrical ultrasound unit
2. Discuss strategies for quality assurance in the setting of obstetrical ultrasound at the individual provider and unit level
3. Identify needs and opportunities for ongoing education and training in ultrasound imaging and ultrasound-guided procedures for maternal-fetal medicine fellows, physicians, and sonographers
4. Review current and emerging approaches to managing the pregnant patient with obstetrical ultrasound abnormalities

KEYWORDS
diagnostic techniques, high-risk pregnancy complications, obstetrics and gynecology, pregnancy, quality assurance, ultrasonography

1 | INTRODUCTION

The field of maternal-fetal medicine (MFM) has seen significant growth and advancements in recent years. In 2010, there were an estimated 1355 active MFM subspecialists in the United States;[1] the total grew to 2079 in 2024, according to Society for Maternal-Fetal Medicine (SMFM) membership data. From 2010 to 2022, the number of MFM fellowship positions expanded from 60 to 139 [1, 2]. Concomitantly, there have been significant advances in ultrasound technology, fetal imaging, prenatal genetic testing, and fetal interventions. With this growth, marked disparities in training and clinical practice have been identified, highlighting the importance of quality oversight and consistency in the utilization and application of ultrasound to optimize patient care. Recognizing this need, an SMFM President's Workshop was organized to establish a contemporary expert opinion on the utilization and application of ultrasound within MFM practices. To ensure comprehensive expertise, the workshop invited leaders in the field of MFM sonography with experience in ultrasound unit administration, quality assurance (QA), MFM fellow training, simulation, genetics, and fetal intervention. It is important to highlight that, for many of the issues addressed, there are no systematically acquired data to provide guidance. Therefore, this document relays shared ideas and consensus opinions among experts in obstetrical ultrasound. The goals of the workshop were to:

- Review best practices and emerging technologies for designing and running an obstetric ultrasound unit, specifically how to:
  - Establish an infrastructure for ultrasound practice in MFM
  - Design a schedule that optimizes workflow and limits wait time
  - Devise an ultrasound unit with uniform rooms containing supplies, projection screens for patients, and appropriate seating for family members
  - Create a practice that supports patient safety and clinician health through applied workplace ergonomics
- Discuss strategies for QA in the setting of obstetric ultrasound via:
  - Utilizing standardized metrics for onboarding new physician-sonologists and sonographers to gauge competency
  - Identifying and tracking quality benchmarks by assessment of ultrasound unit practice performance, including diagnosis of fetal anomalies, growth disturbance, unexpected findings, and other adverse outcomes
- Promote opportunities for ongoing education and training in ultrasound imaging and ultrasound-guided procedures for MFM physicians and sonographers by:
  - Developing ultrasound educational curricula for MFM fellows to perform the full scope of obstetrical ultrasound procedures, including detailed fetal anatomic assessments and fetal echocardiography in all trimesters of pregnancy [3, 4]
  - Promoting continuing medical education (CME) with credits in ultrasound to provide best practices for implementation
  - Establishing a credentialing pathway for MFM sonographers that integrates specialized education and training to advance their expertise and professional recognition
  - Fostering the role and utility of an advanced practice sonographer in MFM practice [5, 6]
- Review current and emerging approaches to managing the pregnant individual with abnormalities detected on obstetric ultrasounds by:
  - Accessing clinicians, such as genetic counselors, with special expertise in interpreting and managing abnormal ultrasound findings
  - Utilizing best practices for effective communication of ultrasound findings with referring physicians

2 | BACKGROUND

A survey consisting of 33 questions was sent to 283 participants to inform workshop presentations and discussions (Table 1). The survey was sent before the workshop, and the results were shared during the opening session and the breakout sessions. The response rate to the survey was 48%.

There are multiple staffing and unit design considerations that impact sonographer and physician-sonologist well-being, including work-related musculoskeletal disorders (WRMSD) [7] which are experienced by 90% of sonographers, costing employers over $120 billion annually in direct and indirect costs [8].

Standardization of room design improves workflow and diminishes variability in equipment and supply placement. Optimally, each room should be organized utilizing a standardized placement so that the sonographer can locate supplies easily. Screens for the patient to visualize the ultrasound should be placed in a way that allows easy viewing, and family seating should be included in the room design if possible. Standardization of terminology and reporting requirements for ultrasound are essential [9]. A 2019 SMFM Practice Management Division benchmarking survey reported that > 60% of respondents reported no

TABLE 1 Results of a survey distributed to workshop attendees.

Question	*n* (%)
Who puts in the billing (CPT) codes for ultrasound examinations?	
Sonographer	49 (36%)
Physician	60 (44%)
Coder/biller	14 (10%)
Other (please specify)	13 (10%)
Which of the following is most representative of your ultrasound practice?	
Physician is expected to back scan (physically scan after the sonographer) and talk to every patient	16 (12%)
Physician is expected to backscan some patients (e.g., anatomy scans)	30 (22%)
Backscanning is at the discretion of the physician and depends on the case	68 (50%)
Physician rarely backscans	21 (16%)
In your opinion, how many 76811 scans is the most that a single sonographer should perform in a hypothetical 8-h day?	
5 or fewer	66 (49%)
6–8	51 (38%)
9–11	15 (11%)
12+	3 (2%)
How frequently do you perform a perinatal consult at the time of scan?	
On every scan	10 (7%)
The majority of scans	19 (14%)
Only for abnormal findings	95 (71%)
Never	10 (7%)
Why do you perform audits?[a]	
Meet accreditation requirements	86 (72%)
Evaluate imaging personnel	66 (55%)
Personal concern for quality	55 (46%)
Not applicable—Practice does not perform regular audits	20 (17%)
How often does your ultrasound unit perform structured (dedicated time/place) audits of your ultrasound examinations for completeness and quality of image acquisition and/or review of findings?[a]	
Never or rarely	27 (23%)
One of two times a year	30 (26%)
Three to four times a year	19 (17%)
Every month	23 (20%)
When a problem arises	34 (30%)
How are your cases selected for audit?[a]	
Random	40 (35%)
Chosen by each sonographer	14 (12%)
Submitted by physician staff	26 (23%)
Cases with adverse outcomes or fetal anomalies (diagnosed and/or missed)	51 (45%)
All cases in a predefined time period (day/week)	11 (10%)
Not applicable—Practice does not perform regular audits	24 (21%)
Other (please specify)	14 (12%)
Who performs your QA?[a]	
Director of ultrasound	49 (42%)
Chief sonographer	49 (42%)
Senior imagers (physicians or sonographers) assigned to review cases	37 (32%)
Teaching/QA sonographer or physician	21 (18%)
Not applicable—We do not perform regular QA	17 (15%)
Other (please specify)	8 (7%)
How many ultrasounds do you read in an 8-h day?	
5–10	6 (5%)
11–20	17 (14%)
21–30	23 (19%)
31–40	28 (23%)
41–50	26 (21%)
51–60	10 (8%)
61–80	5 (4%)
>80	6 (5%)
Our fellows are taught[a]	
Coding	41 (36%)
Report preparation	76 (66%)
Equipment selection/purchase	13 (11%)
Efficient management of ultrasound unit	41 (36%)
None of the above	32 (28%)
For current or recently graduated (last 3 years) fellows: How much time do you spend in the ultrasound unit during your 3 years of training?	
3 months as block(s)	0 (0%)
3 months broken up	6 (6%)
4–6 months as blocks	5 (5%)
4–6 months broken up	6 (6%)
6+months as blocks	17 (17%)
6+ months broken up	9 (9%)
3 months as a mix of blocks and "days/nights/weekends"	1 (1%)
4–6 months as a mix of blocks and "days/nights/weekends"	0 (0%)
6+ months as a mix of blocks and "days/nights/weekends" throughout the 3 years	5 (5%)
Not applicable—Not a current or recently graduated fellow	54 (52%)
Other (please describe)	0 (0%)

(Continues)

TABLE 1 (Continued)

Question	*n* (%)
How do most MFM practitioners receive education/CME regarding ultrasound?[a]	
Regular ultrasound conferences at my institution	63 (56%)
AIUM	69 (61%)
SMFM	84 (74%)
ISUOG	49 (43%)
None of the above	2 (2%)
Other (please specify)	17 (15%)
How do most sonographers receive CME?[a]	
Regular ultrasound conferences at my institution	54 (50%)
AIUM	53 (49%)
SMFM	10 (9%)
ISUOG	6 (6%)
None of the above	10 (9%)
Other (please specify)	28 (26%)
How many genetic counselors do you employ?	
0	10 (8%)
1	26 (22%)
2	25 (21%)
3	19 (16%)
4	15 (13%)
5+	23 (19%)
Who are your genetic counselors employed by?	
Your institution, in your department	81 (69%)
Your institution, in a different department	23 (20%)
A laboratory that you utilize for genetic testing	3 (3%)
An outsourced genetic counseling company	1 (1%)
We do not have genetic counselors	6 (5%)
Other (please specify)	3 (3%)
When you have an ultrasound finding, where do you most often counsel patients?	
In the ultrasound room	77 (65%)
In a separate consult room	34 (29%)
Send to the genetic counselor for counseling	2 (2%)
Schedule counseling on a different day	5 (4%)
How do you most often communicate abnormal findings to a referring doctor?	
By ultrasound report	48 (41%)
By calling the referring physician/office	47 (40%)
By texting the referring physician	2 (2%)
Through electronic health record (EHR)	20 (17%)
What percentage of scans do you read remotely?	
None	36 (31%)
1%–25%	66 (57%)
26%–50%	9 (8%)
51%–75%	3 (3%)
76%–99%	1 (1%)
100%	0 (0%)
If you read remotely, when do you interact (video visit, phone call, email) with the patient?[a]	
Never	20 (18%)
For significant findings	48 (43%)
For incomplete studies	5 (4%)
For all anatomy scans	2 (2%)
Always	7 (6%)
Not applicable—I do not read remotely	35 (31%)
How often is genetic counseling offered to patients referred for a fetal malformation?	
Always	97 (82%)
Sometimes	20 (17%)
Never	1 (1%)
What state do you practice in?[b]	
Alabama	1 (1%)
California	16 (14%)
Colorado	1 (1%)
Connecticut	5 (4%)
Florida	7 (6%)
Georgia	1 (1%)
Illinois	1 (1%)
Indiana	1 (1%)
Louisiana	1 (1%)
Maryland	1 (1%)
Massachusetts	8 (7%)
Michigan	3 (3%)
Minnesota	2 (2%)
Missouri	2 (2%)
Nebraska	2 (2%)
New Jersey	2 (2%)
New York	11 (9%)
North Carolina	1 (1%)
Ohio	7 (6%)
Oregon	3 (3%)
Pennsylvania	8 (7%)
Rhode Island	2 (2%)
South Carolina	5 (4%)
South Dakota	1 (1%)
Tennessee	2 (2%)
Texas	8 (7%)
Virginia	2 (2%)
Washington	4 (3%)
Wisconsin	1 (1%)
Outside of the United States (please specify)	8 (7%)

(Continues)

TABLE 1 (Continued)

Question	*n* (%)
What is your gender?	
Female	85 (73%)
Male	28 (24%)
Nonbinary	1 (1%)
Prefer not to answer	3 (3%)
Other	0 (0%)
What is your current age?	
30–39	35 (30%)
40–49	45 (38%)
50–59	22 (19%)
60–69	13 (11%)
70+	2 (2%)
What is your ethnicity?[a]	
American Indian or Alaskan Native	1 (1%)
Asian or Pacific Islander	17 (15%)
Black or African American	10 (9%)
Hispanic, Latino/a, or of Spanish origin	4 (4%)
White / Caucasian	77 (68%)
Prefer not to answer	9 (8%)
Other (please specify)	2 (2%)
How long have you been performing ultrasound within your practice?	
Current fellow	13 (11%)
1–5 years	35 (30%)
6–10 years	20 (17%)
11–20 years	24 (21%)
Over 20 years	23 (20%)
Which of the following best describes your primary practice site?[a]	
Academic setting	97 (82%)
Private practice	12 (10%)
Community hospital	21 (18%)
How many total ultrasound rooms do you cover in a day (in person and remotely)?	
1–5	56 (49%)
6–10	46 (40%)
11–15	11 (10%)
16+	2 (2%)
How many sonographers do you employ?	
1–4	10 (9%)
5–12	52 (45%)
13–20	38 (33%)
21+	15 (13%)
Do fellows rotate as sonographers through your ultrasound unit or do they scan after sonographers?	
Fellows rotate as sonographers	19 (20%)
Fellows scan after completion of sonographer scan	37 (38%)
Both	41 (42%)
Do you perform GYN scans in your unit?	
Yes, routinely	32 (27%)
Sometimes	35 (30%)
Never	50 (43%)
Do MFM sonographers/fellows perform the technical component of fetal echocardiograms?	
Yes, routinely	56 (49%)
Sometimes	27 (24%)
Never	31 (27%)
If your practice is accredited, what specialty areas are you accredited in?[a]	
OB Standard all trimesters	101 (90%)
OB 1st trimester	64 (57%)
OB 2nd trimester	68 (61%)
Detailed 1st trimester	53 (47%)
Limited OB for Advanced Clinical Providers	17 (15%)
Fetal Echocardiography	55 (49%)
Gynecologic Ultrasound	31 (28%)
My practice is not accredited	6 (5%)

[a]Respondents could choose more than one answer.
[b]States selected by zero respondents are not shown.

discrete data transfer between their ultrasound reporting system and the electronic health record (EHR). The SMFM Clinical Informatics Ultrasound Subcommittee recently published expert opinions on best practices in obstetric ultrasound data communication and data element standardization [9]. For ultrasound orders, it is recommended to utilize the generalized order design approach and embed a conditional request for additional services based on initial study results. For ultrasound-acquired data, the newly developed standards for data transmission should be employed. For coding and billing, the ultrasound reporting system should integrate with the EHR and the procedural codes (CPT) and associated indications (ICD-10) should be easily searchable within the ultrasound reporting system if not auto-populated.

QA programs are required for American Institute of Ultrasound in Medicine (AIUM) and American College of Radiology (ACR) facility accreditation and to improve performance and training, but these programs are

time-consuming and expensive [10, 11]. Practices should monitor outcomes such as correct detection of anomalies, accuracy of fetal growth measurement, frequency of incomplete exams, and unexpected adverse events related to ultrasound. The timing and implementation of monitoring will vary according to practice type. Furthermore, the models for performing reviews have not been established, and a uniform template to collect data may be useful.

MFM fellowships must develop trainee competence in ultrasound, but there is wide variation in program requirements [4]. A recent consensus report describes a core curriculum and competency assessment for MFM fellows in the performance of the detailed obstetric ultrasound to assist in standardizing certain competencies [12].

Additional oversight and educational needs assessments are critical, including evaluating how to incorporate training in invasive procedures such as chorionic villus sampling (CVS) or amniocentesis in MFM fellowship curricula. As the number of diagnostic procedures declines, attaining adequate training becomes more challenging. It is well known that increasing operator experience improves successful completion and decreases procedural-related loss rates. However, there is currently no established volume of procedures that guarantees competency [13, 14]. In a survey sent to 310 MFM fellows, 68% had no requirement for the number of CVS procedures performed priorto graduation [14]. Providing trainees the opportunity to practice procedures on simulators before performing them on patients with ongoing pregnancies improves performance and decreases the risk of the procedure [14–16].

Communication of expectations regarding the ultrasound examination and discussion of results with the patient is vital. Many practices now use telehealth, and patients should know who will provide results and when; results should be provided ideally within 24 h. If certain findings, such as a diagnosis of fetal demise or a condition that necessitates acute management decisions, are sent, communication should be provided to the patient and the referring provider immediately. Communication with referring clinicians is critical, and protocols should be in place for secure and expeditious transmission of results and acknowledgment they were received.

All patients with anomalies found on ultrasound should be counseled about genetic testing options. Genetic counselors often provide this service, which may occur via telehealth. Ultrasound practices should promote multidisciplinary care that optimizes patient outcomes, including referral to fetal care centers and specialists who perform fetal therapy if clinically relevant [17, 18]. Care coordination between referring MFMs and fetal care centers is key to optimizing patient care.

Emerging technologies such as artificial intelligence (AI), virtual care, and home-use devices present opportunities to innovate ultrasound care models. Portable ultrasound devices and wearables can increasingly monitor maternal and fetal health throughout the care continuum. The expanding use of telehealth may alter models for prenatal care design [19]. AI in obstetrics may offer some advantages when enough data are available so that computational analysis will extract any and all patterns within the data and formulate a solution [20]. However, little research has been conducted on ethical issues, and no basic or translational research has been performed on AI in maternal-fetal conditions. Therefore, contributions are at the proof of concept and feasibility stage [21, 22]

3 | KEY FINDINGS

The following key findings emerged after the individual working groups convened at the meeting:

- The efficiency of the ultrasound unit is affected by the physical layout of the unit. The scheduling of ultrasound exams should take the type of ultrasound examination and the sonographer's expertise into account, allowing for adequate time to complete the study, including the interpretation of the findings. A system of incorporating emergencies and delays should be built into the schedule. More data are needed regarding the appropriate number of scans that should be scheduled per sonographer and per MFM each day.
- Ergonomic education of sonographers and physicians is necessary to avoid WRMSDs. Additional physical supports, motorized beds, and staff breaks may ameliorate the risk of injury.
- An onboarding process for assessment of individual competency in performing and interpreting ultrasounds should be in place for clinicians new to a unit, whether sonographers or physicians. Training and familiarity with workplace protocols and procedures should be included in the onboarding process.
- Structured audits are an essential part of obstetrical ultrasound quality assessment. No data suggest the ideal frequency of audits, which prior performance results may influence.
- Ultrasound units should track outcomes, including fetal anomalies, growth disturbances, critical placental or vascular findings, and unexpected outcomes. These conditions should be monitored for accuracy in diagnosis, including false negative and false positive diagnoses.
- Fellow education in ultrasound varies among programs. There are substantial resources available for fellow education and training. Adherence to an ultrasound

curriculum with oversight for completion of training is critical. Programs should have access to additional resources to augment training, including specific courses designed by national and international societies and foundations.

- Familiarity with billing, coding, and report preparation should be part of fellowship education.
- Sonographer training and continuing education are key components of quality in obstetrical ultrasound. During this workshop, there was consensus that a plan should be developed for sonographers certified in obstetrics and gynecology (OB-GYN) to become MFM sonographers through specialized education and experience with high-risk obstetrics. As such, under the leadership of SMFM, a collaborative multi-society MFM Sonographer Certification Taskforce, including SMFM, AIUM, the Society of Diagnostic Medical Sonography (SDMS), and the American Registry for Diagnostic Medical Sonography (ARDMS), was proposed. The workshop also addressed the growing need for advanced practice sonographers (APS) in MFM. An APS is an experienced MFM sonographer with exceptional imaging skills and a comprehensive understanding of fetal anomalies and their associated disease processes and maternal disorders affecting pregnancy. The APS functions as a mid-level provider and physician extender and contributes to the expertise, efficiency, and quality of ultrasound practices. However, at present, there is no formal education or certification pathway for this, and, therefore, roles and responsibilities differ among MFM practices. The aforementioned task force has committed to developing the MFM certification pathway as the initial step in the OB-GYN sonographer career ladder. Once established, the next step will involve defining the metrics for becoming an MFM APS [6, 23, 24]
- When a fetal abnormality is detected, there are various approaches to counseling patients. Communication during the initial visit is paramount for a quality ultrasound unit, but there are many options for the way further counseling can take place. The role of genetic counselors was emphasized, as was the need to identify the appropriate time and space for more comprehensive counseling. A multidisciplinary approach toward counseling may include pediatric subspecialists, geneticists, and other clinicians with special expertise, which is critically important for a comprehensive fetal care team.
- Communicating results accurately and in a timely fashion is an important component of perinatal care. There are a variety of HIPAA-compliant pathways for communicating findings to referring physicians and other providers.
- When telehealth services are utilized, patients should be informed beforehand that a physician is not physically present and should be told when to expect communications of findings, ideally within 24 h of the exam.

3.1 | Best practices for design and daily operation of obstetric ultrasound unit

3.1.1 | Layout design of the ultrasound unit

It is important that vested personnel from the ultrasound unit be involved in planning the layout of the entire unit and individual scanning rooms. Patient privacy and comfort, as well as optimized conditions for ergonomic performance of the scan, should be at the forefront of the design. A suggested size of an ultrasound room is 150 ft^2, which allows adequate space to accommodate the clinician, equipment, and supplies. Within each individual ultrasound room, the positioning of the ultrasound equipment, patient bed, visitor chairs, and supply storage must allow for adequate space to scan ergonomically. It is recommended that the arrangement of the equipment and supplies be similar in each room to promote familiarity and efficiency. There should be a sink in each room or in close proximity that is easy to access and not disruptive to the patient experience. If financially and structurally feasible, a video monitor should be directly in front of the patient and visitors to allow them to comfortably view the examination (while not straining the ergonomic considerations for the performing clinician). While these are ideal best practice recommendations, certain restrictions on implementation may be a function of allottable space and other resources.

The physical layout of the unit, including clinical and administrative functions, has a significant impact on unit flow and should be designed to maximize productivity, comfort, and throughput. Many factors will be dictated by the Americans with Disabilities Act (ADA) standards, but attention to small details can impact efficiency and patient and staff satisfaction. If the ultrasound workload increases, there should be regular re-assessment of size and layout.

3.1.2 | Ergonomics in the ultrasound examination

It is of the utmost importance that trained sonographers and physician sonologists be retained within the workforce. WRMSDs affect up to 90% of clinicians who regularly perform medical ultrasound examinations [25]. This is of particular concern as the workload and patient complexity continue to increase in many ultrasound units.

FIGURE 1 Demonstration of patient positioning and support block to minimize arm and shoulder strain.

Contributing factors include the expanding number of required elements for each ultrasound examination and the added challenges of imaging the burgeoning population of pregnant patients living with obesity. National data suggest that up to 20% of sonographers will leave the profession, and an even higher percentage will need to take medical leave due to WRMSDs [25]. The main contributors leading to injuries are poor posture, poor patient and sonographer positioning, too many exams in a designated time window, inadequate work breaks, suboptimal equipment, and lack of understanding and application related to ameliorating the risk of injury. WRMSDs can be reduced by ensuring that the ultrasound bed's height and distance from the ultrasound equipment can be adjusted, allowing sonographers to sit or stand during exams. Strategically placed blocks or wedges can be used to support the arms and elbows of the sonographers and optimize patient positioning close to the sonographer to limit strain on arms and shoulders (Figure 1). Proper techniques for transabdominal or endocavitary (transvaginal) scanning can also help to reduce stress on wrists and shoulders [22]. Scheduling templates should allow for breaks, as even microbreaks lasting from 30 s to 3 min have been shown to decrease injuries [25]. Sonographer and physician-sonologist education regarding the ergonomics of performing an ultrasound exam is important in the reduction of WRMSDs and can mitigate the risk of injury. We recommend instituting a reporting and tracking system for musculoskeletal injuries within imaging units.

TABLE 2 Comparison of scheduling models.

Single master schedule	Individual sonographer schedule
• More efficient in the setting of delays • Urgent scans absorbed by the entire team • Float or Lead Sonographer (if available) can insert themselves into the schedule as needed	• More equality between sonographers • Easier to schedule procedures for specific physicians • Sonographer can review patient chart in advance • Allows for continuity between patients and sonographer

3.1.3 | Optimal scheduling

Advanced planning and consideration of the daily schedule are essential to a unit's efficiency and success. There are two general ways to organize a schedule: a master schedule for the entire unit or a schedule for each sonographer. In the master schedule model, all the exams are on the main schedule, and each sonographer takes the next patient in line when they are ready. This approach minimizes disruption to the overall day, particularly when there are new findings, late patients, or other unexpected delays. The downstream effect of these delays is absorbed into the schedule and across all sonographers. Alternatively, in the second model, each sonographer or room has an assigned schedule of patients. This ensures that each sonographer has a volume and variety of examination types commensurate with their expertise and training. Each model has pros and cons, and ultimately, it depends on the culture of the unit and the preferences of the sonographers and physicians (Table 2). Furthermore, the level of sonographer expertise may dictate a preference for one schedule over the other.

Delays are inevitable in obstetrical ultrasound units where emergencies and unexpected findings occur frequently. These clinical scenarios may require additional scanning time, patient counseling, or invasive procedures such as CVS or amniocentesis. Other delays include late patient or staff arrival to the unit. To minimize the effects on the remainder of the appointments, one approach is scheduling follow-up patients and growth ultrasounds before lunch and in the last slots of the day, as these evaluations are typically more predictable and may be performed without the immediate involvement of a physician. New patients, second-trimester anatomy surveys, and referrals for known anomalies should be scheduled at the beginning of the morning or afternoon. Another approach is to either have a lead sonographer or "float" who is not assigned any patients for the day. This person can accommodate inpatient ultrasound requests for hospital-based practices,

unscheduled urgent requests, or take patients from other schedules if there is a delay.

Benchmarks to inform best practices regarding how many scans are appropriate per sonographer and per MFM are needed. This is not as simple as dividing the hours in the day, as an ideal schedule will factor in time for pre-charting, report generation, and breaks. Each unique unit will have special considerations, and schedule development should always involve input from sonographers and physician-sonologists. There are some standards for time allotment for individual scans based on expert consensus [25], however, individual patient and unit factors and additional time for pre- and post-examination work were not accounted for. Additional considerations for time allotment include explaining the procedure, obtaining informed consent when appropriate, responding to patient questions or concerns, preparing and signing ultrasound reports, and discussing follow-up appointments.

In summary, ultrasound units are under increased pressure to expand the number of patients that can be seen and increase productivity, resulting in a need to improve efficiency to meet patient needs and financial demands. At the same time, it is critical to ensure that sonographers and physician-sonologists can keep up with these demands while focusing on performing and interpreting ultrasound examinations accurately and preserving their mental and physical health.

3.2 | Creating and maintaining quality standards for obstetric ultrasound

Ultrasound practice accreditation and utilization of a standardized peer-reviewed imaging protocol are considered the cornerstone for an optimal QA program. To achieve the most reliable and accurate information, clinicians who refer patients for an obstetrical ultrasound examination must provide a clinically appropriate indication (including pertinent history) for the correct study to be performed and interpreted accurately.

3.2.1 | Credentialing

In the United States, prenatal imaging typically involves collaboration between sonographers, advanced clinical providers such as certified nurse midwives (CNM), physician assistants (PA), and physician-sonologists. Sonographers should be registered by ARDMS or the American Registry of Radiologic Technologists (ARRT). Advanced clinical providers who perform and interpret obstetrical ultrasounds should meet the AIUM training guidelines for the performance of limited obstetrical ultrasounds. Physician-sonologists should meet the AIUM training guidelines for the type of ultrasound being performed [26, 27]. Almost half of the participants in this workshop felt that physicians performing fetal echocardiography should have additional certification (e.g., ARDMS Fetal Echocardiography certification). Others raised concerns about requiring physicians to obtain even more certification beyond that provided by the American Board of Obstetrics and Gynecology (ABOG) and pointed out the barriers to obtaining ARDMS credentialing. Some of these barriers include time to study for the ARDMS exam, including physics and obstetric ultrasound, which are prerequisites for taking the fetal echocardiogram certification. Recently, however, ARDMS has created a physician pathway to alleviate some of these obstacles [25].

Physician proficiency in scanning was deemed necessary by 58% of participants, while an additional 25% felt that at least a moderate level of skill was required. Only 17% of participants felt that the ability to interpret images was adequate. For quality obstetrical ultrasound, imagers of any discipline, regardless of years of experience, should undergo an onboarding process where individual competency in performance and interpretation of sonographic examinations is assessed prior to independent practice. In addition, onboarding should include training in the protocols, procedures, and processes used within the ultrasound unit. For physicians, competency should be assessed by the Medical Director of Ultrasound or another experienced imager and should include the scope of studies and procedures to be performed. A minimum of 5 observations per study type should be proctored, including invasive procedures such as CVS or amniocentesis; while this threshold is seemingly arbitrary, it is commonly utilized for image competency evaluations [11, 25].

3.2.2 | Structured audits

Review of practice quality requires large-scale audits to assess the completeness of sonographic evaluations and adherence to established imaging protocols. Targeted audits are needed to address individual image quality. These might be focused on the sonographic assessment of specific anatomic structures considered most critical or challenging (e.g., heart, brain, biometry, Doppler), where the accuracy of the data obtained affects management. Individual case reviews should include 5 or more randomly selected cases during a pre-set time period and should include structured, objective image reviews. Documentation of the study within the final report should be reviewed to identify any inaccuracies or discrepancies. The selection of "best case" representation, meaning an ultrasound examination with ideal images as is currently requested by accrediting bodies such as the AIUM, was deemed flawed as it did not reflect daily performance

under the variety of imaging conditions faced by providers. Audits should be performed by skilled imagers trained in objective scoring of cases or images to provide consistent evaluation without bias. Performance deficiencies, including deviations from imaging or reporting protocols, should be addressed individually and professionally, supplemented with supportive education and remediation. All clinicians performing ultrasounds and interpreting images should be reviewed. The cadence of audits should be consistent across imagers and depends on the practice setting. It is recommended that audits should be performed more frequently for individuals in whom deficiencies are identified and their progress monitored over time. The accuracy of prenatal diagnostics reflects the overall quality of an ultrasound unit. A global quality improvement review of the unit with respect to anomalies, growth disturbances, abnormal placentation, and unexpected outcomes should be performed with a focus on correlating prenatal and postnatal outcomes, including false positive and false negative results. A uniform template (Figure 2) that is modifiable and searchable is suggested to collate cases for review by a multidisciplinary group with an interest in prenatal imaging who then meet on a regular basis. The focus of this meeting is to review images and video clips of relevant studies with a discussion of optimization in diagnostic imaging quality from a technical perspective, as well as adherence and effectiveness of existing protocols. Similarly, sharing correct diagnoses of challenging cases enhances group performance, so it is suggested that regular attendance be required for all imagers in the unit.

3.2.3 | Teleultrasound

Teleultrasound is associated with increased levels of complexity in both diagnostic performance and communication of information to primary providers. Best practice includes liberal use of video clips to document relevant anatomy. The communication workflow between the sonographer, interpreting physician-sonologist, referring provider, and patient should be standardized, which becomes especially important when findings require emergent clinical care. The patient should be informed that the study is being interpreted remotely and by whom, as well as when a final report is expected to be available.

3.2.4 | Ongoing support for ultrasound quality assurance

Establishing and maintaining quality is time-consuming and expensive. Optimization will require partnerships with industry stakeholders, including utilizing automation such as AI. Administrative barriers include funding deficits for supporting staff in non-clinical non-revenue generating time. Additionally, there are significant limitations in the available ICD codes for case identification, leading to problematic linkages between prenatal and postnatal records.

3.3 | Needs and opportunities for education in obstetric ultrasound

3.3.1 | Maternal-fetal medicine physicians

Optimizing ultrasound unit quality and safety requires the highest standards of ongoing sonographic education and training of MFM physicians. Great disparities exist in MFM fellows' sonographic education, including differences in perceptions of what constitutes optimal theoretical, practical, and unit-specific training, how and by whom it should be delivered, time that should be spent in the ultrasound unit, and how to ensure competency [3, 4]. AIUM accreditation requires ongoing education of physicians, and there are numerous national and international resources for the completion of CME requirements. The workshop attendees arrived at recommendations addressing the greatest challenges and areas of educational need (Box 1).

It was agreed that ample time, likely in excess of the 3 months required by the Accreditation Council for Graduate Medical Education (ACGME) on the ultrasound unit during MFM fellowship training, will be required to address all areas of competent ultrasound performance.

3.3.2 | Scanning skills

There was no agreement amongst workshop participants regarding the need for MFM fellows or MFM physicians to become skilled sonologists. The consensus was that, while scanning skills vary among a wide range of MFM physicians, it is important for fellows in training to acquire practical skills to perform comprehensive and complex scans. MFM fellows begin fellowship with varying levels of sonographic experience depending on their residency training. The first step upon starting fellowship is to ensure that the competency requirements put forth in the consensus report by the AIUM Multi-Society Task Force in 2018 in OB-GYN residency training are met [28]. This requires the completion of a defined number of practical components based on the criteria for the standard obstetrical ultrasound (CPT 76805) examination, with 5 acceptable examples provided for each component to reflect competency. Subsequently, the fellows should work

Patient Name:		**MRN:**
Referring Clinician/Practice:		
Pertinent Prenatal Imaging Findings: ☐ Fetal anomaly(-ies): ☐ Placental abnormality(-ies): ☐ Cervical abnormality(-ies): ☐ Maternal: uterine/adnexal abnormality(-ies): ☐ Fetal growth disturbance: ☐ Suspected macrosomia EFW: ☐ Suspected fetal growth restriction EFW: ☐ Other:		
Relevant Prenatal Genetic Testing/Screening:		
Sub-specialty Prenatal Consults ☐ Pediatric Cardiology ☐ Pediatric Cardiovascular Surgery ☐ Pediatric Surgery ☐ Pediatric ENT ☐ Dysmorphology		☐ Pediatric Urology ☐ Pediatric Neurology ☐ Pediatric Neurosurgery ☐ Fetal surgery ☐ Other:
GA at Delivery:	**Delivery Hospital/Location:**	**Mode of Delivery:**
Postnatal Outcomes	**NICU Admission:** ☐ Yes ☐ No	**If YES:** **NICU Length of Stay (days):**
	Birth weight(s): Fetus A:	Fetus B: Fetus C:
	Postnatal Diagnosis(es):	
	Postnatal Imaging Results ☐ Echocardiogram ☐ MRI ☐ Ultrasound	**Postnatal Procedures/Surgeries**
	Postnatal genetic testing results (if applicable):	**Postnatal pathology/Autopsy (if applicable):**

FIGURE 2 Sample template for case review and quality assurance audits.

BOX 1: Areas of educational need for MFM practitioners

Scanning skills, including transvaginal ultrasound, image optimization, and interpretation
Performance of and guidance for invasive procedures
Fetal echocardiography and other advanced exam types
Billing and coding
Final report preparation
Unit management
Equipment selection and purchase

towards completing the requirements of the 2023 SMFM consensus report addressing competencies based on the detailed obstetrical ultrasound (CPT 76811) examination [12]. Like the residency requirements document, the consensus report uses similar grading criteria, has core and optional components, and requires 5 passing examples of each anatomic or Doppler component. Completion of both curricula should be the cornerstone of the MFM fellow's practical training. In addition, fellows may consider pursuing credentialing in ARDMS Obstetric and Gynecologic Sonography upon completion of their practical training, including fetal echocardiography.

One of the greatest challenges identified at the workshop was standardizing image review and feedback to fellows. For example, structured, objective image review utilizing the MFM competency metrics should be performed in a systematic manner by reviewers who are trained in image review and are part of the unit's QA team. With emerging technological advances, AI is likely to play a critical future role in training and quality review.

3.3.3 | Invasive procedures

The introduction of cell-free DNA screening has led to a significant decline in invasive procedures such as CVS or amniocentesis [29]. However, invasive testing remains the gold standard for genetic diagnosis and the ability to competently perform invasive procedures is vital to optimize prenatal care. Workshop participants acknowledged the critical role simulation plays in training MFM fellows to perform invasive and therapeutic procedures (e.g., intrauterine transfusion and shunt placement), among others.

3.3.4 | Gynecologic ultrasound

There is heterogeneity among MFM practices regarding the performance of gynecologic (GYN) sonography. Evaluation of the adnexa is part of an obstetrical first-trimester ultrasound. However, practices vary in the gynecological ultrasounds performed by MFM imagers. Some practices offer ultrasound of the female pelvis for specific conditions (e.g., ectopic pregnancies, cesarean scar ectopic pregnancies), and some do not perform any GYN ultrasound at all. There was consensus that in those practices wanting to incorporate GYN ultrasound, additional education and training are necessary [26].

3.3.5 | Fetal echocardiography

Fellows' experience in fetal echocardiography should be an integral component of training and may be accomplished under the guidance of sonographers certified in fetal echocardiography, qualified MFM physicians, or pediatric cardiologists. In addition, MFM fellows may consider pursuing ARDMS certification in fetal echocardiography. It is imperative to note that competency in fetal echocardiography requires dedicated training and in-depth knowledge of fetal cardiovascular diseases and, thus, comprehensive education in fellowship and thereafter [27].

3.3.6 | Billing and coding

Training in billing and proper coding should be ensured for all MFM fellows. This can be accomplished by shadowing MFM providers and by pursuing various courses dedicated to coding organized by SMFM and other sources.

3.3.7 | Report preparation

Proper communication between MFM providers and referring physicians ensures optimal patient management for the best maternal and neonatal outcomes. MFM fellows should be active participants in performing and interpreting obstetrical ultrasound examinations, generating final reports, and communicating directly with referring physicians. Various resources may be utilized in report preparation, such as unit-specific pre-written comments that can be programmed into many commercially available ultrasound reporting systems for automation. Using standard templates and dictation services adds to the efficiency and uniformity of the ultrasound report. Other considerations pertain to optimal communication of findings and reports to referring clinicians (e.g., by phone call, fax,

preliminary report in case of abnormal findings, final report, upload to EHR, etc.) and the provision of select images attached to the report for visual clarification of findings. Some units also add a disclaimer at the bottom of the report stating, "Prenatal ultrasound is unable to diagnose all structural or genetic abnormalities."

3.3.8 | Unit management

Efficient time management is a critical skill for the MFM fellows to learn once they have completed their practical training. This can be accomplished by working alongside the interpreting physician and observing how to supervise sonographers and trainees, review images, and complete reports in a streamlined manner.

3.3.9 | Equipment selection and purchase

MFM fellows lack training and preparation in evaluating sonographic equipment and deciding on the equipment configurations and transducers needed for various scanning scenarios. In addition, there is little training in most programs on what to look for in sonographic report-generating software in terms of communication with the EHR and research needs. Unit directors should involve their fellows in such decision-making discussions and negotiations with the industry. These conversations should include the anticipated needs of the ultrasound unit, quality of machines, ease of use, and financial and budgetary considerations.

3.3.10 | Maternal-fetal medicine (perinatal) sonographers

Diagnostic medical sonography has evolved exponentially in the past 20 years. While many practices utilize sonographers trained in obstetrical ultrasound, MFM practices should aim to integrate highly specialized sonographers with a unique and advanced skill set comprising technical expertise (Box 2), the ability to navigate complex clinical situations, and the skills to interact with challenging patients. Perinatal sonographers must be competent in sonographic pathology and potential complications in the pregnant person and fetus and skilled in communicating findings to MFM physicians. The workshop consensus was that training perinatal sonographers requires, at a minimum, 6 months to a year, depending on baseline experience, theoretical knowledge, and practice resources. Additional areas of expertise discussed were training and accreditation of sonographers in fetal echocardiography. A mechanism for the advancement of the OB-GYN sonographer to varying degrees of perinatal sonographer would provide opportunities for career development and skill enhancement, leading to increased job satisfaction and sonographer retention. As noted above, a multidisciplinary task force led by SMFM has been established to explore routes of credentialing for the advanced skillset required of a perinatal sonographer.

BOX 2: Perinatal sonographer competencies

Detailed first-trimester ultrasound [30]
Detailed anatomy examination in the second and third trimesters [31]
Transvaginal cervical length evaluation [32]
Assist with ultrasound-guided invasive procedures:
- Chorionic Villous Sampling (CVS)
- Amniocentesis
- Percutaneous umbilical cord sampling (PUBS)

Doppler studies and advanced imaging techniques (3D and 4D)
Recognition of genetic syndromes and their sonographic features
Familiarity with complex or abnormal cases associated with high-risk pregnancies
Fetal echocardiography certification is required (if within the sonographer scope of practice) to further distinguish knowledge base and technical expertise beyond the general OB-GYN (non-MFM) sonographer [33]

3.3.11 | Advanced practice sonographer

An advanced practice sonographer (APS), also referred to as an ultrasound practitioner (UP) or an advanced sonographer, has been shown to improve workflow and unit efficiency by serving as a physician extender in ultrasound practices [5, 23, 24]. It is envisioned that a perinatal sonographer with extensive experience and demonstrated excellence in that role may eventually serve as a physician extender with additional clinical or administrative responsibilities. The metrics for becoming a perinatal APS are the next step in advancing the professional echelons of the perinatal sonographer.

3.3.12 | Sonographer contributions to ultrasound unit management

Sonographers play an essential role in the management of an ultrasound unit. Their primary focus is to acquire

high-quality images of fetal and gynecologic structures based on established protocols. However, responsibilities have evolved in all sectors (private, community, and academic) with the growing need for unit efficiency as patient volume has increased and examination requirements have expanded. Sonographers contribute to the management of a unit by ensuring scheduling efficiency. Their administrative duties may include recording clinical indications for the ultrasound examination performed and accurate CPT coding for billing. Sonographers also participate in education on the unit, including onboarding new sonographers, overseeing the process of ultrasound accreditation, and participating in protocol development, research, and quality improvement initiatives. Finally, they may participate in equipment selection and purchase. Sonographers should participate in CME activities and acquire new skills as the field advances. In addition, regular skill evaluation identifies areas of improvement and opportunities for re-education. Employers should provide financial and time support for education to ensure equity in attaining the required CME.

3.4 | Current and emerging approaches to managing the pregnant person with fetal abnormalities detected on obstetric ultrasound

3.4.1 | Counseling when a major anomaly is identified

When a major anomaly is identified by ultrasound, practices should consider where and by whom this information is communicated to the patient. In the survey of workshop participants, about 65% stated that they counsel patients regarding fetal anomalies in the ultrasound room, 28% in a separate consult room, 5% are scheduled for counseling at a different time, and 3% are referred to a genetic counselor.

Communicating what will happen at the ultrasound visit and who will discuss the results with the patient is very important. Sonographers, nurses, or medical assistants should inform the patient if the results will be disclosed by the physician after the exam to reduce the burden on sonographers during the exam. Most participants felt strongly that sonographers should not disclose findings, as any discrepancy between the sonographer and the MFM may lead to confusion and distrust between the patient and the care team. In some states, sonographers are not allowed to disclose results, as this may be considered "interpretation" of the ultrasound, which would be outside their scope of practice. According to AIUM guidelines, ultrasound studies should be supervised and interpreted by a licensed medical provider who meets the training guidelines in the specific area of sonography, and while a sonographer may play a crucial role in extracting the information necessary to formulate a diagnosis, the final diagnoses of the ultrasound studies are the responsibility of the medical provider [34].

Other participants felt that experienced sonographers can safely relay some results to the patient before discussion with the physician. Ideally, standardized scripts should be incorporated into the unit protocols for the disclosure of results.

Some participants felt it was important to disclose as much information as possible to patients at the visit, while others felt that it was preferable to provide some information and then schedule a follow-up to review the results again in more detail to allow for adequate time to convey findings and for the patient to absorb unexpected difficult news. In addition, one must be cognizant of unit workflow and other scheduled patients. Practices should have flexibility in adapting to the individual patient's needs, as some patients may prefer to process the information in different ways, including the option to include other friends or family members. Communication regarding findings should be relayed to patients in a way that is understandable to them, avoiding confusing medical terminology, incorporating images for clarity, and understanding and respecting individual patient preferences related to disclosure.

3.4.2 | The role of genetic counselors

Genetic counselors are used to varying degrees in different practices. Among the workshop participants who completed the survey, fewer than 10% did not have a genetic counselor in their practice, while the remainder had at least one certified genetic counselor.

Participants felt strongly that genetic counseling should be recommended, if available, when major anomalies are detected. Many patients do not understand the benefits of genetic counseling until they actually receive the counseling. The language regarding uptake of genetic counseling or genetic testing was also considered important: patients should be described as "declining" these services or tests rather than "refusing."

3.4.3 | Communication with the referring provider

There were various methods described for how MFMs communicate with referring providers. Identifying HIPAA-compliant ways to communicate abnormal findings to referring providers is important for ongoing communication and coordination of care. Many participants use text messaging or phone calls to communicate abnormal results, although text messaging should

not include protected health information unless the text message is part of an EHR package (e.g., MobileHeartbeat within Epic). Even encrypted commercial messaging products (e.g., WhatsApp) are not HIPAA-compliant. Others have found messaging through the EHR to be a convenient means to communicate with referring providers.

3.4.4 | Communicating with pediatric subspecialists

In groups that are connected to fetal treatment centers, most (59%) have a different team of sonographers than are utilized for diagnostic detailed ultrasound examinations, according to a poll of participants in the breakout group. When referring to a fetal treatment center, clear communication regarding follow-up scans is important to avoid redundancy or uninformative imaging protocols. As the utilization of fetal treatment centers to manage anomalies has become more widespread, it is important that the referring MFM have an active role in the management of these cases. In practices that have a fetal treatment center, establishing metrics and tracking outcomes is important, similar to MFM ultrasound practices. Many fetal treatment centers are part of the North American Fetal Therapy Network (NAFTNet), which has some components of this infrastructure in place.

3.4.5 | Use of telehealth

About 70% of workshop participants report using telehealth for some aspects of ultrasound interpretation or counseling. Most (about 55%) use telehealth for fewer than 25% of examinations. Among those who interpret and report telehealth scans, the majority contact the patient personally if there is a significant finding on the ultrasound, including an anomaly. About 25% of interpreting MFM clinicians do not communicate with pregnant patients, while fewer than 10% communicate with the patient for every scan.

Patients having a scan read remotely should be informed when scheduling the visit that there will not be a physician interpreting their ultrasound examination in person. Synchronous interpretations of scans are ideal, but if this is not possible, sonographers should provide an expectation of when patients will likely hear from the reading physician; participants felt that 24 h was a reasonable window. A script for sonographers to use for these remote ultrasound examinations would be an important adjunct for maintaining standardization of communication and expectations for patients, primary obstetrical clinicians, and the interpreting MFM physician.

3.4.6 | The future of the detailed anatomy ultrasound

Advances in imaging technology and clinician experience have led to a shift in the paradigm for prenatal diagnosis of structural anomalies. Approximately 50% of anatomic malformations can be detected in the later part of the first trimester. A multisociety effort led by AIUM and SMFM will elaborate on the 'indication driven' first-trimester detailed obstetrical ultrasound examination by recommending a coding/billing algorithm and presenting the expanded training and experiential volume required to perform this examination. Of note, this early detailed examination does not replace the second-trimester fetal anatomic assessment.

4 | CONCLUSION AND RESEARCH GAPS

Workshop participants proposed many recommendations for promoting teamwork in the ultrasound unit, investing in sonographer wellbeing, implementing QA processes as standard practice, and emphasizing the need for hands-on scanning by physician sonologists and MFM fellows. Participants stressed the need to recognize the skillset of sonographers and create pathways for career advancement, including recognized responsibilities and compensation enhancements. They also agreed on the concept of a "lead sonographer," an APS or perinatal sonographer with advanced experience in MFM ultrasound or administrative functions. Patient safety and health team communication will be enhanced by working with vendors to push reporting data from the ultrasound reporting system directly into the EHR. The participants felt that having avenues through the EHR to advance patient education on specific conditions would be highly desirable. Future areas for practice improvement and research were identified as follows:

- Benchmarking the volume and type of ultrasound scans per sonographer or exam room per a given time period (day)
- Creating standardized forms for referrals, including type of exam and request for consults as needed, as well as basic information about fetal anomalies
- Standardizing QA for completeness of ultrasound examinations and the quality of individual images. The optimal review cycle should be explored
- Creating a taskforce within SMFM on QA processes and implementation and conducting research on how QA improves outcomes
- Implementing an MFM fellowship ultrasound training curriculum with structured objective competency assessment

- Pursuing opportunities for MFMs to become trained in fetal echocardiography [27]
- Exploring the role of a "lead sonographer," "perinatal sonographer," or "administrative sonographer" who does scheduling, training, and QA for ultrasound units
- Establishing a task force to assess skills, credentialing process, and career advancement for perinatal sonographers
- Creating searchable standardized forms for fetal anomaly tracking, growth abnormalities, and unexpected findings to assure accuracy
- Producing patient education resources about expectations for the ultrasound exam
- Implementing GYN ultrasound education and experience into MFM practices
- Establishing best practices for what information sonographers can give to patients
- Determining the optimal role of genetic counseling and whether patient satisfaction and understanding are improved by genetic counseling
- Determining differences between outcomes with in-person versus virtual ultrasound interpretation and patient counseling

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