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Guideline No. 441: Antenatal Fetal Health Surveillance

(En français : Directive clinique no 441 : Surveillance prénatale du bien-être fœtal)

The English document is the original version. In the event of any discrepancy between the English and French content, the English version prevails

This clinical practice guideline was prepared by the authors and overseen by the SOGC's Maternal Fetal Medicine and Clinical Practice Obstetrics committees. It was reviewed by the SOGC Family Physician Advisory Committee and the Obstetrical Content Review committees and approved by the SOGC Guideline Management and Oversight Committee.
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Weeks Gestation Notation: The authors follow the World Health Organization's notation on gestational age: the first day of the last menstrual period is day 0 (of week 0); therefore, days 0 to 6 correspond to completed week 0, days 7 to 13 correspond to completed week 1, etc. [When applicable]

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RECOMMENDED CHANGES IN PRACTICE

1. Symphysis-fundal height should be considered abnormally low when it is ≥3 cm behind gestational age or below the 10th percentile, based on the INTERGROWTH-21st Project.

This document reflects emerging clinical and scientific advances as of the publication date and is subject to change. The information is not meant to dictate an exclusive course of treatment or procedure. Institutions are free to amend the recommendations. The SOGC suggests, however, that they adequately document any such amendments based on local resources or emerging evidence.

Informed consent: Everyone has the right and responsibility to make informed decisions about their care together with their health care providers. To facilitate this, the SOGC recommends that health care providers provide patients with information and support that is evidence-based, culturally appropriate, and personalized.

Language and inclusivity: The SOGC recognizes the importance to be fully inclusive and when context is appropriate, gender-neutral language will be used. In other circumstances, we continue to use gendered language because of our mission to advance women's health. The SOGC recognizes and respects the rights of all people for whom the information in this document may apply, including but not limited to transgender, non-binary, and intersex people. The SOGC encourages health care providers to engage in respectful conversation with their patients about their gender identity and preferred gender pronouns and to apply these guidelines in a way that is sensitive to each person's needs.

2. All pregnant individuals should be advised to regularly monitor fetal movements from 26 weeks gestation and should present immediately for further assessment if reduced fetal movements are suspected, regardless of the technique used to monitor fetal movements.
3. A single deepest pocket of $\geq$2 cm $\times$ 1 cm by transabdominal sonography should be used as a criterion to fulfill the amniotic fluid component of a biophysical profile.
4. Antenatal fetal health surveillance modalities such as nonstress test, biophysical profile, or fetal Doppler sonography should be used only when 1 or more risk factors for fetal decompensation have been identified.

KEY MESSAGES

1. Antenatal fetal health surveillance should be used with consideration for the whole clinical picture, including individual patient risk factors, local resources and associated protocols, urgency of assessment, and patient preferences, in a shared decision-making model.
2. Antenatal fetal health surveillance modalities assess the fetus at a single point in time and may have poor predictive value for ongoing fetal well-being.
3. It is important to develop clear regional protocols for testing, consultation, transfer of care, and communication, based on resource availability.

ABSTRACT

Objective: To summarize the current evidence and to make recommendations for antenatal fetal health surveillance (FHS) to detect perinatal risk factors and potential fetal decompensation in the antenatal period and to allow for timely intervention to prevent perinatal morbidity and/or mortality.

Target population: Pregnant individuals with or without maternal, fetal, or pregnancy-associated perinatal risk factors for antenatal fetal decompensation.

Options: To use basic and/or advanced antenatal testing modalities, based on risk factors for potential fetal decompensation.

Outcomes: Early identification of potential fetal decompensation allows for interventions that may support fetal adaptation to maintain well-being or expedite delivery.

Benefits, harms, and costs: Antenatal FHS in pregnant individuals with identified perinatal risk factors may reduce the chance of adverse outcomes. Given the high false-positive rate, FHS may increase unnecessary interventions, which may result in harm, including parental anxiety, premature or operative birth, and increased use of health care resources. Optimization of surveillance protocols based on evidence-informed practice may improve perinatal outcomes and reduce harm.

Evidence: Medline, PubMed, Embase, and the Cochrane Library were searched from inception to January 2022, using medical subject headings (MeSH) and key words related to pregnancy, fetal monitoring, fetal movement, stillbirth, pregnancy complications, and fetal sonography. This document represents an abstraction of the evidence rather than a methodological review.

Validation methods: The authors rated the quality of evidence and strength of recommendations using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. See online Appendix A (Tables A1 for definitions and A2 for interpretations of strong and weak recommendations).

Intended audience: All health care team members who provide care for or education to obstetrical patients, including maternal fetal medicine specialists, obstetricians, family physicians, midwives, nurses, nurse practitioners, and radiologists.

SUMMARY STATEMENTS

1. Accurate and ongoing early identification of risk factors for potential fetal decompensation allows care providers to develop an individualized care plan to optimize fetal well-being (*moderate*).
2. The nonstress test (NST) may be used in conjunction with a review of the total clinical picture to assess fetal well-being. An NST should be used only in the presence of a clear indication or finding associated with increased risk of fetal hypoxemia (*moderate*).
3. Sonography can evaluate amniotic fluid, estimated fetal weight, biophysical profile/modified biophysical profile, and Doppler blood flows to provide information regarding fetal well-being in pregnancies at risk of fetal morbidity (*moderate*).
4. Interprofessional team communication and documentation should be clear, using accepted and defined terminology (*high*).

RECOMMENDATIONS

1. Care providers should review and document perinatal risk factors (prior pregnancy, fetal, maternal, familial) at the initial visit and update factors throughout pregnancy (*strong, moderate*).
2. Pregnant individuals should be advised of local resources and/or the need for transfer of care based on pregnancy risk factors (*strong, moderate*).
3. Regular prenatal visits should include assessment and documentation of the presence of fetal heart tones, uterine size, pregnancy concerns or risk factors, the plan of care, and the discussion with the pregnant individual (*strong, moderate*).
4. All pregnant individuals should be advised to regularly monitor fetal movements starting at 26 weeks gestation (*conditional, low*).
5. If a reduction of fetal movements is identified, regardless of the technique used to assess fetal movements, pregnant individuals should be advised to present to their care provider or local obstetrical unit immediately for further evaluation (*strong, low*).
6. The nonstress test (NST) should be administered and interpreted by appropriately trained health professionals (*strong, high*).
7. A $\geq$2 cm $\times$ 1 cm pocket of fluid by transabdominal sonography should be used as the criterion for the amniotic fluid component of the biophysical profile (*strong, moderate*).
8. To ensure patient safety, care providers should develop clear protocols locally to communicate and document changes in fetal status identified during antenatal fetal surveillance and escalation of care (*strong, moderate*).
9. Care providers should use non-routine antenatal fetal health surveillance modalities, such as an NST, biophysical profile, or fetal Doppler sonography, only in the presence of a clear indication or finding associated with increased risk of fetal hypoxemia (*strong, moderate*).

INTRODUCTION

Unlike any other patient in medicine, a fetus can be assessed only via indirect observation, through maternal perception of fetal movements (FMs), fetal heart rate (FHR) patterns, and sonography. These approaches for antenatal fetal health surveillance (FHS) aim to distinguish fetuses who are well and may be kept safely in utero from those who are undergoing gradual decline, allowing the clinician to consider delivery before the onset of asphyxia and/or stillbirth (Figure 1). The goal of antenatal FHS is to detect perinatal risk factors for and the presence of fetal decompensation in the antenatal period to allow for timely interventions to prevent perinatal morbidity and mortality.

As our understanding and knowledge of perinatal risk factors grows, the list of indications that may benefit from antenatal FHS increases, and, therefore, its use also continues to increase. Early detection of fetal concerns allows for potential interventions, such as increased surveillance and planned birth to prevent stillbirth. The outcomes for babies born preterm have improved due to advances in neonatal intensive care. Despite these advances and the widespread use of antenatal FHS, the rate of stillbirth, although low, has not declined significantly in the last 30 years.[1] Based on the Canadian definition of stillbirth, approximately 7 to 8 in 1000 pregnancies end in stillbirth,[2] although this may include those who undergo elective interruption of pregnancy.

While our techniques for assessment and intervention have evolved, built on a foundation of basic science, there is limited high-quality research to guide decision-making on the modality, timing of initiation, frequency of surveillance, and effectiveness of a given test result. Consequently, recommendations are often based on expert opinion. The potential benefits of FHS must be balanced against potential harms to the pregnant individual (operative birth, anxiety, increased frequency of antenatal medical appointments) and the fetus (premature delivery) as well as the potential impact on medical infrastructure and resource utilization.

ABBREVIATIONS

AFI	amniotic fluid index
BPP	biophysical profile
CST	contraction stress test
FHR	fetal heart rate
FHS	fetal health surveillance
FM	fetal movement
mBPP	modified biophysical profile
MHR	maternal heart rate
NST	nonstress test
RFM	reduced fetal movement
SDP	single deepest pocket
SFH	symphysis-fundal height

PHYSIOLOGY OF FETAL OXYGENATION

An understanding of the fetal physiological response to acute or chronic hypoxemia elucidates the merit of specific testing approaches and the frequency of testing. Adequate fetal oxygenation is key to maintaining fetal well-being. The complex pathway of oxygen delivery from the pregnant person's lungs to their bloodstream, followed by delivery to the uterus and placenta, diffusion to fetal blood, and distribution to fetal tissues, is subject to a variety of interruptions.

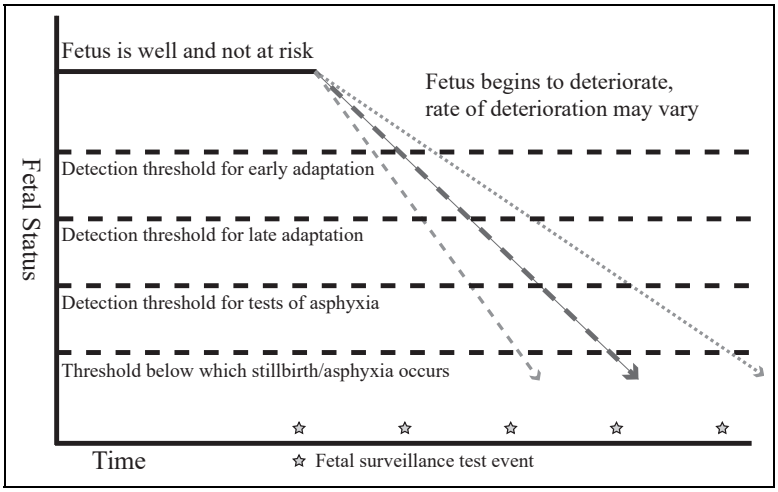
Fetal oxygen reserve is the surplus of oxygen maintained by the fetoplacental unit, allowing it to meet metabolic needs. Short-term hypoxia can be tolerated by a healthy fetus with good oxygen reserves. During periods of impaired gas exchange, the fetus compensates by using adaptive mechanisms to maintain fetal oxygenation. If fetal compensation fails, due to ongoing hypoxemia, the fetus decompensates, resulting in hypotension and ischemia.[3] Without adequate oxygenation, the fetus develops acidosis, leading to morbidity and, ultimately, death.[4,5]

The onset of hypoxemia/asphyxia can be sudden (acute) or more gradual (chronic), and it may result in end-organ damage, including neurodevelopmental injury and fetal death. Many pathophysiological mechanisms that result in fetal morbidity or mortality are not known or clearly understood, which makes it challenging to determine the appropriate timing and frequency of antenatal surveillance. Even in the most ideal circumstances, it is impossible to prevent harm to all fetuses. Events resulting in acute asphyxia may result in fetal deterioration in a short window of time that may limit successful detection before fetal injury or death. In chronic asphyxia, although the fetus may follow a predictable pattern of adaptation, the rate of the progression may be highly variable (Figure 1).

Fetal Adaptation Mechanisms

In an acute event, FHR may change in an attempt to increase circulation of available oxygen. Bradycardia may allow for increased cardiac filling and thus a larger cardiac stroke volume, while tachycardia may increase the frequency of output. When a fetus is chronically unable to receive adequate oxygenation, it must adapt by prioritizing

Figure 1. Hypothetical representation of FHS in a deteriorating fetus, which includes the interplay between the rate of fetal deterioration (variable slope), different detection thresholds of adaptation, and frequency of fetal surveillance. Slope of decline likely depends on fetal oxygen reserve, pathophysiology of the hypoxia, and maternal condition. In ideal circumstances, antenatal FHS allows detection of fetal decline and intervention (delivery) before fetal death or irreversible morbidity.



blood flow to critical organs over non-essential ones to prevent asphyxia of those critical organs ("brain sparing").[6] Redistribution of oxygen relies on vasoconstriction of blood vessels to divert blood flow away from non-essential areas, whereas vasodilation draws blood toward critical organs. Fetal adaptation and redistribution of blood flow can be identified through examination of changes in FMs and observed through fetal growth assessments, fetal Doppler sonography, and amniotic fluid assessment.

Decompensation With Ongoing Hypoxia

As a fetus undergoes worsening oxygen deprivation, it will generally follow a predictable pattern of vascular adaptations.[7] If vascular adaptations are sufficient, end organ dysfunction is avoided, but, when adaptation mechanisms are overwhelmed and fail, end organ asphyxia and dysfunction occur, particularly in the midbrain.

The midbrain autonomic centres, which are sensitive to hypoxia, control fetal autonomic behaviours such as heart rate variability, breathing motions, and FMs, which can be observed to identify signs of fetal end organ dysfunction. When there is inadequate oxygenation, these critical regions become compromised, and the fetal behaviours are altered. The loss of behaviours is thought to be progressive and forms the basis for the biophysical profile (BPP) score, with a lower score reflecting deeper degrees of compromise.[8]

Other considerations for determining the timing and mode of antenatal surveillance include fetal maturation, variable speed of deterioration, and the pathophysiology underlying hypoxia. The interpretation of antenatal surveillance must consider gestational age norms, since fetal neurodevelopment and cardiovascular physiology mature continually throughout gestation.[9] Antenatal surveillance may require an individualized approach, considering potential risk factors for stillbirth, local protocols, access to antenatal surveillance, and the preferences of the pregnant individual, in a shared decision-making model.

IDENTIFICATION OF AT-RISK PREGNANCY

A detailed review of pregnancy history, maternal characteristics and health, and issues in the current pregnancy is critical to optimizing surveillance. Surveillance is also a dynamic process throughout the course of the pregnancy, requiring regular assessment. Risk factors necessitate additional testing, interventions such as delivery, or transfer of care to specialized centres or providers. A pregnancy may be affected by more than 1 risk factor, resulting in a complex estimate of the risk of adverse outcomes and necessitating an individualized approach. Specific guidelines address the most common risk factors and guide practice. Appendix B provides relevant guidelines and key references, highlights potential risk factors, and encourages enhanced surveillance. However, this list is not exhaustive and should not replace clinical judgment. Some risk factors, such as maternal anti-Ro/SSA antibodies, maternal isoimmunization, and fetal structural or genetic variants, may require specialized knowledge and care. In these circumstances, a multidisciplinary approach

is paramount to optimizing maternal care and FHS to prevent adverse outcomes.

SUMMARY STATEMENT 1 and RECOMMENDATIONS 1 AND 2

ANTENATAL FETAL HEALTH SURVEILLANCE

Antenatal FHS comprises multiple modalities, including prenatal assessments by an obstetrical care provider, maternal perception of FMs, FHR monitoring, nonstress test (NST), contraction stress test (CST), and sonography (fetal biometry, BPP, modified biophysical profile [mBPP], amniotic fluid evaluation, Doppler assessment). The primary goals of all antenatal FHS modalities are (1) to provide reassurance of fetal well-being and normal fetal oxygenation before labour and (2) to identify potential hypoxia during the antenatal period, thus allowing interventions to reduce adverse outcomes, principally stillbirth. These modalities are often combined to provide a more robust clinical assessment and avoid unnecessary intervention resulting from a false-positive result (abnormal test result in a non-compromised fetus) from any one particular test, which is especially important when delivery would be preterm. The timing of initiation of surveillance, and the frequency of surveillance, may vary depending on the modality used, the specific risk factors identified, and their predicted impact on pregnancy. There is no ideal test for all at-risk fetuses, and some antenatal fetal tests may be more appropriate than others, depending on risk factors, as many different pathophysiological processes lead to fetal hypoxemia and in utero death.[10]

PRENATAL ASSESSMENTS

Prenatal assessments by a care provider can be conducted in person, via virtual telehealth platforms or both. The standards for routine prenatal care were recently evaluated and updated by a panel of pregnancy care experts convened by the American College of Obstetricians and Gynecologists and the University of Michigan. This effort considered virtual delivery of care. The revised standards are contained in the Michigan Plan for Appropriate Tailored Healthcare in Pregnancy (MiPATH).[11,12] According to this plan, the frequency and modality of visits should depend on the model of practice, risk factors, social and structural determinants of health, changes in clinical status, and patient-specific needs. Individuals with pregnancy-associated risk factors may require more frequent visits than those receiving usual prenatal care. Care providers should use the perinatal forms developed in their jurisdiction to ensure accurate information, clear interdisciplinary communication, and adherence to a regular schedule of assessments.

Routine antenatal visits often have several core components designed to identify risk factors that might require an increased frequency of assessment or additional modalities of surveillance.

Components of the initial intake visit are the following:

- History: medical, family, social, environmental, genetic, pregnancy.
- Initial testing: blood work, sonography, screening for fetal aneuploidy.
- Physical assessment: physical examination, height, weight, blood pressure.
- Discussion of plan of care and initial birth planning.
- Prenatal education options: diet, activity, work-related limitations, prenatal education.

Ongoing routine prenatal assessments include maternal and fetal components. Maternal assessment includes a review of symptoms and an evaluation of maternal blood pressure. Routine urinalysis for protein and glucose is not recommended as a screening tool.[13,14] Insufficient or rapid weight gain during pregnancy has been associated with adverse outcomes, particularly in pregnant individuals with a body mass index in the underweight or obese category. However, atypical gestational weight gain on its own is not a reliable screening tool to guide antepartum FHS. Modification of gestational weight gain has not been clearly demonstrated to improve fetal outcomes.[15] Maternal weight is often monitored at routine prenatal visits; however, given the limited evidence supporting this practice, weight monitoring could be discontinued in pregnant individuals who do not wish to be weighed regularly.

Fetal assessment includes evaluation of fetal heart tones to confirm viability, symphysis-fundal height (SFH), and maternal perception of FMs. If the assessment also includes FHR, fetal compromise may be suspected if tachycardia (FHR $>$ 160 bpm), bradycardia (FHR $<$ 110 bpm), or an irregular heart rate are noted. If the FHR is not in the normal range at the time of auscultation, a prolonged auscultation ($\geq$2 minutes), with simultaneous confirmation of maternal heart rate (MHR), is recommended. If the FHR continues to be concerning, further assessment including FHR monitoring or sonography, may be required. Although no strong evidence was found to support this clinical pathway, it seems reasonable and

may detect a fetus who is compromised, necessitating additional management.

Uterine size, as a proxy for estimated fetal size, can be assessed by abdominal palpation or measurement of SFH on physical examination. SFH is considered discordant with gestational age when it differs from the gestational age in weeks by ≥3 cm,[16] or is above the 90th or below the 10th percentile according to the INTERGROWTH-21st Project SFH data.[17] Resources for providers are available on the INTERGROWTH-21st website (https://intergrowth21.tghn.org/standards-tools/). When the SFH is discordant with gestational age, referral for sonography to assess fetal biometry is indicated, if available. A sonography referral can also be considered if macrosomia is suspected upon measurement of SFH or abdominal palpation. A Cochrane review did not find sufficient evidence to recommend SFH measurement over abdominal palpation for the detection of fetal growth restriction.[18] However, SFH measurement is more amenable to objective documentation than clinical palpation alone, so it is often the preferred modality.

RECOMMENDATION 3

MATERNAL PERCEPTION OF FETAL MOVEMENTS

The use of maternal perception of FMs to assess fetal status requires no technology, can be assessed regularly and longitudinally, and is available to all pregnant individuals. Pregnant individuals may first feel FMs between 16 and 20 weeks gestation, although this may vary, and usually can identify a regular pattern of movements by approximately 26 weeks gestation. Perceived FMs represent only a portion of actual FMs, as pregnant individuals feel only approximately 40% of all FMs at term.[19] Multiple variables affect maternal perception of FMs, including gestational age, maternal activity, maternal habitus, previous experience with identifying FMs, anterior placental location, multiple gestation, and amniotic fluid volume.

While a variety of protocols have been used to quantify maternal perception of FMs, neither the ideal number of FMs nor the duration of FM counting have been determined, and a Cochrane review did not find any specific method of FM counting to be superior.[19] International guidelines have moved away from recommending specific techniques to assess maternally perceived FMs[20,21] and instead emphasize the importance of maternal intuition. However, FM counting may provide a pregnant person with a concrete mechanism to express concern for the pregnancy. Counting tools that suggest a set number of movements expected in a specific time interval may improve compliance and provide objective guidance for pregnant individuals. However, these should not override maternal intuition of fetal well-being, and any perception of reduced FM (RFM) should prompt further evaluation.

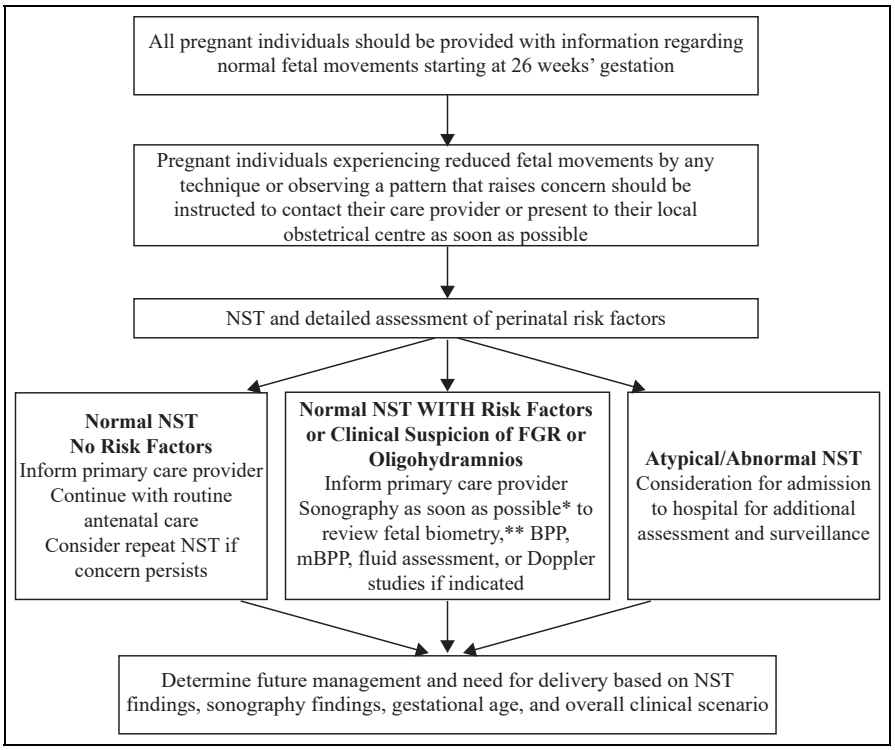
Physiologically, RFM may be associated with hypoxia; however, there is conflicting evidence on the association between maternally perceived RFM and stillbirth. A large Australian retrospective cohort study showed an association between maternally perceived RFM and stillbirth only in those individuals who presented with RFMs on multiple occasions.[22] Recent large trials, including AFFIRM, Mindfetalness, and My Baby's Movements, evaluated pregnancy outcomes following education campaigns on the importance of maternal perception of RFM and fetal evaluation protocols following presentation for RFM, and did not show a reduction in stillbirth rates following intervention.[20,23,24] These studies also demonstrated increased rates of obstetrical intervention and planned preterm birth. Since maternal perception of RFM has become ingrained in routine prenatal care, it may be challenging to accurately identify the role that maternal perception of RFM plays in reducing the risk of stillbirth, even in well-designed trials. For this reason, caregivers continue to regard RFM as an indication for further assessment. Additionally, 1 study showed a reduction in the rate of stillbirth following the integration of maternal observation of FMs when pregnant individuals presented for assessment sooner, which may have allowed for timely intervention for compromised fetuses.[25] For this reason, pregnant individuals should be encouraged to present to care as soon as they experience RFM.

Response to Maternally Perceived Reduced Fetal Movement

When a pregnant individual presents with RFM, a complete evaluation of maternal and fetal status, including a review of risk factors and an NST, should be completed. Figure 2 provides an algorithm to guide care providers on the management of RFM, considering local resources and protocols, patient-specific factors, and shared decision-making between the clinician and pregnant individual. Unless an urgent decision is required, care providers should review fetal anatomy to rule out major fetal malformations before conducting an intervention for fetal well-being. This may not be necessary if fetal anatomy was evaluated earlier in the pregnancy.

RECOMMENDATIONS 4 AND 5

Figure 2. Algorithm to guide care providers on the management of RFM, considering local resources and protocols, patient-specific factors, and shared decision-making between the clinician and pregnant individual.



NST: nonstress test, BPP: biophysical profile, FGR: fetal growth restriction; mBPP: modified biophysical profile.
*Recommended within 24 hours if available.
**If sonography is available and fetal biometry has not been completed within the previous 14 days.

ASSESSMENT OF FETAL HEART RATE PATTERN

Nonstress Test

An NST is commonly used because it is non-invasive and relatively simple to perform. In an NST, external electronic fetal monitoring is used to infer adequate oxygenation status through expected neurological and cardiovascular reflex responses. FMs result in FHR acceleration and are absent in progressive fetal compromise, often associated with hypoxia. Autonomic function is reflected in heart rate variability. A loss of variability most often reflects a fetal sleep cycle but may also indicate midbrain compromise resulting from hypoxemia. In fetuses with no congenital anomalies or other predictable causes of stillbirth, the rate of stillbirth within a week after a normal NST was 1.9/1000, a negative predictive value of 99.8%.[21] While a normal NST is therefore reassuring, the rate of fetal decompensation is variable, and multiple risk factors may prompt providers to consider more frequent assessments.

Evidence

Electronic fetal monitoring was introduced before robust evidence of benefit had been published.[26] A 2015 Cochrane review of NSTs, which identified only 6 studies (n = 2105) of adequate quality, concluded that there was no clear evidence of improved perinatal outcome with the use of NST for assessment of fetal well-being.[27] The results were generalized, however, so an NST may have value, depending on the clinical situation. Historically, NSTs were often the only modality of fetal surveillance used clinically, making past research outcomes difficult to apply to modern FHS protocols, which include advances in and increased use and breadth of sonographic assessment, including point of care ultrasound.[28] As a result, there is no strong evidence to guide recommendations, particularly with respect to a specific and/or a combination of risk factors. Thus, most NST recommendations are based on consensus and expert opinion.[29]

When to Use

In current practice, NST is generally used in the following contexts: (1) initial test in low-risk patients presenting with a concern (e.g., decreased FMs, fall or trauma, vaginal bleeding), or (2) high-risk patients requiring frequent fetal assessments. NST surveillance can be initiated at 32^{0} weeks gestation or later for most at-risk pregnant individuals. In some clinical scenarios (i.e., early onset fetal

growth restriction or presentation for an acute event etc.), surveillance before 32^{0} weeks gestation may be considered. NST surveillance can be initiated when delivery might be offered for fetal indications. Interpretation should be completed by an individual familiar with the expected norms at earlier gestational ages, particularly as there is an increased chance of an atypical NST even when using criteria adjusted for gestational age. An NST can be used in an inpatient or outpatient setting. An NST implies the absence of regular uterine contractions, which would represent a stress for the fetus. If regular uterine activity is identified by palpation or with a tocodynamometer, the test should be documented as an FHR assessment with uterine activity, not an NST.

Technique

Prerequisites. The following are required to conduct an NST:

- a caregiver (physician, nurse, or midwife) with current knowledge and competence in FHS[3] to classify and interpret the NST;
- an external electronic fetal monitor, including a transducer (for FHR) and tocodynamometer (for uterine activity), that can provide continuous interpretable tracing throughout the period of NST testing;
- if there is an event button, patient understanding of how to use it to document perceived FMs; and
- absence of regular contractions.

Procedure. To conduct an NST, take the following steps:

- Encourage patient to void and position in semi-Fowler position or in the left lateral position on a reclining chair, bed, or stretcher.
- Position the transducer and tocodynamometer to achieve a continuous interpretable tracing of both FHR and any uterine activity (confirm the absence of uterine activity through abdominal palpation and by asking the patient);
  - Any time the FHR is auscultated, differentiate FHR and tracing output from MHR[30] and FHR from another fetus, in the case of a multiple pregnancy.
- Conduct NST for a minimum of 20 minutes. If criteria for a normal NST (Table 1), are not reached within 20 minutes, the test can be continued to a maximum of 80 minutes.
- Follow facility guidelines for labelling, documentation, and classification of the NST. Consider creating a standardized form at your facility to ensure consistent documentation, including:
  - identified maternal, fetal, or pregnancy risk factors;
  - maternal perception of FMs in the previous 24 hours;
  - variables that may affect FHR variability and acceleration (e.g., medications or substance use);
  - clinical indication for NST;
  - maternal vital signs;
  - NST outcome, classification, and interpretation, with consideration of the clinical picture; and
  - changes made to clinical plan based on NST classification.

Classification

The NST results are classified as normal, atypical, or abnormal (Table 1). A normal NST should be reviewed by the most responsible provider or their designate as soon as possible after completion (ideally within 24 hours). For an atypical or abnormal NST, the individual performing the test should notify the most responsible provider once the classification becomes apparent. The interpretation, changes to the clinical plan, and discussion with the pregnant individual and health care team should be documented immediately by the most responsible provider.

Fetal monitoring technology has changed, particularly with regard to signal processing, and most modern FHR monitors now include auto-correlation algorithms as part of their signal processing. While these provide smoother, cleaner-appearing tracings, they may be more susceptible to subtle manifestations of MHR artefact (mistakenly capturing the MHR and outputting it as the presumed FHR) and multiple-gestation FHR artefact (capturing the FHR of one fetus and mistakenly outputting it as that of another fetus).[31–33] Adverse event reports related to these artefacts[31,32] have led to recall and warning notices[34,35] and additional recommendations from manufacturers. FHR monitors now also have "coincidence" alarms, which are activated when there is suspicion of MHR artefact or multiple-gestation FHR artefact, also known as "signal ambiguity." Coincidence alarms trigger the health care team to verify the accuracy of the FHR signal(s) by optimizing position of the transducers and/or by point of care ultrasound, as detailed in a recent SOGC technical update.[30] If there is more than 1 coincidence alarm during an NST, the results may be difficult to interpret accurately, and additional steps to verify fetal well-being may be required.

Contraction Stress Test

The CST is infrequently performed in current practice, having largely been replaced by obstetrical sonographic assessment. It involves continuous electronic fetal monitoring for a minimum 10-minute period with 3 uterine

Table 1. Classification of NST[a]

Parameter	Normal NST	Atypical NST	Abnormal NST
Baseline	110–160 beats/min	100–109 beats/min, OR >160 beats/min for >30–80 minutes, OR Rising baseline, OR Arrhythmia (irregular rhythm)	<100 beats/min, OR >160 for >80 minutes, OR Erratic baseline
Variability	Moderate (6–25 beats/min), OR Minimal (5 beats/min for <40 minutes)	Minimal (≤5 beats/min for 40–80 minutes)	Minimal (≤5 beats/min for >80 minutes), OR Marked (>25 beats/min for >10 minutes), OR Sinusoidal
Decelerations[b]	None, OR Non-repetitive uncomplicated variable decelerations, OR Early decelerations in the presence of uterine activity	Repetitive uncomplicated variable decelerations, OR Episodic gradual decelerations in the absence of uterine activity, OR If uterine activity present, intermittent late decelerations	Complicated variable decelerations, OR Recurrent episodic gradual decelerations in the absence of uterine activity, OR If uterine activity present, recurrent late decelerations OR Prolonged deceleration (>2 minutes)
Accelerations[c]	≥2 accelerations within a 40-minute window over a maximum of 80 minutes	2 accelerations separated by >40 minutes over a maximum of 80 minutes of testing	<2 accelerations within 80 minutes of testing
Action	Further assessment optional • If the indication for the test is RFM, assess for pregnancy-associated risk factors, suspicion for fetal growth restriction or oligohydramnios to determine whether additional assessment is needed	Further assessment required • Review clinical picture • Further investigation with prolonged FHR monitoring or sonography may be required • May require admission to hospital for additional surveillance	Urgent action required • Review clinical picture • Further investigation with sonography may be required • May require admission to hospital for additional surveillance • If artefact is suspected, consider rapid bedside sonography • May require delivery

FHR: fetal heart rate; NST: nonstress test; RFM: reduced fetal movement.

[a]Adapted from the SOGC Clinical Practice Guideline: Dore S, Ehman W. No. 396-Fetal Health Surveillance: Intrapartum Consensus Guideline. J Obstet Gynaecol Can. 2020;42:316-48 e9.

[b]Deceleration criteria: Uncomplicated variable: 15 beats/min below baseline lasting ≥15 seconds Complicated variable: Any of 1) deceleration lasting ≥60 seconds AND down to ≤60 beats/min or decrease by ≥60 beats/min below baseline, 2) overshoot of ≥20 beats/min × 20 seconds after deceleration, 3) variable deceleration in the presence of a) minimal or absent baseline variability or b) baseline tachycardia or baseline bradycardia Gradual: Gradual drop and return to baseline, assess for uterine activity for further classification

[c]Acceleration criteria: ≥32 weeks gestation: ≥15 beats/min above baseline for ≥15 seconds lasting <2 minutes. <32 weeks gestation: ≥10 beats/min above baseline for ≥10 seconds lasting <2 minutes

contractions (spontaneous or induced using oxytocin or nipple stimulation). The CST may be performed for further assessment of an equivocal NST and is classified depending on the presence or absence of late decelerations. In current practice, CST may be used to determine the likelihood of fetal tolerance of labour when initiating induction for a fetus with suspected compromise. Access to urgent cesarean delivery should be considered if a CST is being performed.

SUMMARY STATEMENT 2 and RECOMMENDATION 6

SONOGRAPHY IN FETAL SURVEILLANCE

Sonography has become a cornerstone of antenatal FHS, as it allows real-time observation of fetal behaviour, assessment of fetal-placental vascular physiology, semi-quantitative assessment of amniotic fluid, and fetal measurements to assess growth. Routine prenatal care includes first- and second-trimester sonographic examinations, as described in previous SOGC guidelines.[36–38] Additional use of sonography for FHS, for example, BPP, is founded on observational studies showing lower perinatal morbidity and mortality when results are reassuring.

Box. Components of fetal biophysical profile

Component	Criteria
Breathing movements	At least 1 episode continuing more than 30 seconds
Movements	At least 3 body or limb movements
Tone	An episode of active extension with return to flexion of a limb or trunk, or Opening and closing of the hand
Amniotic fluid volume[a]	Single deepest pocket ≥2 cm × 1 cm with no cord or fetal parts present
Nonstress test	Normal, based on the criteria described in Table 1

[a]Modified from Manning FA. Dynamic ultrasound-based fetal assessment: the fetal biophysical profile score. Clin Obstet Gynecol. 1995;38:26-44 to align with definition of oligohydramnios.

However, evidence from well-designed randomized trials is lacking and is likely to remain so because use of sonography is already ingrained in clinical practice. There is considerable variation in clinical practice regarding the gestational age of initiation, frequency, timeliness, and indications for the use of this technology. Robust cost-effectiveness studies are limited.

Amniotic Fluid Assessment

Amniotic fluid levels in the context of intact membranes represent a balance between fetal urine production and fluid consumption via swallowing. When adapting to hypoxia, the fetus prioritizes blood flow to other more vital organs, which reduces fetal renal perfusion and subsequently decreases urine output, resulting in oligohydramnios. The assessment of amniotic fluid is at best semi-quantitative, and several methods are in use, such as the amniotic fluid index (AFI) and single deepest pocket (SDP). The definition of oligohydramnios using AFI (<5 cm) is associated with more interventions without improved outcomes[39]; therefore, it is recommended that oligohydramnios be defined as SDP <2 cm × 1 cm.[40] Polyhydramnios may be defined as AFI ≥25 cm or SDP >8 cm × 1 cm. Polyhydramnios, particularly when severe, is associated with adverse outcomes and fetal anomalies. Most of the literature has studied AFI, and there are no prospective studies of outcomes of polyhydramnios based on SDP. Until more data are available, continued use of the AFI to define polyhydramnios may be appropriate. A common, pragmatic, blended approach uses SDP to screen for polyhydramnios. If the SDP is >8 cm, then an AFI is done to more precisely define whether the fluid level is normal or abnormal, and whether polyhydramnios is mild (25.0−30.0 cm), moderate (30.1−35.0 cm), or severe (>35.0 cm).

Biophysical Profile

BPP is a widely used assessment tool that combines a 4-component sonographic assessment of fetal behaviours and amniotic fluid (Box), with or without an NST. Each component is counted as 2 points toward a total of 10 points, and interpretation depends on the score obtained (Table 2). If a score of 8 can be achieved with sonography,

Table 2. Perinatal mortality (PNM) within 1 week of biophysical profile by BPP score[a]

Test score result	Interpretation	PNM within 1 week without intervention	Management
10/10 8/10 (normal fluid) 8/8 (NST not done)	Risk of fetal asphyxia extremely rare	1/1000	Intervention for obstetric and maternal factors
8/10 (abnormal fluid)	Probable chronic fetal compromise	89/1000	Determine that there is evidence of renal tract function and intact membranes. If so, delivery of the term fetus is indicated. For fetuses <34^0 weeks gestation intensive surveillance may be preferred to maximize fetal maturity
6/10 (normal fluid)	Equivocal test, possible fetal asphyxia	Variable	Repeat test within 24 hours
6/10 (abnormal fluid)	Probable fetal asphyxia	89/1000	Delivery of the term fetus. In the preterm fetus <34^0 weeks gestation, intensive surveillance may be preferred to maximize fetal maturity
4/10	High probability of fetal asphyxia	91/1000	Delivery is usually indicated. For pregnancies at <32+0 weeks gestation, management should be individualized, and extended monitoring may be appropriate.
2/10	Fetal asphyxia almost certain	125/1000	Deliver for fetal indications
0/10	Fetal asphyxia almost certain	600/1000	Deliver for fetal indications

BPP: biophysical profile; NST: nonstress test; PNM: perinatal mortality.

[a]Modified from Manning FA. Dynamic ultrasound-based fetal assessment: the fetal biophysical profile score. Clin Obstet Gynecol. 1995;38:26-44 to align with definition of oligohydramnios.

an NST is not necessary.[41] Several modifications of the scoring system include the addition of placental scoring[10] and weighted scoring,[42] but most providers continue to use the BPP in its original format. The modified BPP, which is less labour-intensive but with a similar predictive value was developed as a fetal surveillance tool.[43] It combines an NST (an acute measure of fetal well-being) with amniotic fluid assessment (assessing chronic or adaptive change) based on data suggesting these are the 2 most important predictive elements of a BPP.[44,45] The false-negative and false-positive rates of the BPP are 0.6/1000 and 50/100, respectively. In comparison, the false-negative and false-positive rates associated with the mBPP are 0.8/1000 and 60/100, respectively.[43]

A Cochrane meta-analysis of 5 trials involving 2974 patients concluded that the available evidence does not support the use of BPP as a test of fetal well-being in at-risk pregnancies, as there was no significant difference in incidence of perinatal death and low Apgar scores following its use, although the cesarean delivery rate was increased. Therefore, if BPP is used for antenatal FHS, it is essential that it is performed in a facility with experience in performing and interpreting BPPs in the context of gestational age and clinical factors, and only when there is a specific indication. This may avoid false-positive results, which can result in unnecessary and potentially harmful interventions, as well as avoiding inappropriate interpretation of atypical fetal behaviours as normal FMs.[46]

Fetal Biometry and Growth

Fetal biometry assessment by sonography can be used to identify fetuses who are larger or smaller than expected for gestational age, both of which have been associated with adverse pregnancy outcomes. The frequency of fetal biometry assessment following the detailed anatomical assessment between 18–22 weeks gestation depends on the risk factors identified in the pregnancy, local protocols, and a discussion between the patient and clinician. When clinically indicated, fetal biometry should be assessed no more frequently than every 14 days.[47] According to published guidelines, the identification of a fetus who is small for gestational age, which may raise concern about fetal growth restriction or a significant slowing in fetal growth velocity, should prompt an increase in surveillance.[48–50]

Doppler Assessment of Fetal and Placental Circulation

Estimating blood flow and assessing resistance/impedance in a variety of critical vessels allows detection of fetal physiological adaptation or maladaptation and pathophysiological changes that are associated with increased perinatal mortality and morbidity. Commonly assessed vessels include umbilical arteries, middle cerebral arteries, and the ductus venosus, and this is the subject of an upcoming SOGC guideline. Randomized controlled trials have shown the usefulness of umbilical artery Doppler sonography in assessing fetal growth restriction and gestational hypertension, and they may support the use of ductus venosus in early-onset fetal growth restriction. Doppler sonography is also critical in surveillance of monochorionic diamniotic twin pregnancies.[51] However, Doppler sonography has a high rate of false-positive results and should not be performed unless there are risk factors or indications.

SUMMARY STATEMENT 3 AND RECOMMENDATION 7

COMMUNICATION, DOCUMENTATION, AND PATIENT SAFETY

Patient safety science involves systematic and detailed studies of adverse outcomes to identify lessons learned and make continual improvements. Although human error may be a contributing factor to adverse outcomes, patient safety approaches should focus on supporting health care providers emotionally, assessing events for systems issues, and finding solutions, along with providing training or coaching, as needed.[52] Challenges with communication have been identified as a major contributor to adverse events.[53] Two communication scenarios are critical in antepartum FHS: (1) initial transmission of findings and (2) escalation of concern. For initial transmission of findings, validated tools of communication, such as the SBAR (Situation, Background, Assessment, Recommendation) format,[54] have been used to provide a structure for communicating patient information. Facilities should implement such a structured communication format and ensure that all providers are familiar with this tool and use consistent terminology. Regarding escalation of concern, similar structured tools have been proposed as part of the Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) program: "I am **C**oncerned! I am Uncertain! This is a **S**afety issue!" (CUS).[55] A concerted effort should be made to create an organizational culture in which all team members feel empowered to raise concerns and there is a structured pathway to advance these concerns to more senior leadership if they are not addressed.

SUMMARY STATEMENT 4 and RECOMMENDATION 8

CHOOSING WISELY

Antenatal FHS could reduce adverse fetal and postnatal outcomes, including the risk of stillbirth. However, the evidence supporting this benefit is limited. When a priori risk of an adverse event or outcome is low, use of the various antenatal FHS modalities (except prenatal visits and maternal perception of FMs) has a higher likelihood of resulting in a false-positive finding. This can result in unnecessary interventions, including iatrogenic premature delivery, and can increase parental anxiety needlessly. Therefore, non-routine antenatal FHS modalities should be used only when there is a clear indication for these assessments. The indication should be a recognized risk factor for fetal hypoxemia. This strategy can reduce false-positive antenatal FHS abnormal findings and associated unnecessary medical interventions, optimize the use of health care resources, and minimize unwarranted maternal and parental distress.

RECOMMENDATION 9

CONCLUSION

Antenatal FHS is a multi-modality surveillance process with two principal objectives: (1) to provide reassurance of fetal well-being and normal fetal oxygenation before labour; and (2) to identify potential hypoxia during the antenatal period, allowing interventions to reduce adverse outcomes, principally stillbirth.

Most surveillance protocols are based on expert opinion, as robust studies providing clear guidance on the optimal modality, timing of initiation, and frequency are lacking. It is important to balance the impact of intense surveillance on the medical system and family with the risk of adverse outcomes. For pregnancies at increased risk of adverse outcomes, particularly stillbirth, the selected surveillance pathway should be based on local resources and protocols as well as on a discussion between the clinician and pregnant individual in a shared decision-making model.

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APPENDIX A

Table A1. Key to Grading of Recommendations, Assessment, Development and Evaluation Quality of Evidence

Grade	Definition
Strength of recommendation	
Strong	High level of confidence that the desirable effects outweigh the undesirable effects (strong recommendation for) or the undesirable effects outweigh the desirable effects (strong recommendation against)
Conditional [a]	Desirable effects probably outweigh the undesirable effects (weak recommendation for) or the undesirable effects probably outweigh the desirable effects (weak recommendation against)
Quality of evidence	
High	High level of confidence that the true effect lies close to that of the estimate of the effect
Moderate	Moderate confidence in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low	Limited confidence in the effect estimate: The true effect may be substantially different from the estimate of the effect
Very low	Very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

[a]Do not interpret conditional recommendations to mean weak evidence or uncertainty of the recommendation.

Adapted from GRADE Handbook (2013), Table 5.1.

Table A2. Implications of Strong and Conditional recommendations, by guideline user

Perspective	Strong Recommendation • "We recommend that…" • "We recommend to not…"	Conditional (Weak) Recommendation • "We suggest…" • "We suggest to not…"
Authors	The net desirable effects of a course of action outweigh the effects of the alternative course of action.	It is less clear whether the net desirable consequences of a strategy outweigh the alternative strategy.
Patients	Most individuals in the situation would want the recommended course of action, while only a small proportion would not.	The majority of individuals in the situation would want the suggested course of action, but many would not.
Clinicians	Most individuals should receive the course of action. Adherence to this recommendation according to the guideline could be used as a quality criterion or performance indicator.	Recognize that patient choices will vary by individual and that clinicians must help patients arrive at a care decision consistent with the patient's values and preferences.
Policymakers	The recommendation can be adapted as policy in most settings.	The recommendation can serve as a starting point for debate with the involvement of many stakeholders.

Adapted from GRADE Handbook (2013), Table 6.1.

APPENDIX B

Appendix B. Factors to Identify Pregnancies at Increased Risk of Adverse Outcomes

Pregnancy factors	Maternal factors
Prior history	**Characteristics**
Acute fatty liver of pregnancy	Maternal age <20 years[8]
HELLP syndrome	Advanced maternal age (>35 years)[9]
Fetal growth restriction[1]	Body mass index ≥30[10,11]
Placental abruption[2]	Social determinants of health
Preeclampsia[3,4,5]	Alcohol and substance use in pregnancy[12,13]
Preterm birth	
Stillbirth[6,7]	
Unexplained hydrops	
Current pregnancy	**Chronic medical conditions**
Amniotic fluid abnormalities:	Autoimmune disorders:
- Anhydramnios, oligohydramnios, polyhydramnios	- Antiphospholipid antibody syndrome
- Preterm premature rupture of membranes[14]	- Systemic lupus erythematosis
Gestational factors:	- Sjogren syndrome
- Infectious exposures[15,16,17]	- Anti-Ro/SSA antibody positive
- Gestational diabetes	Cardiovascular disorders:
- Post-term pregnancy (>42 weeks gestation)	- Hypertension[5]
- Preeclampsia[3,4,5]	- Congenital cardiac abnormalities
- Preterm labour	- Arrhythmia
- Trauma	Endocrine disorders:
Fetal factors:	- Diabetes[20]
- Fetal growth restriction[1]	- Graves' disease
- Isoimmunization	Hematologic disorders:
- Multiple gestation[18,19]	- Anemia
- Pathogenic genetic variants	- Hemoglobinopathy
- Reduced fetal movements	- Thrombophilia
- Structural anomalies	Others:
- Single umbilical artery	- Hepatic disease
Placental factors:	- Renal disease
- Antepartum hemorrhage	- Infection (HIV/AIDS)[21]
- Chronic abruption	
- Placental malformations[22,23,24]	

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