



Fetal Health Surveillance: Antepartum and Intrapartum Consensus Guideline

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Robert Liston, Diane Sawchuck, David Young

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This guideline has been reviewed and approved by the Maternal-Fetal Medicine Committee, the Clinical Obstetrics Committee, and the Executive and Council of the Society of Obstetricians and Gynaecologists of Canada.

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Abstract

Objective: This guideline provides new recommendations pertaining to the application and documentation of fetal surveillance in the antepartum and intrapartum period that will decrease the incidence of birth asphyxia while maintaining the lowest possible rate of obstetrical intervention. Pregnancies with and without risk factors for adverse perinatal outcomes are considered. This guideline presents an alternative classification system for antenatal fetal non-stress testing and intrapartum electronic fetal surveillance to what has been used previously. This guideline is intended for use by all health professionals who provide antepartum and intrapartum care in Canada.

Options: Consideration has been given to all methods of fetal surveillance currently available in Canada.

Outcomes: Short- and long-term outcomes that may indicate the presence of birth asphyxia were considered. The associated rates of operative and other labour interventions were also considered.

Evidence: A comprehensive review of randomized controlled trials published between January 1996 and March 2007 was undertaken, and MEDLINE and the Cochrane Database were used to search the literature for all new studies on fetal surveillance both antepartum and intrapartum. The level of evidence has been determined using the criteria and classifications of the Canadian Task Force on Preventive Health Care (Table 1).

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Key Words: Fetal surveillance, intermittent auscultation, electronic fetal monitoring, umbilical Doppler, uterine artery Doppler, contraction stress test, biophysical profile, fetal movement, antepartum, intrapartum, non-stress test

This guideline reflects emerging clinical and scientific advances as of the date issued and are subject to change. The information should not be construed as dictating an exclusive course of treatment or procedure to be followed. Local institutions can dictate amendments to these opinions. They should be well documented if modified at the local level. None of these contents may be reproduced in any form without prior written permission of the SOGC.

Table 1. Key to evidence statements and grading of recommendations, using the ranking of the Canadian Task Force on Preventive Health Care

Quality of Evidence Assessment*	Classification of Recommendations†
I: Evidence obtained from at least one properly randomized controlled trial	A. There is good evidence to recommend the clinical preventive action
II-1: Evidence from well-designed controlled trials without randomization	B. There is fair evidence to recommend the clinical preventive action
II-2: Evidence from well-designed cohort (prospective or retrospective) or case-control studies, preferably from more than one centre or research group	C. The existing evidence is conflicting and does not allow to make a recommendation for or against use of the clinical preventive action; however, other factors may influence decision-making
II-3: Evidence obtained from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled experiments (such as the results of treatment with penicillin in the 1940s) could also be included in this category	D. There is fair evidence to recommend against the clinical preventive action E. There is good evidence to recommend against the clinical preventive action
III: Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees	I. There is insufficient evidence (in quantity or quality) to make a recommendation; however, other factors may influence decision-making

*The quality of evidence reported in these guidelines has been adapted from the Evaluation of Evidence criteria described in the Canadian Task Force on Preventive Health Care.²⁶⁵

†Recommendations included in these guidelines have been adapted from the Classification of Recommendations criteria described in the Canadian Task Force on Preventive Health Care.²⁶⁵

CHAPTER 1: ANTENATAL FETAL ASSESSMENT

Recommendation 1: Fetal Movement Counting

- Daily monitoring of fetal movements starting at 26 to 32 weeks should be done in all pregnancies **with** risk factors for adverse perinatal outcome. (I-A)
- Healthy pregnant women **without** risk factors for adverse perinatal outcomes should be made aware of the significance of fetal movements in the third trimester and asked to perform a fetal movement count if they perceive decreased movements. (I-B)
- Women who do not perceive six movements in an interval of two hours require further antenatal testing and should contact their caregivers or hospital as soon as possible. (III-B)
- Women who report decreased fetal movements (< 6 distinct movements within 2 hours) should have a complete evaluation of maternal and fetal status, including non-stress test and/or biophysical profile. Prior to considering an intervention for fetal well-being, an anatomical scan to rule out a fetal malformation should be done, if one has not already been done. Management should be based upon the following:
 - Non-stress test is normal and there are no risk factors: the woman should continue with daily fetal movement counting. (III-B)
 - Non-stress test is normal and risk factors or clinical suspicion of intrauterine growth restriction/intrauterine growth restriction/oligohydramnios is identified: an ultrasound for either full biophysical profile or amniotic fluid volume assessment within 24 hours. The woman should continue with daily fetal movement counting. (III-B)
 - Non-stress test is atypical/abnormal: further testing (biophysical profile and/or contraction stress test and assessment of amniotic fluid volume) should be performed as soon as possible. (III-B)

Recommendation 2: Non-Stress Test

- Antepartum non-stress testing may be considered when risk factors for adverse perinatal outcome are present. (III-B)
- In the presence of a normal non-stress test, usual fetal movement patterns, and absence of suspected oligohydramnios, it is not necessary to conduct a biophysical profile or contraction stress test. (III-B)
- A normal non-stress test should be classified and documented by an appropriately trained and designated individual as soon as possible, (ideally within 24 hours). For atypical or abnormal non-stress tests, the nurse should inform the attending physician (or primary care provider) at the time that the classification is apparent. An abnormal non-stress test should be viewed by the attending physician (or primary care provider) and documented immediately. (III-B)

Recommendation 3: Contraction Stress Test

- The contraction stress test should be considered in the presence of an atypical non-stress test as a proxy for the adequacy of intrapartum uteroplacental function and, together with the clinical circumstances, will aid in decision making about timing and mode of delivery. (III-B)
- The contraction stress test should **not** be performed when vaginal delivery is contraindicated. (III-B)
- The contraction stress test should be performed in a setting where emergency Caesarean section is available. (III-B)

Recommendation 4: Biophysical Profile

- In pregnancies at increased risk for adverse perinatal outcome and where facilities and expertise exist, biophysical profile is recommended for evaluation of fetal well-being. (I-A)
- When an abnormal biophysical profile is obtained, the responsible physician or delegate should be informed immediately. Further management will be determined by the overall clinical situation. (III-B)

Recommendation 5: Uterine Artery Doppler

Previous obstetrical history	Previous early onset gestational hypertension Placental abruption Intrauterine growth restriction Stillbirth
Risk factors in current pregnancy	Pre-existing hypertension Gestational hypertension Pre-existing renal disease Long-standing type I diabetes with vascular complications, nephropathy, retinopathy Abnormal maternal serum screening (hCG or AFP > 2.0 MOM) Low PAPP-A (consult provincial lab for norms)

- Where facilities and expertise exist, uterine artery Doppler may be performed at the time of the 17 to 22 weeks' gestation detailed anatomical ultrasound scan in women with the following factors for adverse perinatal outcome. (II-A)
- Women with a positive uterine artery Doppler screen should have the following:
 - A double marker screen (for alpha-fetoprotein and beta hCG) if at or before 18 weeks' gestation. (III-C)
 - A second uterine artery Doppler at 24 to 26 weeks. If the uterine artery Doppler is positive at the second scan, the woman should be referred to a maternal-fetal medicine specialist for management. (III-C)

Recommendation 6: Umbilical Artery Doppler

- Umbilical artery Doppler should not be used as a screening tool in healthy pregnancies, as it has not been shown to be of value in this group. (I-A)
- Umbilical artery Doppler should be available for assessment of the fetal placental circulation in pregnant women with suspected placental pathology. (I-A) Fetal umbilical artery Doppler assessment should be considered (1) at time of referral for suspected growth restriction, or (2) during follow-up for suspected placental pathology.
- Depending on other clinical factors, reduced, absent, or reversed umbilical artery end-diastolic flow is an indication for enhanced fetal surveillance or delivery. If delivery is delayed to improve fetal lung maturity with maternal administration of glucocorticoids, intensive fetal surveillance until delivery is suggested for those fetuses with reversed end-diastolic flow. (II-1B)

CHAPTER 2: INTRAPARTUM FETAL ASSESSMENT**Recommendation 7: Labour Support During Active Labour**

1. Women in active labour should receive continuous close support from an appropriately trained person. (I-A)

Recommendation 8: Professional One-to-One Care and Intrapartum Fetal Surveillance

1. Intensive fetal surveillance by intermittent auscultation or electronic fetal monitoring requires the continuous presence of nursing or midwifery staff. One-to-one care of the woman is recommended, recognizing that the nurse/midwife is really caring for two patients, the woman and her unborn baby. (III-C)

Recommendation 9: Intermittent Auscultation in Labour

1. Intrapartum fetal surveillance for healthy term women in spontaneous labour in the absence of risk factors for adverse perinatal outcome.

Intermittent auscultation following an established protocol of surveillance and response is the recommended method of fetal surveillance; compared with electronic fetal monitoring, it has lower intervention rates without evidence of compromising neonatal outcome. (I-B)

2. Epidural analgesia and intermittent auscultation.

Intermittent auscultation may be used to monitor the fetus when epidural analgesia is used during labour, provided that a protocol is in place for frequent intermittent auscultation assessment (e.g., every 5 minutes for 30 minutes after epidural initiation and after bolus top-ups as long as maternal vital signs are normal). (III-B)

Recommendation 10: Admission Fetal Heart Test

1. Admission fetal heart tracings are not recommended for healthy women at term in labour in the absence of risk factors for adverse perinatal outcome, as there is no evident benefit. (I-A)
2. Admission fetal heart tracings are recommended for women with risk factors for adverse perinatal outcome. (III-B)

Recommendation 11: Intrapartum Fetal Surveillance for Women With Risk Factors for Adverse Perinatal Outcome

1. Electronic fetal monitoring is recommended for pregnancies at risk of adverse perinatal outcome. (II-A)
2. Normal electronic fetal monitoring tracings during the first stage of labour.

When a normal tracing is identified, it may be appropriate to interrupt the electronic fetal monitoring tracing for up to 30 minutes to facilitate periods of ambulation, bathing, or position change, providing that (1) the maternal-fetal condition is stable and (2) if oxytocin is being administered, the infusion rate is not increased. (III-B)

Recommendation 12: Digital Fetal Scalp Stimulation

1. Digital fetal scalp stimulation is recommended in response to atypical electronic fetal heart tracings. (II-B)
2. In the absence of a positive acceleratory response with digital fetal scalp stimulation,
 - Fetal scalp blood sampling is recommended when available. (II-B)
 - If fetal scalp blood sampling is not available, consideration should be given to prompt delivery, depending upon the overall clinical situation. (III-C)

Recommendation 13: Fetal Scalp Blood Sampling

1. Where facilities and expertise exist, fetal scalp blood sampling for assessment of fetal acid–base status is recommended in women with “atypical/abnormal” fetal heart tracings at gestations > 34 weeks when delivery is not imminent, or if digital fetal scalp stimulation does not result in an acceleratory fetal heart rate response. (III-C)

Recommendation 14: Umbilical Cord Blood Gases

1. Ideally, cord blood sampling of both umbilical arterial and umbilical venous blood is recommended for ALL births, for quality assurance and improvement purposes. If only one sample is possible, it should preferably be arterial. (III-B)
2. When risk factors for adverse perinatal outcome exist, or when intervention for fetal indications occurs, sampling of arterial and venous cord gases is strongly recommended. (I-insufficient evidence. See Table 1).

Recommendation 15: Fetal Pulse Oximetry

1. Fetal pulse oximetry, with or without electronic fetal surveillance, is not recommended for routine use at this time. (III-C)

Recommendation 16: ST Waveform Analysis

1. The use of ST waveform analysis for the intrapartum assessment of the compromised fetus is not recommended for routine use at this time. (I-A)

Recommendation 17: Intrapartum Fetal Scalp Lactate Testing

1. Intrapartum scalp lactate testing is not recommended for routine use at this time. (III-C)

**CHAPTER 3:
QUALITY IMPROVEMENT AND RISK MANAGEMENT****Recommendation 18: Fetal Health Surveillance Education**

1. Regular updating of fetal surveillance skills is required. Although there is no best evidence to indicate how often practitioners should update their knowledge and skills, periodic review is advised. Each facility should ensure that fetal surveillance updates are interprofessional to ensure common terminology and shared understanding and to develop the concept of team responsibility. (III-B)

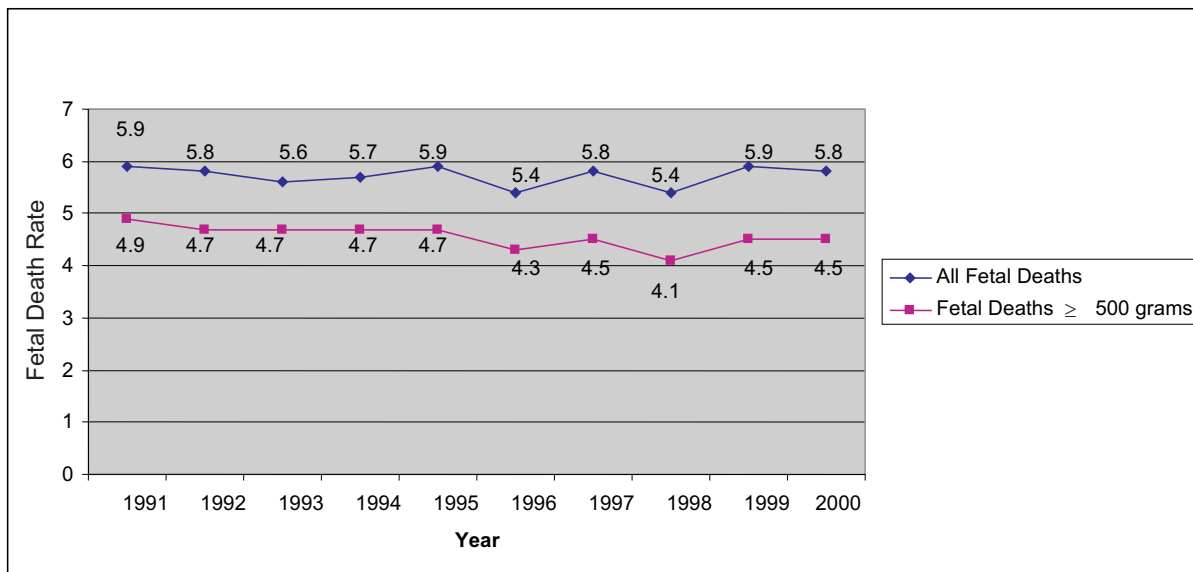
INTRODUCTION

This document reflects the current evidence and national consensus opinion on fetal health surveillance during the antenatal and intrapartum periods. It reviews the science behind, the clinical evidence for, and the effectiveness of various surveillance methods available today. Research has shown that improvements in fetal outcomes as a result of surveillance are very difficult to document because of (1) variations in the interpretation of fetal surveillance tests, especially electronic fetal heart monitoring; (2) variations in interventions applied when abnormal results are present; and (3) the lack of standardization of the important outcomes.¹ Although antenatal fetal surveillance using various modalities is an integral part of perinatal health care across Canada, there is limited Level I evidence to support such a practice. Indeed, the only testing modality for which there is Level I evidence for effect is the use of umbilical artery Doppler as a means of surveillance of growth restricted fetuses.² Although specific patient populations with risk factors for adverse perinatal outcome have been identified, large randomized trials establishing the benefits of antenatal testing in the reduction of perinatal morbidity and mortality have not been performed. In Canada, antenatal and intrapartum deaths are rare. Between 1991 and 2000, the crude fetal mortality rate (the number of stillbirths per 1000 total live births and stillbirths in a given place and at a given time/during a defined period) fluctuated between 5.4 per 1000 total births and 5.9 per 1000 total births.³ In 2000, the rate was 5.8 per 1000 total births (Figure 1). The fetal mortality rate for = 500 g ranged from a high of 4.9 per 1000 total births in 1991 to a low of 4.1 per 1000 total births in 1998. In 2000, the rate was 4.5 per 1000 total births.³

These rates are some of the lowest worldwide and are a reflection of overall population health, access to health services, and provision of quality obstetric and pediatric care across the nation.^{3,4} Despite the low fetal mortality rate in Canada, a portion of deaths remain potentially preventable. However, antenatal and intrapartum testing strategies appropriately applied to all women (with and without risk factors for adverse perinatal outcome) will still not prevent all adverse perinatal outcomes. This may be because the effectiveness of a testing modality requires timely application, appropriate interpretation, recognition of a potential problem, and effective clinical action, if possible. Because of the relatively low prevalence of fetal and perinatal mortality, it is estimated that large randomized controlled trials with at least 10 000 women would be required to adequately

Abbreviations Used in This Guideline

AEDF	absent end-diastolic flow
AFI	amniotic fluid index
AFP	alpha-fetoprotein
AV	atrioventricular
AWHONN	Association of Women's Health, Obstetric and Neonatal Nurses
BPP	biophysical profile
BPS	biophysical status
CHAT	context, history, assessment, tentative plan
CP	cerebral palsy
CST	contraction stress test
DV	ductus venosus
ECG	electrocardiogram
EDV	end-diastolic velocity
EFM	electronic fetal monitoring
FBS	fetal blood sampling
FHR	fetal heart rate
FPO	fetal pulse oximetry
HIE	hypoxic-ischemic encephalopathy
HRO	high reliability organizations
IUGR	intrauterine growth restriction
IUPC	intrauterine pressure catheter
IUT	intrauterine transfusion
MCA	middle cerebral artery
NE	neonatal encephalopathy
NICHD	National Institute of Child Health and Human Development
NICU	neonatal intensive care unit
NST	non-stress test
OCT	oxytocin challenge test
PCEA	patient-controlled epidural analgesia
PI	pulsatility index
PNM	perinatal mortality
PSV	peak systolic velocity
PVL	periventricular leukomalacia
QI	quality improvement
RCT	randomized controlled trial
UV	umbilical vein
VBAC	vaginal birth after Cesarean section

Figure 1. Rate of fetal death: Canada (excluding Ontario)

The crude fetal mortality rate is defined as the number of stillbirths per 1000 total births (live births and stillbirths), in a given place and time. The fetal mortality rate for > 500 g is based on the exclusion of all stillbirths and live births with a birth weight of < 500 g or, if the birth weight is unknown, those with a gestational age of < 22 weeks. Ontario data is excluded because of data quality concerns (Health Canada, 2003).

assess any benefits from antenatal fetal assessment.⁵ In the absence of conclusive evidence, and in the presence of suggestive theoretic, animal, and clinical data, these guidelines are designed for two purposes: (1) to outline appropriate antenatal and intrapartum fetal surveillance techniques for healthy women *without* risk for adverse perinatal outcome, and (2) to identify specific patient populations expected to benefit from antenatal and intrapartum testing and to outline available testing techniques that could be appropriate. Antenatal and intrapartum fetal testing for women with risk factors should take place only when the results will guide decisions about future care, whether that is continued observation, more frequent testing, hospital admission, or need for delivery. It is recommended that each hospital adapt its own protocols suggesting the indications, type, and frequency of antenatal and intrapartum testing, and the expected responses to abnormal results.

This guideline presents an alternative classification system for antenatal fetal non-stress testing and intrapartum electronic fetal surveillance to what has been used previously. Anecdotal evidence suggested opportunity for confusion in communication and lack of clarity in treatment regimens

using “reassuring/non-reassuring” or “reactive/non-reactive” terminology. This guideline presents an alternative classification system designed to (1) promote a consistent assessment strategy for antenatal and intrapartum cardiotocography, (2) promote a consistent classification system for antenatal and intrapartum cardiotocography, and (3) promote clarity and consistency in communicating and managing electronic fetal heart tracing findings. To accomplish this, a three-tier classification system is used for antenatal and intrapartum cardiotocography, with the following categories: normal, atypical, and abnormal. This system was partly derived from principles and terminology presented in the guidelines Intrapartum Fetal Surveillance,⁶ and The Use of Electronic Fetal Monitoring.⁷ The specific criteria defining each category for non-stress testing and intrapartum electronic fetal monitoring are outlined in the respective sections of this guideline. It should be emphasized that an understanding of the antenatal and intrapartum maternal-fetal physiological processes underlying electronic fetal surveillance are crucial for the appropriate application, interpretation, and management of clinical situations where normal, atypical, or abnormal tracings are identified.

Antenatal Fetal Surveillance

ANTENATAL FETAL TESTING TECHNIQUES

Antenatal fetal testing techniques described in this guideline fall into six categories and may be used simultaneously or in a hierarchical fashion. They are (1) fetal movement counting, (2) non-stress test, (3) contraction stress test, (4) biophysical profile and/or amniotic fluid volume, (5) maternal uterine artery Doppler, and (6) fetal umbilical artery Doppler. The only antenatal surveillance technique recommended for *all* pregnant women, with and without risk factors, is maternal awareness of fetal movements.

A successful antenatal fetal testing program would ideally reduce the fetal and neonatal outcomes of asphyxia listed in Table 2.

Figure 2 depicts the

progressive deterioration in fetal cardiovascular and behavioural variables seen with declining metabolic status. Doppler abnormalities progress from the arterial to the venous side of the circulation. Although cardiac adaptations and alterations in coronary blood flow dynamics may be operational for a variable period, overt abnormalities of cardiac function and evidence of markedly enhanced coronary blood flow usually are not seen until the late stages of disease. The decline in biophysical variables shows a reproducible relationship with the acid-base status. If adaptation mechanisms fail, stillbirth ensues.⁸

PATIENTS AT RISK

Perinatal morbidity and/or mortality due to fetal asphyxia have been shown to be increased among women with conditions identified in Table 3. Some form of antenatal fetal testing may be beneficial in the ongoing care of women with these problems. Evidence to support the use of any of the testing parameters currently available in Canada is presented in the following sections. However, the only testing modality that has clearly been shown beneficial in randomized controlled trials is Doppler velocity wave form analysis of the fetal umbilical artery in pregnancies complicated by fetal growth restriction. Apart from some evidence that maternal perception of fetal movement may be beneficial in all pregnancies, there is no support for routine application

Table 2. Adverse fetal and neonatal outcomes associated with antepartum asphyxia*

Fetal outcomes	Neonatal outcomes
Stillbirth	Mortality
Metabolic acidosis at birth	Metabolic acidosis
	Hypoxic renal damage
	Necrotizing enterocolitis
	Intracranial hemorrhage
	Seizures
	Cerebral palsy
	Neonatal encephalopathy

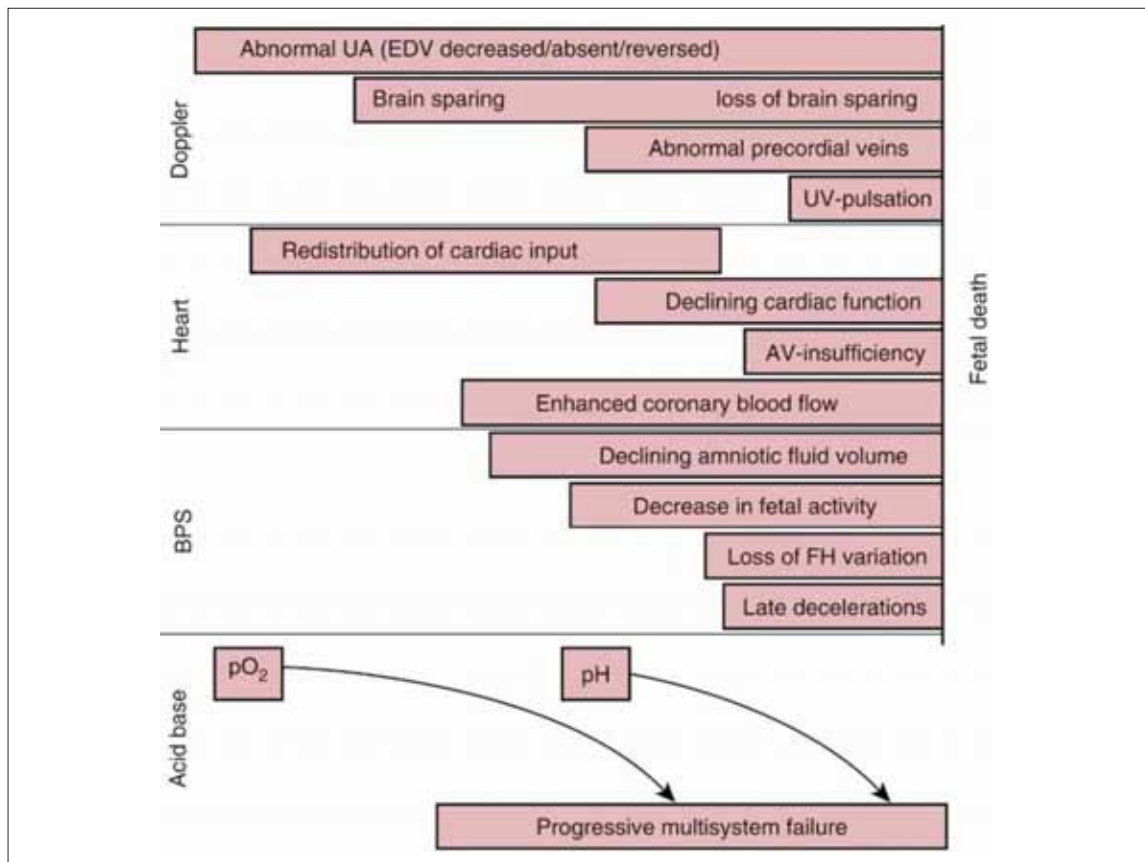
* Asphyxia is defined as hypoxia with metabolic acidosis

of antenatal fetal testing in the management of uncomplicated pregnancies less than 41 weeks' gestation. There is little point initiating fetal testing before neonatal viability and in situations where there are fetal abnormalities that are incompatible with life, and this should be discussed with the patient, and the risks of increased anxiety leading to inappropriate and harmful intervention made clear.

WHEN TO INITIATE ANTENATAL TESTING

Prenatal assessment of the fetal condition has two objectives: (1) to exclude fetal abnormality (done predominantly in the first half of pregnancy) and (2) to monitor the condition of the presumed normal fetus, with a view of determining the optimal time for delivery.⁸ The decision to initiate antenatal fetal testing should be individualized and reflect the risk factor(s) associated with an individual pregnancy. The maternal obstetrical history, severity of maternal and fetal disorders in the current pregnancy, and the gestational age at onset should be taken into account in determining the appropriate time to initiate antenatal fetal testing. For instance, maternal awareness of fetal movements should be encouraged in *all* pregnant women, with or without risk factors for adverse perinatal outcome, starting between 26 and 32 weeks' gestation. Fetal umbilical artery Doppler assessment should be considered (1) at the time of diagnosis of

Figure 2. Progressive deterioration in fetal cardiovascular and behavioural variables



Progressive deterioration in fetal cardiovascular and behavioral variables seen with declining metabolic status. In most fetuses with intrauterine growth restriction. Doppler abnormalities progress from the arterial to the venous side of the circulation. Although cardiac adaptations in coronary blood flow dynamics may be operational for a variable period, overt abnormalities of cardiac function and evidence of markedly enhanced coronary blood flow usually are not seen until the late stages of disease. The decline in biophysical variables shows a reproducible relationship with the acid-base status. If adaptation mechanisms fail, stillbirth ensues AV, atrioventricular; EDV end-diastolic velocity; FH, fetal heart rate; UV, umbilical vein. This figure was published in *High Risk Pregnancy: Management Options*, 3rd edition. James et al. Copyright Elsevier (2006).

suspected fetal growth restriction or (2) as a follow-up for suspected severe placental pathology or known fetal growth restriction. Non-stress testing and amniotic fluid volume assessment in otherwise healthy postdates pregnancies should begin between 287 and 294 days (41 and 42 weeks),²³ or two weeks before the time of an adverse event in a previous pregnancy. Antenatal fetal testing should be performed without delay for women who present with decreased fetal movement. Antenatal testing in insulin-dependent or insulin-requiring pregnancies that are well controlled and otherwise uncomplicated should begin at 32 to 36 weeks' gestation.²⁴ Perinatal morbidity and mortality is increased further in women with poorly controlled diabetes, and the gestational age at initiation of antenatal fetal assessment should reflect the clinical suspicion of increased risk, once the fetus has reached viability.

FREQUENCY OF TESTING

The frequency of antenatal fetal testing should be individualized to reflect the risk factor(s) associated with an individual pregnancy and should correspond to the perceived risk of fetal asphyxia evidenced by testing results. Antenatal testing frequency should reflect the degree of risk in cases where the perceived risk persists, and testing will usually be performed once to twice weekly. However, antenatal fetal testing may be required daily or even more frequently to aid in the timing of delivery to maximize gestational age while avoiding significant intrauterine morbidity in the preterm fetus.²⁵ With either individual or combined forms of testing, consideration should be given to the entire clinical picture, including gestational age, maternal age, previous obstetrical history, and the presence or absence of underlying current medical conditions and/or obstetrical complications in planning ongoing antenatal care.

METHODS OF ANTENATAL FETAL SURVEILLANCE

1. Fetal Movement Counting

Decreased placental perfusion and fetal acidemia and acidosis are associated with decreased fetal movements.²¹ This is the basis for maternal monitoring of fetal movements or “the fetal movement count test.” The concept of counting fetal movements is attractive, since it requires no technology and is available to all women.

Review of the Evidence

In a review of the literature since 1970 on fetal movement counting in western countries, Froen²⁶ analyzed 24 studies and performed several meta-analyses on the data. His major findings included the following.

- In high-risk pregnancies, the risk for adverse outcomes in women with decreased fetal movements increased: mortality, OR 44 (95% CI 22.3–86.8); IUGR, OR 6.34 (95% CI 4.19–9.58); Apgar < 7 at 5 minutes, OR 10.2 (95% CI 5.99–17.3); need for emergency delivery, OR 9.40 (95% CI 5.04–17.5).
- There was a trend to lower fetal mortality in low-risk women in the fetal movement groups versus controls, although this difference was not statistically significant (OR 0.74; 95% CI 0.51–1.07). Fetal mortality among fetal movement counters versus controls was OR 0.64 (95% CI 0.41–0.99). Note that this analysis is skewed by the inclusion of the large study by Grant et al.,²⁷ discussed below.
- Fetal mortality during the studies on fetal movement counts (in both the study and the control groups) was lower than in the immediate previous periods OR 0.56 (95% CI 0.40–0.78). The odds of fetal mortality had a similar decrease between the two periods OR 0.49, (95% CI 0.28–0.85).
- The frequency of extra alarms due to reduced movements was 3% in observational studies. In the case-control studies, the increase was 2.1% (from 6.7% to 8.8%). Therefore, monitoring of fetal movements will increase the number of antenatal visits in pregnancy by 2 to 3 per hundred pregnancies.

These analyses provide support for the use of fetal movement counting in pregnancies with or without risks factors for adverse perinatal outcomes. A large RCT may be necessary to confirm these observations. Other literature providing no evidence to support the use of fetal movement counting was also reviewed, specifically the trial conducted by Grant et al.,²⁷ which is the largest RCT performed to date on the use of fetal movement counts. Since the study population was larger (N = 68 000) than all previous studies combined, and the study is unlikely to be replicated, it requires

Table 3. Obstetrical history and current pregnancy conditions associated with increased perinatal morbidity/mortality where antenatal fetal surveillance may be beneficial

Previous obstetrical history	
Maternal	Hypertensive disorder of pregnancy Placental abruption
Fetal	Intrauterine growth restriction Stillbirth
Current pregnancy	
Maternal	Post-term pregnancy (> 294 days, > 42 weeks) ^{9,10} Hypertensive disorders of pregnancy ¹¹ Pre-pregnancy diabetes ¹² Insulin requiring gestational diabetes ¹³ Preterm premature rupture of membranes ¹⁴ Chronic (stable) abruption ¹⁵ Iso-immunization ⁸ Abnormal maternal serum screening (hCG or AFP > 2.0 MOM) in absence of confirmed fetal anomaly ¹⁶ Motor vehicle accident during pregnancy ¹⁷ Vaginal bleeding Morbid obesity ^{18,19} Advanced maternal age Assisted reproductive technologies
Fetal	Decreased fetal movement ^{20,21} Intrauterine growth restriction ²² Suspected Oligohydramnios/Polyhydramnios Multiple pregnancy Preterm labour

special attention. The study, which was conducted mainly in the UK, and at a few centres in Sweden, Belgium, and the USA, compared antenatal fetal deaths in women who were asked to perform daily fetal movement counts with those in women who were not asked to perform counts. The study also looked at unexplained stillbirths (the target group of fetal movement counts). The authors' main conclusion was that a formal protocol for fetal movement counts had no advantage over no formal protocol in reducing stillbirths. The authors stated that 1250 women would have to perform fetal movement counts to prevent one stillbirth.

In reviewing this study, several methodological issues were identified that lead to questions about the validity of the results and conclusions. These issues include the following.

Delayed response

Other studies on fetal movement counts required reporting of reduced fetal movements within 1 to 12 hours. In contrast, admission for reduced fetal movements was delayed by up to 48 hours in this study. Furthermore, 14% of these women were managed by telephone advice alone. This may explain the high stillbirth rate on admission (85%, 100/117). Therefore, the outcomes of the study may reflect the inadequate management protocol in cases of reduced fetal movement, rather than the test's inherent usefulness.

Inadequate and inconsistent management protocol

The management of women with decreased fetal movements was not standardized. For instance, ultrasound scans were performed in only 11% of women with fetuses alive on admission. Many of the women who presented with decreased movements and a living fetus (30%, 11/36) were falsely reassured and were sent home only to have a subsequent stillbirth. These data also suggest that with decreased fetal movement counts, electronic fetal heart monitoring alone may not be sufficient to ensure fetal well-being.

Poor reporting of outcome

No data on neonatal deaths or perinatal morbidity were collected.

Blinding of patients

Approximately 60% of the controls signed a consent form, possibly prejudicing outcomes, as these patients were aware of formal fetal movement counting.

Crossover of patients

Approximately 6.9% of the control groups filled in fetal movement count charts.

Reporting decreased movements

Controls had a lower reporting rate (65 vs. 84; $P < 0.05$). However, the reporting rate in these women was still quite high, suggesting possible contamination of results.

Compliance

Only 60% of patients complied with charting and only 50% reacted to the study threshold of decreased movements.

Table 4. Issues relevant for fetal movement counts^{28,29}

Gestational age	Fetal movements are perceived by women regularly after 24 weeks in a constant fashion. ³⁰ Most studies initiated fetal movements at 28-32 weeks. ²⁶ In extremely early gestational age, iatrogenic preterm delivery may have grave consequences. Therefore, fetal movement counting should not be encouraged prior to viability and possibly should start at 26-32 weeks based on the facilities available.
Non-perception of fetal movements	Women perceived 87-90% of fetal movements. ^{31,32} A small percentage of women do not perceive fetal movements. Fetal movement counting can not be used in these women. Perception may improve with looking at movements during ultrasound scanning. ³³
Optimal time for testing	Fetal movements were found to be increased at evening time. ^{34,35}
Position	Fetal movements are perceived best when lying down. ³⁶
Activity	Maternal exercise was not shown to alter fetal activity. ³⁷
Food	Most studies did not show an increase of movements following food or glucose. ^{35,38-41}
Smoking	Smoking reduces fetal movements temporarily by increasing carboxyhemoglobin levels and reducing fetal blood flow. ⁴²
Drug effect	Most drugs have no effect on fetal movements. Depressant drugs and narcotics may reduce fetal movements. ⁴³ Notably, antenatal corticosteroids may have the same effect for two days. ⁴⁴
Anxiety and stress	Fetal movement counting does not increase maternal stress or anxieties. ^{26,27}

Validity of fetal movement count charts

The average time to achieve 10 movements in most previous studies was about 20 minutes. In this study it was 162 minutes.

The concerns identified in study methodology and subsequent conclusions, significantly discount the role of this Grant et al.²⁷ RCT in formulating the fetal movement count recommendations in this guideline.

There are a number of issues relevant to fetal movement counting, as outlined in Table 4.

Which Method of Fetal Movement Count Should Be Used?

A variety of methods have been described, which are usually variations on the methodologies of two early studies.

- The Cardiff method, first reported by Pearson and Weaver⁴⁵ suggests a count to 10 movements in a fixed time frame. The original study required counting for

12 hours. Modified protocols include those of Liston (count to 6 hours)²⁸ and Moore (count to 2 hours).⁴⁶

- The Sadovsky method suggests a count of movements in a specific time frame (usually 30 minutes to two hours).⁴⁷

There are no studies comparing the effect on outcome of using different fetal movement count charts. A vigilant and perceptive woman probably does not need to do a formal fetal movement count. In addition, all studies, with the exception of that by Grant et al.,²⁷ showed that any of the methods outlined above resulted in a reduction of stillbirth rate. Ideally, the testing should be performed for the shortest time possible to identify fetuses at risk. A short observation period allows women to concentrate on the fetal movement count while minimizing any imposition on routine daily activity. The following testing approach is recommended: women should count distinctive fetal movements until they reach a count of six movements. If the count does not reach six movements in two hours, the woman should have further antenatal testing. Optimally, the woman should perform the count in the early evening when she is lying down, tilted, or semi-recumbent.

The rationale for this recommendation comes from data generated from research on fetal activity and previous studies on fetal movement counting, specifically those of Sadovsky,⁴⁷ Moore,⁴⁶ and Neldam,⁴⁸ and research data derived from studies on fetal behaviour. In most pregnancies, 10 fetal movements occurred within a 20-minute window.^{46,49,50} Patrick et al.⁵¹ showed that the fetal sleep cycle normally lasts about 20 to 40 minutes and practically never exceeds 90 minutes in the normal, healthy fetus. Sadovsky⁵² suggested that three movements per hour were abnormal. In Nedlam's study,⁴⁸ 4% of women perceived three movements or fewer per hour for two consecutive hours; in Rayburn and McKean's⁵³ study, this rate was 5%.

Therefore, counting up to six movements in a two-hour period offers short test duration, a proven track record, and a relatively low rate of alarm. Women should be informed that in most fetuses with a positive test (fewer than 6 movements in 2 hours), the result is often a false positive, and a good outcome ensues. However, ancillary fetal surveillance should be undertaken.

Purpose of Fetal Movement Counting

The purpose of fetal movement counting is to evaluate three types of fetus: (A) the healthy fetus, (B) the structurally normal, at risk fetus that may benefit from intense monitoring or delivery, and (C) the anomalous fetus.

- The healthy fetus is identified by exclusion. Fetuses with normal activity of six or more movements in the interval of two hours are almost invariably healthy.

SOGC Clinical Tip

Optimally, the technique for fetal movement counting is performed with the woman concentrating on the movements and in a reclined (not supine) position.

Women who report a general reduction of movements, although the specific target of six movements is reached, may desire or benefit (through reduction of anxiety) from further antenatal testing.

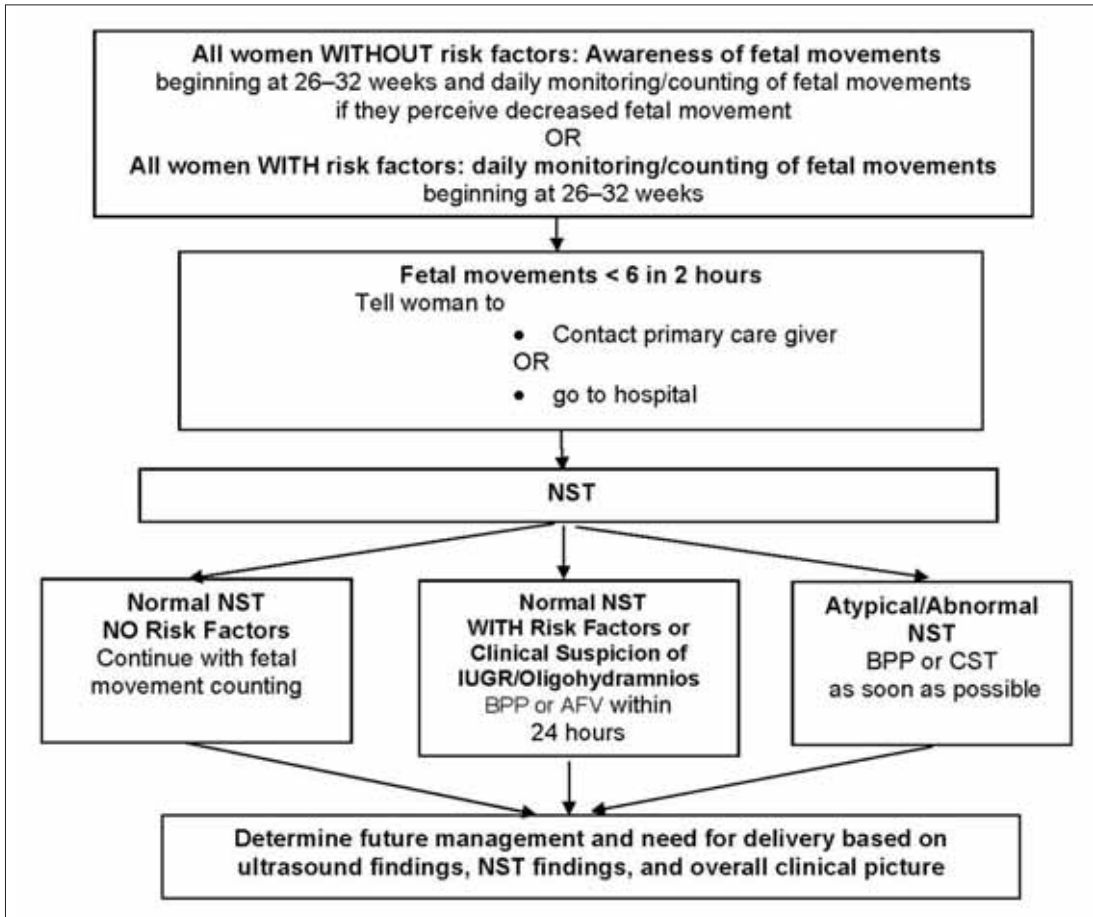
- The structurally normal fetus at risk for adverse outcome due to either maternal diseases or fetal conditions, such as IUGR, should have daily fetal movement counts. In these pregnancies, additional testing is usually prescribed in the form of interval non-stress testing or ultrasound scanning for amniotic fluid volume, biophysical profile, estimated fetal weight, or Doppler flow studies, as indicated and as available.
- Fetuses with anatomical malformation often have abnormal behaviour. Sadovsky et al.⁵² showed that reduced fetal movement was found in 16.5% of babies with anomalies, compared with 1% of those with normal movements. Rayburn and Barr⁵⁴ found that 28% of anomalous fetuses had decreased fetal movements compared with 4% in non-anomalous fetuses. Therefore, a fetus with decreased movements on which an anatomical ultrasound has not been done requires a scan to rule out a fetal malformation prior to considering an intervention for fetal well-being.

Clinical Management of Decreased Fetal Movement

There are no studies comparing different algorithms for diagnosis and management of decreased fetal movements. Most studies have relied on electronic fetal heart rate monitoring and ultrasound scans. The ultrasound scan can identify a fetal anomaly, decreased amniotic fluid volume, poor biophysical score, and IUGR. One study found ultrasound scans to be superior to fetal heart rate monitoring.⁵⁵

Women who report decreased fetal movements (< 6 distinct movements within two hours) should have an evaluation of maternal and fetal status. The first-line fetal tests include the non-stress test and biophysical profile. There is no specific recommended time frame for testing; however, in most studies with reduction in stillbirth rate, this testing was performed within 1 to 12 hours. When the non-stress test is normal and there are no risk factors, women should continue with daily fetal movement counting. If the non-stress test is normal and risk factors are identified,

Figure 3. Fetal movement algorithm



e.g., gestational hypertension or suspicion of small for gestational age fetus or oligohydramnios, further testing within 24 hours (ultrasound or biophysical profile) is recommended. Women should continue with daily fetal movement counting. In situations where the non-stress test is atypical/abnormal, further testing (biophysical profile or contraction stress test) should be performed as soon as possible. It is prudent to ensure that an anatomical scan to rule out a fetal malformation has been done prior to intervening for fetal well-being.

Recommendation 1: Fetal Movement Counting

1. Daily monitoring of fetal movements starting at 26 to 32 weeks should be done in all pregnancies *with* risk factors for adverse perinatal outcome. (I-A)
2. Healthy pregnant women *without* risk factors for adverse perinatal outcomes should be made aware of the significance of fetal movements in the third trimester and asked to perform a fetal movement count if they perceive decreased movements. (I-B)

3. Women who do not perceive six movements in an interval of two hours require further antenatal testing and should contact their caregivers or hospital as soon as possible. (III-B)

4. Women who report decreased fetal movements (< 6 distinct movements within 2 hours) should have a complete evaluation of maternal and fetal status, including non-stress test and/or biophysical profile. Prior to considering an intervention for fetal well-being, an anatomical scan to rule out a fetal malformation should be done, if one has not already been done. Management should be based upon the following:

- Non-stress test is normal and there are no risk factors: the woman should continue with daily fetal movement counting. (III-B)
- Non-stress test is normal and risk factors or clinical suspicion of intrauterine growth restriction/oligohydramnios is identified: an ultrasound for either full biophysical profile or

amniotic fluid volume assessment within 24 hours. The woman should continue with daily fetal movement counting. (III-B)

- Non-stress test is atypical/abnormal: further testing (biophysical profile and/or contraction stress test and assessment of amniotic fluid volume) should be performed as soon as possible. (III-B)

2. Non-Stress Test

Despite widespread use, there is poor evidence that antenatal non-stress testing can reduce perinatal morbidity or mortality.⁵⁶ In fact, the four blinded randomized trials evaluating the non-stress test, although small, demonstrated a trend to an increase in perinatal deaths in the cardiotocography group (OR 2.85; 95% CI 0.99–7.12).⁵⁶ There is a need for further study and evaluation of the non-stress test. Despite the evidence from these RCTs, the NST is embedded in clinical practice and for this reason discussion of this testing modality and recommendations about its use are included in this guideline. If it is to be used, it should be used in women with risk factors for adverse perinatal outcome. There is no good evidence on which to base a recommendation for frequency of non-stress testing. In most cases a normal NST is predictive of good perinatal outcome for one week (providing the maternal-fetal condition remains stable), except in women with insulin-dependent diabetes or with a postdates pregnancy, in which case NSTs are recommended at least twice weekly.^{23,57,58}

When used, the non-stress test is performed during the antenatal period when the uterus is relaxed, i.e., the fetus is not exposed to the “stress” of uterine contractions. The woman should empty her bladder and be positioned on either a bed or a reclining chair in the left lateral recumbent position.⁵⁹ The recording should last at least 20 minutes. The baseline fetal heart rate should be within the normal range of 110 to 160 bpm. Moderate variability of 6 to 25 bpm is expected, but variability assessment was not the original objective of the NST. Historically, a normal (reactive) non-stress test includes at least two accelerations from the baseline within the 20-minute period of testing that reach a peak or acme of at least 15 bpm above the baseline and have a duration from onset to return to baseline of at least 15 seconds.⁶⁰ A negative predictive value of the test for fetal and neonatal death is 99% within one week of testing.⁶¹ Therefore, a normal tracing meeting the acceleration criteria is sufficient for assurance of fetal well-being and does not warrant any other testing.⁶² If the fetal heart acceleratory response does not meet the criteria after 20 minutes of testing, the recording should continue for another 20 minutes to account for the average period of non-rapid eye movement sleep when fetal movement and subsequently heart rate variability are reduced. Note that this criterion applies

to the term or near-term fetus. In particular, caution should be used in applying the usual acceleratory (reactive) criteria in the interpretation of the non-stress test in the premature fetus. For fetuses less than 32 weeks’ gestation, accelerations would be expected to increase 10 bpm for at least 10 seconds.⁶³ Neither the administration of glucose nor the performance of manual stimulation is recommended as a technique to encourage fetal heart rate accelerations in the fetus. Studies in which the NST was used as the primary screening tool have demonstrated that up to 40% of fetuses will not meet the acceleration criteria within 40 minutes of testing. The majority of these fetuses are healthy; nevertheless, Brown and Patrick⁶⁴ demonstrated that the length of time that the fetus lacks accelerations is strongly correlated with fetal compromise. They concluded that if the fetus lacks accelerations for greater than 80 minutes, then the fetus is likely compromised and will continue to lack accelerations. These findings have been confirmed by Leveno et al.⁶⁵ If the fetus lacks accelerations after 40 minutes of testing, the primary care provider should be informed, and the electronic fetal monitoring should be continued. A decision should be made to proceed either to amniotic fluid assessment and or to multiple parameters testing (such as a biophysical profile or contraction stress testing). Although the use of vibroacoustic stimulation has demonstrated a decrease in both testing time and number of non-reactive antenatal cardiotocographs, its use is not recommended to stimulate fetal heart accelerations, because the predictive reliability and safety of this modality are still unknown.⁶⁶

Classification of Non-Stress Tests

Although non-stress tests originally assessed the “reactive or non-reactive” fetus according to whether or not the acceleration criteria were met, the other parameters of electronic fetal heart assessment including baseline rate, variability, and the presence or absence of decelerations should also be assessed. If uterine activity is present, then strictly speaking this is no longer a non-stress test, but a spontaneous contraction stress test. These spontaneous contractions may not be of a frequency sufficient to meet the requirements of a formal “contraction stress test”; nevertheless, decelerations of the fetal heart in association with such uterine activity must be evaluated.

For the purposes of classification, the National Institute of Child Health and Human Development definitions are used.⁶³ For accelerations, this means that the acme of the acceleration is ≥ 15 beats/minute above the baseline, and the acceleration lasts ≥ 15 seconds and < 2 minutes from the onset to return to baseline. Before 32 weeks’ gestation, accelerations are defined as having an acme ≥ 10 beats/min above the baseline with a duration of ≥ 10 seconds from onset to the return to baseline.

Table 5. Antepartum classification: non-stress test

Parameter	Normal NST (Previously "Reactive")	Atypical NST (Previously "Non-Reactive")	Abnormal NST (Previously "Non-Reactive")
Baseline	110–160 bpm	<ul style="list-style-type: none"> • 100–110 bpm • > 160 bpm < 30 min. • Rising baseline 	<ul style="list-style-type: none"> • Bradycardia < 100 bpm • Tachycardia > 160 for > 30 min. • Erratic baseline
Variability	<ul style="list-style-type: none"> • 6–25 bpm (moderate) • ≤ 5 (absent or minimal) for < 40 min. 	≤ 5 (absent or minimal) for 40–80 min.	<ul style="list-style-type: none"> • ≤ 5 for ≥ 80 min. • ≥ 25 bpm > 10 min. • Sinusoidal
Decelerations	None or occasional variable < 30 sec.	Variable decelerations 30–60 sec. duration	<ul style="list-style-type: none"> • Variable decelerations > 60 sec. duration • Late deceleration(s)
Accelerations Term Fetus	≥ 2 accelerations with acme of ≥ 15 bpm, lasting 15 sec. < 40 min. of testing	≤ 2 accelerations with acme of ≥ 15 bpm, lasting 15 sec. in 40–80 min.	<ul style="list-style-type: none"> • ≤ 2 accelerations with acme of ≥ 15 bpm, lasting 15 sec. in > 80 min.
Preterm Fetus (< 32 weeks)	≥ 2 accelerations with acme of ≥ 10 bpm, lasting 10 sec. < 40 min. of testing	≤ 2 accelerations of ≥ 10 bpm, lasting 10 sec. in 40–80 min.	≤ 2 accelerations of ≥ 10 bpm, lasting 10 sec. in > 80 min.
ACTION	FURTHER ASSESSMENT OPTIONAL, based on total clinical picture	FURTHER ASSESSMENT REQUIRED	URGENT ACTION REQUIRED An overall assessment of the situation and further investigation with U/S or BPP is required. Some situations will require delivery.

For the purpose of clarity and consistency in interpretation, communication, and management, this guideline classifies non-stress tests as (1) normal, (2) atypical, or (3) abnormal (Table 5). A classification of normal refers to what was previously described as a “reactive” NST, and further testing would be undertaken according to the presence of risk factors and the overall clinical situation.

An atypical classification may result from a baseline fetal heart rate of (1) 100 to 110 bpm, (2) > 160 bpm for up to 30 minutes, or (3) a rising baseline. An atypical tracing would also include absent or minimal variability for 40 to 80 minutes, or the presence of variable decelerations of 30 to 60 seconds in duration. The occurrence of two accelerations in 40 to 80 minutes of monitoring is also considered atypical. Atypical tracings require further evaluation of the total clinical picture and of the fetal status. The individual carrying out the test should inform the primary care provider prior to discontinuing the testing, and the primary care provider should arrange for or perform further assessment.

An abnormal tracing is one that persistently lacks accelerations after 80 minutes or one that contains significant

abnormality of baseline heart rate or variability and/or shows evidence of significant deceleration. The presence of an abnormal non-stress test demands immediate further investigation and possibly delivery. All facilities where testing is carried out should have clearly stated, readily accessible protocols in place for interdisciplinary communication and action in the presence of an abnormal non-stress test. Such action would include the initiation of intrauterine resuscitation, consultation or communication with an obstetrician and/or MFM sub-specialist, and arrangement for further testing and/or consideration of delivery and/or transport.

Maternal Glucose Administration

Maternal glucose administration has been used in clinical practice in an attempt to stimulate the fetus to alter the results of a non-reactive NST. A Cochrane review of two trials with a total of 708 participants examined the efficacy of this practice.⁶⁶ The authors concluded that antenatal maternal glucose administration did not decrease the incidence of non-reactive antenatal cardiotocography tests, and it is not recommended.

Manual Fetal Manipulation

Manual fetal manipulation has also been used in clinical practice in an attempt to stimulate a fetus to alter the results of a non-reactive NST. A Cochrane review of three trials with a total of 1100 women with 2130 episodes of participation examined the efficacy of this practice.⁶⁷ The authors concluded that manual fetal manipulation did not decrease the incidence of non-reactive antenatal cardiotocography test (OR 1.28; 95% CI 0.94–1.74), and it is not recommended.

Recommendation 2: Non-Stress Test

1. Antepartum non-stress testing may be considered when risk factors for adverse perinatal outcome are present. (III-B)
2. In the presence of a normal non-stress test, usual fetal movement patterns, and absence of suspected oligohydramnios, it is not necessary to conduct a biophysical profile or contraction stress test. (III-B)
3. A normal non-stress test should be classified and documented by an appropriately trained and designated individual as soon as possible, (ideally within 24 hours). For atypical or abnormal non-stress tests, the nurse should inform the attending physician (or primary care provider) at the time that the classification is apparent. An abnormal non-stress test should be viewed by the attending physician (or primary care provider) and documented immediately. (III-B)

3. Contraction Stress Test

The contraction stress test, or oxytocin challenge test, is a test of fetal well-being first described by Ray et al. in 1972.⁶⁸ It evaluates the response of the fetal heart rate to induced contractions and was designed to unmask poor placental function.^{68,69} In a time when uteroplacental function is often evaluated by biophysical variables (e.g., biophysical profile) or vascular flow measurements (e.g., Doppler interrogation of uterine or fetal vessels), the contraction stress test is now being performed much less frequently.^{69,70}

The CST may still be used when the fetus is at risk for the consequences of uteroplacental pathology. This includes maternal conditions such as diabetes or hypertension and fetal conditions such as growth restriction or postdates.⁶⁹ The CST should not be used in any woman for whom vaginal delivery is contraindicated (i.e., women with placenta previa or previous classical Caesarean section).⁶⁹ The CST should not be performed below the gestational age at which intervention would be made on behalf of the fetus if abnormal (generally 24 weeks).^{69,71} This test should be performed in hospital where emergency Caesarean section is available,⁷⁰ and the woman should be fully informed of the risks and benefits of the test. The objective is to induce three

contractions, lasting one minute each, within a ten minute period,⁷⁰ so that the fetal heart response to the contractions can be evaluated.

The CST may be performed using maternal nipple stimulation or an oxytocin infusion. For nipple stimulation, the woman is instructed to rub one nipple through her clothing with the palmar surface of her fingers rapidly, but gently, for two minutes and then to stop for five minutes. Uterine activity is then evaluated. If contractions are inadequate, a second cycle of two minutes of stimulation is recommended.⁷² Bilateral nipple stimulation may then be considered. Nipple stimulation is associated with no greater risk of uterine hyperstimulation and has a shorter average testing time than oxytocin infusion.^{73–75} Should nipple stimulation fail to induce contractions that meet the test criteria, then oxytocin infusion should be considered.

For oxytocin-induced contractions, the woman is placed in semi-recumbent position with an intravenous line in place.^{69,72} An NST is performed prior to the CST. If then considered appropriate, uterine contractions are induced using exogenous oxytocin, commencing at 0.5 to 1 mU/min, and increasing every 15 to 30 minutes by 1 mU/min, until three contractions lasting one minute each within a 10-minute period are achieved.⁷⁰ Hyperstimulation may occur; Freeman reported hyperstimulation of up to 10% in tests in which oxytocin was increased every 15 minutes. Therefore, increasing at longer intervals, e.g., every 30 minutes, may be wise.⁷⁶

The tracing is evaluated for baseline rate, baseline variability, and decelerations.^{69,70} A CST is considered *positive* if late decelerations occur with more than 50% of the induced contractions (even if the goal of three contractions in 10-minutes has not yet been reached). A *negative* CST has a normal baseline fetal heart rate tracing without late decelerations.⁶⁸ An equivocal test is defined as repetitive decelerations, not late in timing or pattern.⁷⁰ A CST is deemed unsatisfactory if the desired number and length of contractions is not achieved or if the quality of the cardiotocography tracing is poor.

The oxytocin stress test requires a lengthy observation period and IV access and has a high rate of equivocal results.⁷⁷ It has been almost completely replaced by the other tests of fetal well-being described in this guideline. The advantage of the CST is that it most closely approximates intrapartum surveillance of the fetus at risk.⁶⁹ There is still a place for the CST in a modern obstetrical unit where a fetus with other abnormal testing parameters is to be delivered that might be a candidate for a vaginal delivery if contractions are tolerated. A fetus demonstrating an atypical/abnormal NST and a positive CST is less likely to tolerate labour and will require careful intrapartum

observation.^{71,78} The test may also provide information supporting prolongation of the pregnancy when the fetus is at risk at a gestational age remote from term.

The CST has a high negative predictive value (99.8%).⁷⁹ Its positive predictive value for perinatal morbidity however is poor (8.7–14.9%).⁷⁰ It should never be used alone to guide clinical action.⁶⁹ The corrected perinatal mortality rate within one week of a negative contraction stress test is 1.2/1000 births.

Recommendation 3: Contraction Stress Test

1. The contraction stress test should be considered in the presence of an atypical non-stress test as a proxy for the adequacy of intrapartum uteroplacental function and, together with the clinical circumstances, will aid in decision making about timing and mode of delivery. (III-B)
2. The contraction stress test should *not* be performed when vaginal delivery is contraindicated. (III-B)
3. The contraction stress test should be performed in a setting where emergency Caesarean section is available. (III-B)

4. Sonographic Assessment of Fetal Behaviour and/or Amniotic Fluid Volume

Sonography allows the simultaneous assessment of several fetal behavioural and physiologic characteristics. The BPP is an evaluation of current fetal well-being. It is performed over 30 minutes and assesses fetal behaviour by observing fetal breathing movement, body movement, tone, and amniotic fluid volume.⁸⁰ In the presence of intact membranes, functioning fetal kidneys, and unobstructed urinary tract, decreased amniotic fluid reflects decreased renal filtration due to redistribution of cardiac output away from the fetal kidneys in response to chronic hypoxia.⁸¹

The sonographic components⁸⁰ of the fetal BPP are shown in Table 6.

Each of these individual ultrasound assessed variables is scored 0 (if absent) or 2 (if present) and summed for a maximum score of 8. The inclusion of the NST brings the maximum possible score to 10 when the NST is normal. The original BPP included all five components in every pregnancy assessment. A more recent approach is to carry out the ultrasound components, reserving the NST for pregnancies in which one of the ultrasound components is absent. A score of 10 or 8 (including 2 for fluid present) is considered normal, 6 is considered equivocal, and 4 or less is abnormal. (Reassessment of a patient with an equivocal result, 6 of 10 [normal fluid], will be reassuring in 75% of cases.⁸⁰) Representative perinatal mortality and suggested clinical management are shown in Table 7.

The BPP identifies less than a 2 cm by 2 cm pocket of amniotic fluid as oligohydramnios.⁸⁰ There are two other

Table 6. Components of fetal biophysical profile

Component	Criteria
1. Breathing movements	At least one episode continuing more than 30 seconds.
2. Movements	At least three body or limb movements.
3. Tone	An episode of active extension with return to flexion of a limb or trunk, or opening and closing of the hand.
4. Amniotic fluid volume	At least one cord and limb-free fluid pocket which is 2 cm by 2 cm in two measurements at right angles.

commonly used techniques for quasi-quantitative evaluation of amniotic fluid volume. The first is the maximal vertical pocket depth.⁸² This approach identifies a pocket depth of 2 to 8 cm as normal, 1 to 2 cm as marginal, < 1 cm as decreased, and > 8 cm as increased. The second technique is the AFI. The AFI attempts to assess amniotic fluid volume more broadly by summing the deepest vertical pocket of fluid in the four quadrants of the uterus.⁸³ The AFI uses the 5th and 95th percentiles for gestational age to signify oligohydramnios and polyhydramnios respectively.⁸⁴ Dye dilution techniques at amniocentesis have not shown one method of sonographic prediction of amniotic fluid volume to be better at determining true amniotic fluid volume.⁸⁵ There is evidence from recent RCTs that use of AFI, rather than pocket size, increases intervention frequency without improving outcomes.^{86–89} This is despite a well-conducted blinded prospective cohort⁹⁰ that found AFI as a more sensitive, but still poor, predictor of adverse pregnancy outcome.

A systematic review⁵ of four RCTs using the biophysical profile for fetal assessment in high-risk pregnancies concluded that there is not enough evidence to clearly inform providers' care decisions. Retrospective and prospective reports of large cohorts indicate that lower BPP score is associated with more frequent fetal acidosis,^{91,92} perinatal morbidity and mortality,^{93,94} and cerebral palsy.⁹⁵ This level II evidence is the basis of BPP use for assessment of antenatal health surveillance. It should be acknowledged that the amniotic fluid criterion definition has varied somewhat in this data.⁹⁶

Some centres carry out a "modified" BPP as the primary screen of antenatal surveillance. The modified BPP consists of a non-stress test and an AFI (> 5 cm is considered

Table 7. Perinatal mortality within one week of biophysical profile by BPP score*

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. In the preterm fetus < 34 weeks, intensive surveillance may be preferred to maximize fetal maturity. ³⁰
6/10 (normal fluid)	Equivocal test, possible fetal asphyxia	Variable	Repeat test within 24 hr
6/10 (abnormal fluid)	Probable fetal asphyxia	89/1000	Delivery of the term fetus. In the preterm fetus < 34 weeks, intensive surveillance may be preferred to maximize fetal maturity. ³⁰
4/10	High probability of fetal asphyxia	91/1000	Deliver for fetal indications.
2/10	Fetal asphyxia almost certain	125/1000	Deliver for fetal indications.
0/10	Fetal asphyxia certain	600/1000	Deliver for fetal indications.

*Modified from Manning FA, Dynamic ultrasound-based fetal assessment: The fetal biophysical score⁸⁰

adequate). If either assessment measure is of concern, then the complete BPP is performed. There is less level II evidence supporting this approach.^{25,97}

Recommendation 4: Biophysical Profile

1. In pregnancies at increased risk for adverse perinatal outcome and where facilities and expertise exist, biophysical profile is recommended for evaluation of fetal well-being. (I-A)
2. When an abnormal biophysical profile is obtained, the responsible physician or delegate should be informed immediately. Further management will be determined by the overall clinical situation. (III-B)

5. Uterine Artery Doppler

Background Information

In normal pregnancy, the developing placenta implants on maternal decidua, and the trophoblast invades the maternal spiral arteries, destroying the elastic lamina and transforming these vessels into low resistance shunts in order to improve blood supply to the fetoplacental unit. Impaired trophoblastic invasion is associated with pre-existing hypertension and subsequent development of hypertensive disorders of pregnancy, IUGR, placental abruption, and intrauterine fetal demise. Doppler ultrasound of the uterine

SOGC Clinical Tip

Assessments of amniotic fluid volume by the amniotic fluid index increases care provider intervention rates without demonstrating improved outcomes, when compared with the single largest pocket (maximal vertical depth) approach.

arteries is a non-invasive method of assessing the resistance of vessels supplying the placenta. In normal pregnancies, there is an increase in blood flow velocity and a decrease in resistance to flow, reflecting the transformation of the spiral arteries. In pregnancies complicated by hypertensive disorders, Doppler ultrasound of the uterine artery shows increased resistance to flow, early diastolic notching, and decreased diastolic flow.

Several studies^{98–101} have examined the potential value of uterine artery Doppler in predicting pregnancies at risk of complications related to impaired placentation. Studies can be divided into unselected and selected populations. “Selected populations” refers to women who are at higher risk of developing complications, e.g., chronic hypertension, previous gestational hypertension, or previous

Table 8. Indications for uterine artery Doppler at 17 to 22 weeks

Previous obstetrical history	Previous early onset gestational hypertension Placental abruption Intrauterine growth restriction Stillbirth
Risk factors in current pregnancy	Pre-existing hypertension Gestational hypertension Pre-existing renal disease Longstanding Type I diabetes with vascular complications, nephropathy, retinopathy Abnormal maternal serum screening (hCG or AFP > 2.0 MOM) Low PAPP-A (consult provincial lab for norms)

pregnancy affected by intrauterine growth restriction. Each of these studies used different Doppler indicators, such as resistance index or pulsatility index greater than the 95th centile, unilateral or bilateral early diastolic notching in the wave form, and varying clinical end points such as development of gestational hypertension, preterm birth, or intrauterine growth restriction. However, the findings can be summarized as follows:

- Approximately 1% of at-risk pregnancies have abnormal uterine artery Doppler resistance and/or notching after 26 weeks' gestation.
- The likelihood of development of gestational hypertension and/or growth restriction in these pregnancies is increased fourfold to eightfold.
- Conversely, normal uterine artery pulsatility index or resistance index significantly reduces the likelihood of these pregnancy complications (negative predictive value varying between 80% and 99%).

Data on the use of uterine artery Doppler screening in healthy or unselected populations without risk factors for adverse outcome is less well substantiated. Nevertheless, even in this population abnormal (positive) uterine artery Doppler is a better predictor of the onset of gestational hypertension than any other single maternal characteristic (e.g., age, race, height, weight, smoking, alcohol consumption, past medical history, previous gestational hypertension or abruption, and new partner). Once again, normal uterine artery Doppler pulsatility or resistance index is highly correlated with the likelihood of a completely uncomplicated pregnancy outcome.¹⁰⁰

In centres utilizing uterine artery Doppler, this testing modality has been incorporated into routine ultrasound screening (18–22 weeks). In the small number of women demonstrating a positive uterine artery Doppler, a second evaluation is carried out at 24 to 26 weeks, and if the abnormality persists, increased maternal and fetal surveillance is implemented for the duration of the pregnancy. It should be understood that uterine artery Doppler assessment is not yet established for routine use in Canada.

A positive uterine artery Doppler screen consists of mean resistance index of > 0.57, pulsatility index > 95th centile, and/or the presence of uterine artery notching.

Recommendation 5: Uterine Artery Doppler

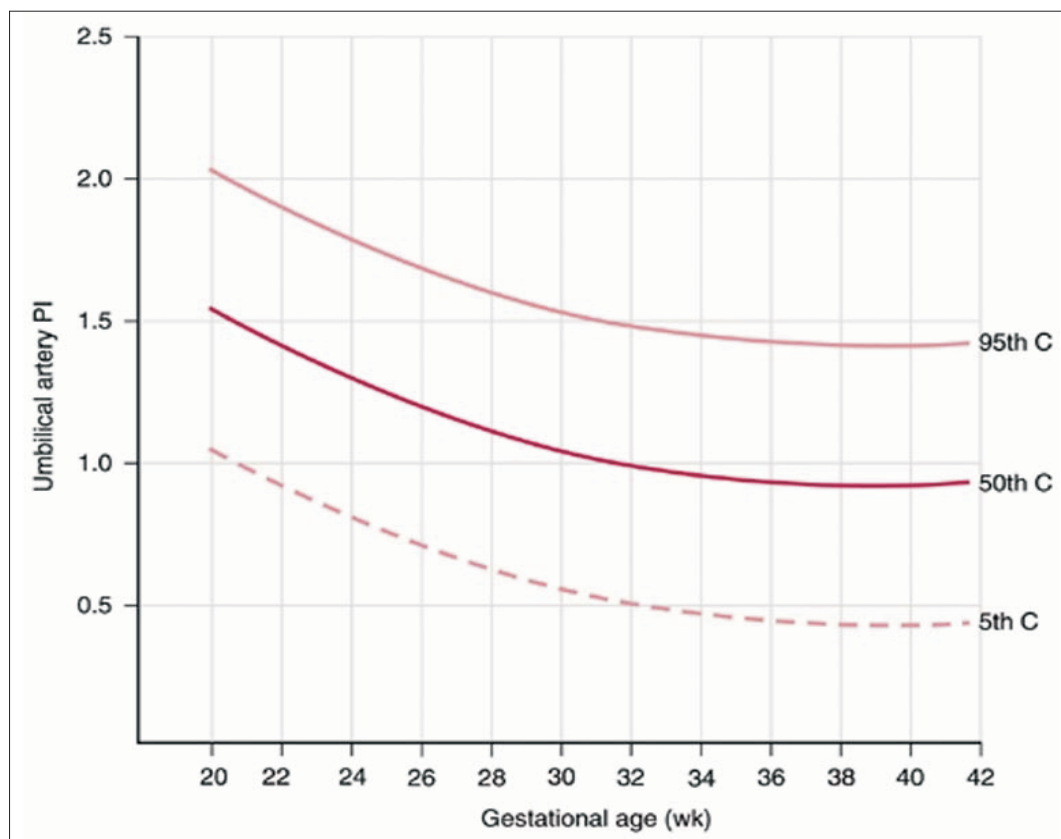
1. Where facilities and expertise exist, uterine artery Doppler may be performed at the time of the 17 to 22 weeks' gestation detailed anatomical ultrasound scan in women with the following factors for adverse perinatal outcome. (II-A)
2. Women with a positive uterine artery Doppler screen should have the following:
 - A double marker screen (for alpha fetoprotein and beta hCG) if at or before 18 weeks' gestation. (III-C)
 - A second uterine artery Doppler at 24 to 26 weeks. If the uterine artery Doppler is positive at the second scan, the woman should be referred to a maternal-fetal medicine specialist for management. (III-C)

6. Umbilical Artery Doppler

The following will serve as an adjunct and update to the SOGC Clinical Practice Guideline "The Use of Fetal Doppler in Obstetrics."¹⁰²

In normal pregnancy, the fetal umbilical circulation is characterized by continuous forward flow, i.e., low resistance, to the placenta, which improves with gestational age as primary, secondary, and tertiary branching of the villus vascular architecture continue to develop. Resistance to forward flow therefore continues to decrease in normal pregnancy all the way to term.^{103,104} Increased resistance to forward flow in the umbilical circulation is characterized by abnormal systolic to diastolic ratio, pulsatility index (PI) or resistance index (RI) greater than the 95th centile and implies decreased functioning vascular units within the placenta (see Table 8).⁸ Embolization experiments in the sheep placenta suggest that absent end-diastolic flow velocities are not achieved until more than 50% of functional villi have been obliterated.^{105–107}

A number of randomized trials using umbilical artery Doppler velocimetry to assess pregnancies at risk of placental insufficiency have demonstrated improved perinatal outcome when umbilical Doppler is used to assess fetal

Figure 4. Umbilical artery pulsatility Index: 20 to 42 weeks

Umbilical artery pulsatility index (5th, 50th, and 95th percentiles) from a cross-sectional study of 1556 healthy pregnancies at 20 to 42 weeks' gestation. All fetuses were singletons, and gestational age was confirmed by early ultrasound measurements of crown-rump length. Recordings from umbilical artery were made in the absence of fetal body breathing movements. The pulsatility index was calculated as (systolic velocity - diastolic velocity/mean velocity). This figure was published in *High Risk Pregnancy: Management Options*, 3rd edition. James et al. Copyright Elsevier (2006).

well-being. Furthermore, the Cochrane meta-analysis of randomized trials¹⁰⁸ on the use of umbilical artery Doppler in pregnancies with risk factors for adverse perinatal outcome demonstrates a clear reduction in perinatal mortality in normally formed fetuses. This is the only form of fetal surveillance that has been shown to improve perinatal mortality in randomized controlled trials.

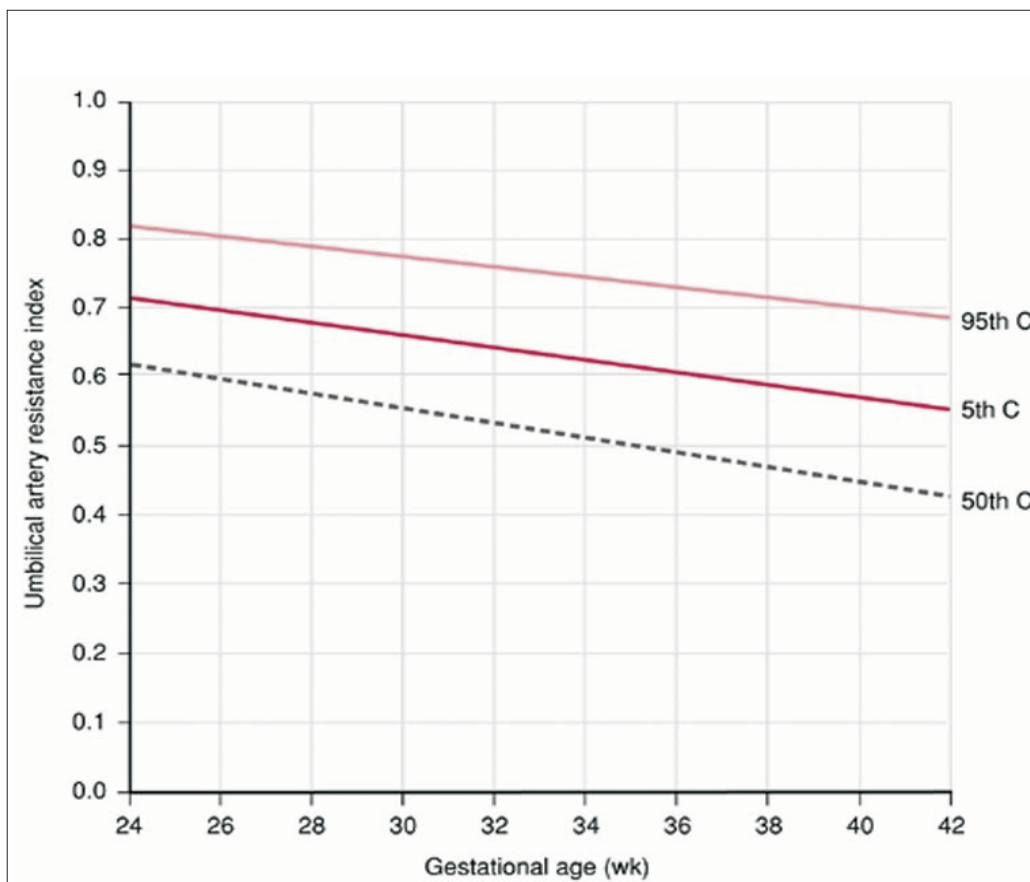
Recommendation 6: Umbilical Artery Doppler

1. Umbilical artery Doppler should not be used as a screening tool in healthy pregnancies, as it has not been shown to be of value in this group. (I-A)
2. Umbilical artery Doppler should be available for assessment of the fetal placental circulation in pregnant women with suspected placental insufficiency. (I-A) Fetal umbilical artery Doppler assessment should be considered (1) at time of referral for suspected growth restriction, or (2) during follow-up for suspected placental pathology.
3. Depending on other clinical factors, reduced, absent, or reversed umbilical artery end-diastolic flow is an indication for enhanced fetal surveillance or delivery. If delivery is delayed to improve fetal lung maturity with maternal administration of glucocorticoids, intensive fetal surveillance until delivery is suggested for those fetuses with reversed end-diastolic flow. (II-1B)

7. Other Fetal Artery Doppler Parameters When Doppler Expertise Is Available

A. Progression of Cardiovascular Compromise in the Fetus With Intrauterine Growth Restriction

AEDF velocity in the umbilical artery is correlated with increasing impediment of flow towards the placenta and decreased number of functioning tertiary villi. This finding is also highly associated with PNM, fetal acidosis, and increased need for NICU admission.¹⁰⁹ It is recognized, however, that this finding may occur days to weeks prior to abnormalities found on other measures of fetal health

Figure 5. Umbilical artery resistance index: 24 to 42 weeks

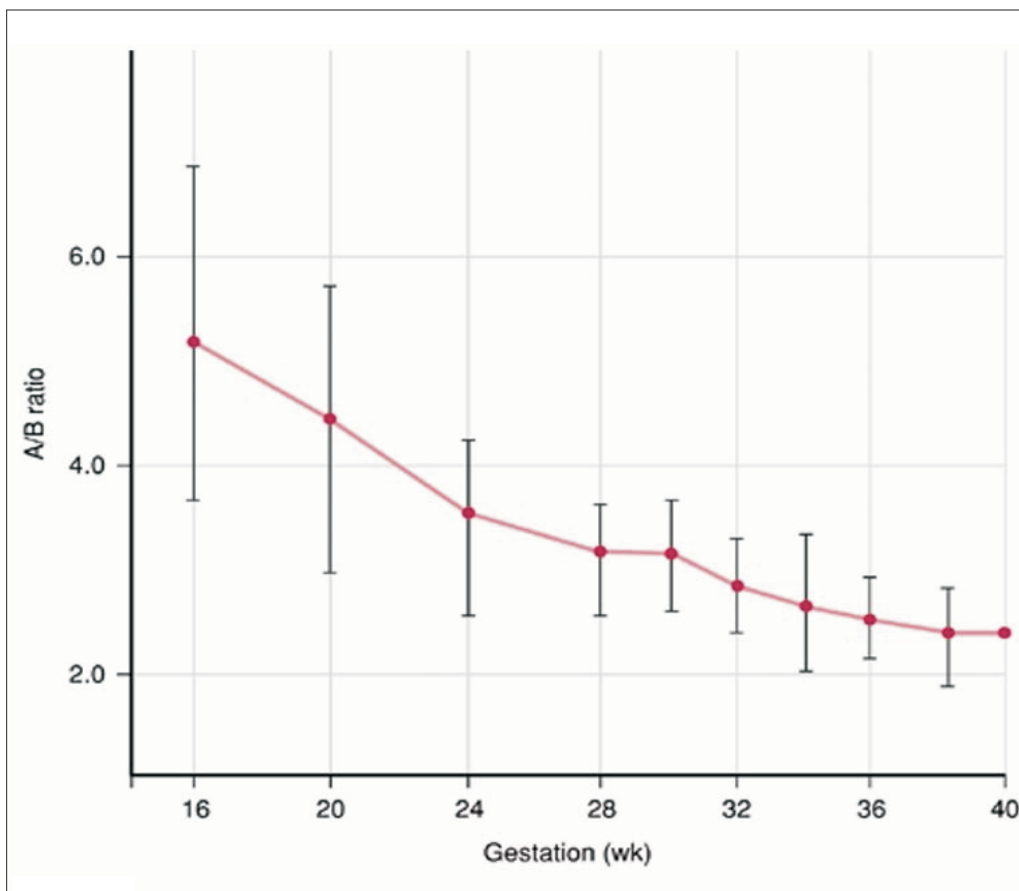
Umbilical artery resistance index (5th, 50th, and 95th percentiles) from cross-sectional study of 1675 pregnancies at 24 to 42 weeks' gestation. Each fetus contributed only one measurement to the study. Signals were recorded from a free-floating loop in the middle of the umbilical cord. Resistance (Pourcelot) index was calculated as (systolic diastolic velocity/systolic velocity). This figure was published in *High Risk Pregnancy: Management Options*, 3rd edition. James et al. Copyright Elsevier (2006).

(NST, BPP, CST) indicating urgent delivery. This is of major importance, especially in the circumstance of IUGR < 32 weeks' gestation, when preterm birth must be weighed against risks of intrauterine asphyxia in choosing timing of delivery.^{105,106,109} Other Doppler parameters, particularly assessment of the central venous system, can better predict impending cardiac compromise and the need for delivery.^{110–112}

Initially, as fetal hypoxemia develops, redistribution of blood flow occurs such that MCA resistance indices fall as umbilical arterial resistance increases, leading to the so-called “brain sparing” effect. Decreased cerebral impedance, like descending aorta impedance also leads to reversal of blood flow in the aortic isthmus. Changes in the cerebral

flow parameters, however, do not correlate well with the final stages of asphyxic compromise and therefore are not helpful in choosing timing for delivery. Increased resistance in the umbilical arteries and descending aorta does lead, however, in an increase in right ventricular end-diastolic pressure (after load), leading to decreased right ventricular compliance and increased venous pressure in the right atrium and systemic veins. This can be detected using transtricuspid E/A (early and late diastolic filling) ratios, which increase with decreased ventricular compliance.^{110–114}

Further deterioration of right ventricular contractility will lead to right ventricular dilatation and tricuspid regurgitation (insufficiency), further exacerbating right atrial filling pressure and resistance to venous filling.

Figure 6. Systolic-to-diastolic ratio (A/B ratio)

Systolic-to-diastolic ratio (A/B ratio) calculated from umbilical artery flow velocity waveforms (mean \pm 2 SDs) obtained in a longitudinal study of 15 normal pregnancies. Study subjects were scanned every 2 weeks, from 24 to 28 weeks' gestation until delivery. Eight of the study subjects had been recruited at 16 weeks and were also scanned every 4 weeks throughout the second trimester. In all subjects, gestational age was confirmed by ultrasound scanning 16 weeks' gestation. A range-gated pulsed Doppler beam was guided from the ultrasound image to insonate the umbilical artery. This figure was published in *High Risk Pregnancy: Management Options*, 3rd edition. James et al. Copyright Elsevier (2006).

Resistance to venous filling is reflected best by increased pulsatility in the ductus venosus^{115–118} during atrial contraction, a finding highly correlated with impending asphyxia and acidosis. Further increases in systemic venous pressures lead to maximum dilatation of the ductus venosus and direct transmission of cardiac impulses to the umbilical vein, causing umbilical venous pulsations. This finding is shown to be highly correlated with severe acidosis and impending fetal demise.

B. Middle Cerebral Artery Peak Systolic Velocity as a Predictor of Fetal Anemia

Many authors conclude that MCA PSV is highly correlated with severe fetal anemia (sensitivity as high as 100%).^{119–125} An increase in the percentage of false-positive determinations in the range of 15% to 28% comes with moderate and milder degrees of anemia. In fetuses with non-immune hydrops or when prospectively following a fetus at risk of parvovirus B19-induced fetal anemia, MCA PSV serves as a useful measure of fetal anemia severe enough to require IUT.

Intrapartum Fetal Surveillance

HYPOXIC ACIDEMIA, METABOLIC ACIDOSIS, ENCEPHALOPATHY, AND CEREBRAL PALSY

Uterine contractions during labour normally decrease uteroplacental blood flow which results in reduced oxygen delivery to the fetus. Most healthy fetuses tolerate this reduction in flow and have no adverse effects. The distribution of oxygen to the fetus depends on the delivery of oxygen from the maternal lungs to the uterus and placenta, diffusion from the placenta to fetal blood, and distribution of fetal oxygenated blood to various fetal tissues through fetal cardiovascular activities.¹²⁶ Disturbances in any of these three steps will reduce availability of oxygen to the fetus (See Table 9).

Asphyxia (hypoxic acidemia) is a condition of impaired gas exchange, which when persistent, leads to progressive hypoxemia, hypercapnia, and metabolic acidosis.¹²⁷ Babies born following labour demonstrate slightly altered average values of umbilical artery blood gases compared with those born without labour.¹²⁸ These minor changes carry no prognostic significance. Respiratory acidosis, characterized by lowered pH and elevated pCO₂ with a normal base deficit, reflects impaired gas exchange for a short duration. When this occurs, secondary postnatal complications are uncommon, and prognosis is excellent. With more prolonged impairment in gas exchange, compensatory physiological mechanisms are invoked to improve oxygen delivery and counter the production of organic acids. Metabolic acidosis, defined by lowered pH and base deficit over 12 mmol/L occurs in 2% of deliveries.¹²⁹ The majority (75%) of these babies will be asymptomatic and hence have no increased likelihood of long-term sequelae.^{129,130} Others will develop some form of NE; however, NE may also arise from other causes.

Hypoxic Acidemia

Hypoxic acidemia may occur at any point during the infant's antepartum, intrapartum, or postpartum life. The type of resultant cerebral injury depends upon the nature of the insult and on the maturation of the brain and its vascular supply at the time of the insult. The term fetus sustains injury principally to the subcortical white matter and cerebral cortex. These "watershed" areas between the end branches of the major cerebral vessels are the regions of the brain at highest risk. Often, this injury involves the motor

cortex, especially the proximal extremities and upper extremities. The most frequent consequence of this injury is spastic quadriplegia. Deeper brain substance injury may occur with severe hypoxic/hypotensive insult. The preterm fetus is more susceptible to decreases in cerebral perfusion affecting the periventricular white matter. This region involves descending fibres from the motor cortex. The lesion is called periventricular leukomalacia and is visible on cranial ultrasound. Moderate injury is more likely to affect the lower limbs, but severe lesions often involve both lower and upper extremities. Long-term manifestations include spastic diplegia, spastic quadriplegia, and other visual and cognitive deficits.

Neonatal Encephalopathy

Neonatal encephalopathy and its subset HIE are conditions defined in term infants (> 37 completed weeks of gestation) and near-term infants (> 34 completed weeks of gestation). A large population-based study reported an incidence of NE of 3.8/1000 term infants and the incidence of HIE at 1.9 per 1000 term births.¹³¹ NE can result from many conditions, and 70% of cases occur secondary to events arising before the onset of labour, such as prenatal stroke, infection, cerebral malformation, and genetic disorders. In one series, only 19% of cases of NE met criteria suggestive of intrapartum hypoxia, and a further 10% experienced a significant intrapartum event that may have been associated with intrapartum hypoxia.¹²⁷ The overall incidence of NE attributable to intrapartum abnormality is approximately 1.6 per 10 000.

Hypoxic Ischemic Encephalopathy

Hypoxic ischemic encephalopathy refers to the subset of NE that is accompanied by umbilical artery blood gases demonstrating metabolic acidosis at birth along with the absence of other possible causes such as infection, anomaly or inborn error of metabolism. HIE is classified according to severity^{132,133} and neonatal death and long-term disability are related to the degree of HIE. Mild HIE carries no increased likelihood of long-term disability. Infants with moderate HIE have a 10% risk of death, and those who survive have a 30% risk of disabilities. Sixty percent of infants with severe HIE die, and many, if not all, survivors have disabilities.¹³³⁻¹³⁵ These studies report outcomes when treatment for NE was mostly supportive. More recently, early

Table 9. Factors that may affect fetal oxygenation in labour

Maternal factors	Decreased maternal arterial oxygen tension
	respiratory disease
	hypoventilation, seizure, trauma
	smoking
	Decreased maternal oxygen carrying capability
	significant anemia (e.g., iron deficiency, hemoglobinopathies)
	carboxyhemoglobin (smokers)
	Decreased uterine blood flow
	hypotension (e.g., blood loss, sepsis)
	regional anaesthesia
Uteroplacental factors	maternal positioning
	Chronic maternal conditions
	vasculopathies (e.g., systemic lupus erythematosus, type I diabetes, chronic hypertension)
	antiphospholipid syndrome
	Excessive uterine activity
	hyperstimulation secondary to oxytocin, prostaglandins (PGE ₂) or spontaneous labour
	placental abruption
	Uteroplacental dysfunction
	placental abruption
	placental infarction-dysfunction marked by IUGR, oligohydramnios, or abnormal Doppler studies
Fetal factors	chorioamnionitis
	Cord compression
	oligohydramnios
	cord prolapse or entanglement
	Decreased fetal oxygen carrying capability
significant anaemia (e.g., isoimmunization, maternal-fetal bleed, ruptured vasa previa)	
Carboxyhemoglobin (if mother is a smoker)	

neonatal treatment with head or body cooling has demonstrated improved outcomes for moderate and severe forms of HIE.^{133,136} In addition, rates of moderate and severe HIE are falling in some jurisdictions.^{137,138}

Cerebral Palsy

CP is a chronic motor disorder of cerebral origin characterized by the early onset of abnormal movement or posture that is not attributable to a recognized progressive disease. “Research supports that spastic quadriplegia, especially with an associated movement disorder, is the only type of CP associated with acute interruption of blood supply. Purely dyskinetic or ataxic CP, especially when there is an associated learning difficulty, commonly has a genetic origin and is not caused by intrapartum or peripartum

asphyxia.”¹³⁹ Although term and near term infants are at relatively low risk for CP compared with very preterm infants, they still make up at least one half of all cases of CP. Infants < 1500 g at birth account for approximately 25% of the cases of CP. The incidence of CP at full term is 2–3/1000 live births and has not changed in the past three or four decades. The increased survival of extremely premature neonates has resulted in an increase in the incidence of CP in very low birth weight survivors. However, these infants are such a small number of the overall population that their effect on the total incidence of CP is not significant. An international consensus panel on CP suggested that the following four criteria are essential before considering an association between CP and intrapartum asphyxia.

- Evidence of metabolic acidosis in umbilical cord arterial blood obtained at delivery: pH < 7 and base deficit ≥ 12 mmol/L.
- Early onset of severe or moderate neonatal encephalopathy in infants born at or beyond 34 weeks' gestation.
- Cerebral palsy of the spastic quadriplegic or dyskinetic type.*
- Exclusion of other identifiable etiologies, such as trauma, coagulopathy, infectious conditions or genetic disorders.¹⁴⁰

* Spastic quadriplegia and, less commonly, dyskinetic cerebral palsy are the only types of cerebral palsy associated with acute hypoxic intrapartum events. Spastic quadriplegia is not specific to intrapartum hypoxia. Hemiparetic cerebral palsy, hemiplegic cerebral palsy, spastic diplegia, and ataxia are unlikely to result from acute intrapartum hypoxia.^{127,140}

In summary, a chain of events exists from hypoxic acidemia through metabolic acidosis, neonatal encephalopathy, and long-term sequelae. The likelihood of a hypoxic event resulting in long-term sequelae is dependent upon the nature and duration of the insult, and the vulnerability of the fetus. Most term infants subject to hypoxia of short duration will completely recover. The total clinical history, the character of the labour, the gestational age and birth weight of the newborn, the appearance of the newborn infant, and the early neonatal course all provide some clues to the pattern of events and the likelihood of long-term effects. Umbilical cord blood gas analysis can provide a measure of the severity of the metabolic acidosis but not the duration of the hypoxic insult. The American College of Obstetricians and Gynecologists Task Force¹³⁹ suggests criteria, the presence of which provide reasonable evidence for an intrapartum insult of some type, but not specific to asphyxia. These are

- A sentinel (signal) hypoxic event occurring immediately before or during labour.
- A sudden and sustained fetal bradycardia or the absence of fetal heart rate variability in the presence of persistent, late, or variable decelerations, usually after a hypoxic sentinel event when the pattern was previously normal.
- Apgar scores of 0–3 beyond 5 minutes.
- Onset of multisystem involvement within 72 hours of birth.
- Early imaging study showing evidence of acute nonfocal cerebral abnormality.

FETAL SURVEILLANCE IN LABOUR

The goal of intrapartum fetal surveillance is to detect potential fetal decompensation and to allow timely and effective intervention to prevent perinatal/neonatal morbidity or mortality. The fetal brain is the primary organ of interest, but at present it is not clinically feasible to assess its function during labour. However, FH characteristics can be assessed, and the fact that changes in fetal heart rate *precede* brain injury constitutes the rationale for FH monitoring; that is, timely response to abnormal fetal heart patterns might be effective in preventing brain injury. During the contractions of normal labour there is a decrease in uteroplacental blood flow and a subsequent increase in fetal pCO₂ and a decrease in pO₂ and pH. In the healthy fetus, these values do not fall outside critical thresholds, and the fetus does not display any changes in heart rate characteristics. However, in the fetus with compromised gas exchange, there may be an increase in pCO₂ and a decrease in pO₂ and pH which exceed critical thresholds and the fetus may display changes in heart characteristics.

Over the past two decades, research findings have led to challenges about the clinical value of electronic fetal heart monitoring.^{141–143} Meta-analysis of these data has led to two significant observations.^{144,145} First, EFM compared with IA has not been shown to improve long-term fetal or neonatal outcomes as measured by a decrease in morbidity or mortality.^{144,145} Continuous EFM during labour is associated with a reduction in neonatal seizures but with no significant differences in long-term sequelae, including cerebral palsy, infant mortality, and other standard measures of neonatal well-being.¹⁴⁶ Secondly, EFM is associated with an increase in interventions, including Caesarean section, vaginal operative delivery, and the use of anaesthesia.^{145,147}

The aim of this section is to provide guidelines for intrapartum care providers that will lead to the best possible fetal outcomes while maintaining the lowest possible rates of intervention.

Regardless of the method of fetal surveillance used, there should be discussion with the woman about her wishes, concerns, and questions regarding the benefits, limitations, and risks of the procedure. She should be involved in the decision-making process regarding the selection of fetal health surveillance methods and all aspects of care.¹⁴⁸

SOGC Clinical Tip

During pregnancy, women should be offered information on the benefits, limitations, indications, and risks of IA and EFM use during labour.

A. Labour Support

A discussion of labour support is integral to a guideline on fetal surveillance because of the potential that supportive care has to enhance outcomes, regardless of the method of fetal surveillance used. Labour support describes the caring work, or social support provided to a labouring woman.^{149–151} It consists of emotional support (continuous presence, reassurance, and praise), comfort measures (touch, massage, warm baths/showers, encouraging fluid intake and output), advocacy (communicating the woman's wishes), and provision of information (coping methods, update on progress of labour).^{151,152} The systematic review of 15 randomized controlled trials undertaken by Hodnett et al.¹⁵¹ found that continuous labour support was associated with reduced use of intrapartum pain medication (RR 0.87; 95% CI 0.79–0.96), reduced use of regional analgesia/anaesthesia (RR 0.90; 95% CI 0.81–0.99), decreased operative vaginal deliveries (RR 0.89; 95% CI 0.83–0.96), decreased Caesarean births (RR 0.90; 95% CI 0.82–0.99), increased spontaneous vaginal births (RR 1.08; 95% CI 1.04–1.13), and reduced likelihood of reports of negative experiences (RR 0.73; 95% CI 0.65–0.83).¹⁵¹ On the basis of these findings, the authors concluded that all women should have support throughout labour and birth.

It is unclear, however, who should provide the labour support, because 13 of the 15 labour support trials looked at support persons other than nurses: midwives/midwifery students (5 studies), spouses/family members (3 studies), Lamaze instructors (1 study), laywomen (1 study), and doulas (3 studies). Despite the fact that many organizations have concluded that one-to-one nursing care and support in labour is a priority,^{152–154} the review by Hodnett et al.¹⁵¹ concluded that continuous nursing care in labour would not have the same beneficial effects. However, because it is known that the birth experience can have a lasting, even lifelong, effect on women's psychological well-being,^{155,156} every effort should be made to provide women in labour with continuous support. It is also important to recognize that the labouring woman and her fetus are, in essence, two patients, both with clinical and support needs. This, along with the attendance required to meet the recommendations for the frequency of IA and EFM surveillance, establishes that the near-continuous presence of a nurses or midwives is required for the optimal care of women in labour.

Recommendation 7: Labour Support During Active Labour

1. Women in active labour should receive continuous close support from an appropriately trained person. (I-A)

Recommendation 8: Professional One-to-One Care and Intrapartum Fetal Surveillance

1. Intensive fetal surveillance by intermittent auscultation or electronic fetal monitoring requires the continuous presence of nursing or midwifery staff. One-to-one care of the woman is recommended, recognizing that the nurse/midwife is really caring for two patients, the woman and her unborn baby. (III-C)

B. Intermittent Auscultation

By the start of the 20th century, auscultation of the fetal heart rate during labour was the predominant method of assessment, and it remained so for many decades.¹⁵⁷ However, when electronic fetal monitoring was introduced in the 1960s, the idea of receiving continuous data by EFM was thought to be superior to the intermittent data collected through auscultation; that is, more data would be better. The practice of EFM is still a routine part of intrapartum care in many units. In the 1980s in the United States, about 62% of women had EFM,¹⁵⁸ although Flamm¹⁵⁹ argued that this number was probably vastly underreported because of the way the data were collected. Flamm's contention was that almost all women in labour receive EFM. A 1989 Canadian survey found that 72% of women had EFM at some point during their labour.¹⁴⁸ By 1992, EFM was reported to be used in nearly three out of four pregnancies in the United States.¹⁶⁰ In the late 1990s in the United States, the use of EFM at some point during labour increased from 83% of live births^{161,162} to 93% of live births in 2002.¹⁶⁸ Only about 6% of surveyed women reported that they experienced exclusive use of handheld devices, including a fetoscope or Doppler, to monitor the fetal heart rate during their labour.¹⁶³ The follow-up survey of US women¹⁶⁴ and a 2003 Canadian study¹⁶⁵ confirm that most women experience continuous EFM during labour. Although the current rate of EFM use in Canada is not reported in the Canadian Perinatal Health Report,³ British Columbia reports EFM used in over 72% of labouring women during the 2005–2006 fiscal year, down from 84% in 2000–2001.¹⁶⁶ These data suggest that despite many published recommendations promoting IA as a primary method of fetal surveillance in low-risk women, relatively small numbers of women are benefiting from this surveillance method during labour. Moreover, many health care providers believe that EFM should be a routine part of intrapartum clinical care.

For a detailed review of the IA technique, readers are referred to the Association of Women's Health, Obstetric and Neonatal Nurse's document titled "Fetal Heart Rate Auscultation."¹⁶⁷

Table 10. Recommended frequency of auscultation

	First stage—latent phase	First stage—active phase	Active second stage
	For the latent phase of labour, there are very limited data on which to base a recommendation for IA. Optimally, most women will be in their own home environment with family support during this period but may be in hospital because of geographic /weather considerations.		
SOCG*	Recommended at the time of assessment, approximately q1h	q 15–30 minutes	q 5 minutes
ACOG†		q 15 minutes	q 5 minutes
AWHONN‡		q 15–30 minutes	q 5–15 minutes
RCOG§		q 15 minutes	q 5 minutes

*Society of Obstetricians and Gynecologists of Canada, 2007

† American College of Obstetricians and Gynecologists, 2005

‡ Association of Women's Health, Obstetric and Neonatal Nurses ; Feinstein, Sprague, & Trepanier, 2000¹⁶⁶

§ Royal College of Obstetricians and Gynaecologists, 2001⁷

Intermittent Auscultation in Labour

Intermittent auscultation is the recommended fetal surveillance method during labour for healthy women without risk factors for adverse perinatal outcome. Goodwin¹⁶⁸ defines intermittent auscultation as “an auditory or listening technique for sampling and counting fetal heart beats at specified intervals that should not be viewed as electronic fetal monitoring with a stethoscope or “hearing” an EFM tracing.

Assessment via Intermittent Auscultation

Auscultation requires the ability to differentiate the sounds generated by the device used. The maternal pulse should be checked during auscultation to differentiate maternal and fetal heart rates. False conclusions about fetal status could be reached if the maternal sounds are mistaken for fetal heart sounds. If the fetal heart is technically inaudible so that the fetal heart rate cannot be established, then electronic fetal monitoring should be commenced. A variety of techniques can be used for listening and counting the fetal heart rate, and little evidence exists to guide care providers in “best practice.”

Baseline fetal heart rate

A baseline heart rate is assessed by listening and counting between uterine contractions.¹⁶⁸ The greatest accuracy results when the FHR is counted for 60 seconds. Once a baseline is established, regular assessments as per institutional protocol help determine if the heart rate is within the same range (Table 10). There is scant evidence to guide care providers in choosing counting times after contractions. For regular assessments during labour, both 30- and

60-second sampling periods following contractions were used in the randomized trials. In active labour, the 30-second sampling periods may be more feasible. However, a 60-second count will improve accuracy.¹⁶⁸ The normal fetal heart rate is 110 to 160 bpm. Tachycardia (defined as a fetal heart rate above 160 bpm for > 10 minutes) and bradycardia (defined as a fetal heart rate below 110 bpm for > 10 minutes) can be identified.

SOGC Clinical Tip

The FHR should be assessed regularly to ensure that it is in the same range after the contraction as it was in the previous assessments. If not, assess possible causes for the change.

Rhythm

The rhythm (regular or irregular) of the FHR can also be assessed with IA. A dysrhythmia is said to occur when there is an irregular heart rate not associated with uterine activity.^{169,170} Dysrhythmias are further classified as fast, slow, or irregular. When a dysrhythmia is identified, further assessment with other methods (e.g., ultrasound, echocardiography) may be necessary to determine the type of dysrhythmia present or to rule out artifact.

Heart rate changes

The practitioner can identify changes from the fetal heart rate baseline using auscultation.¹⁷¹ It is possible to detect

Table 11. Management of abnormal fetal heart rate by intermittent auscultation

Management of abnormal fetal heart rate by intermittent auscultation	
Tachycardia	Reposition woman to increase uteroplacental perfusion or alleviate cord compression. Rule out fever, dehydration, drug effect, prematurity Correct maternal hypovolemia, if present, by increasing IV fluids Check maternal pulse and blood pressure.
Bradycardia	Reposition woman to increase uteroplacental perfusion or alleviate cord compression Perform vaginal exam to assess for prolapsed cord or relieve cord compression Administer oxygen at 8–10 L/min Correct maternal hypovolemia, if present, by increasing IV fluids Check maternal pulse and blood pressure
Decelerations	Reposition woman Assess for passage of meconium Correct hypotension, if present Administer oxygen at 8–10 L/min
Additional measures	Continue to auscultate FHR to clarify and document components of FHR Consider initiation of electronic fetal monitoring (EFM) If abnormal findings persist despite corrective measures, and ancillary tests are not available or desirable, expedited delivery should be considered

Adapted from: Feinstein NF, Sprague A, Trépanier MJ. Fetal heart rate auscultation. Washington: 2000; AWHONN (Association of Women's Health, Obstetrical and Neonatal Nurses).¹⁶⁷

abrupt increases (accelerations) from the baseline (e.g., during fetal activity) or abrupt/gradual decreases in the FHR. However, there are no data to indicate that the practitioner can distinguish the type of deceleration.¹⁷¹ Therefore, the deceleration patterns classified visually with EFM cannot be classified with auscultation.

What is not assessed?

Nurses, midwives, and physicians have grown accustomed to using labels to describe FHR baseline variability and decelerations from the baseline that are assessed visually by EFM. However, baseline variability and classification of decelerations cannot be reliably identified with auscultation.^{169,172} Although some practitioners believe counting the fetal heart rate for shorter and more frequent intervals may provide information about variability, there are no research studies that support this practice as a means of accurately and reliably evaluating variability. Subtle variations from baseline, including absent FHR variability and sinusoidal patterns, cannot be detected using auscultation.^{169,172}

Clinical decisions with normal/abnormal findings

Practitioners must have the knowledge to differentiate between normal fetal auscultation findings and abnormal auscultation findings. In addition, they must be skilled in

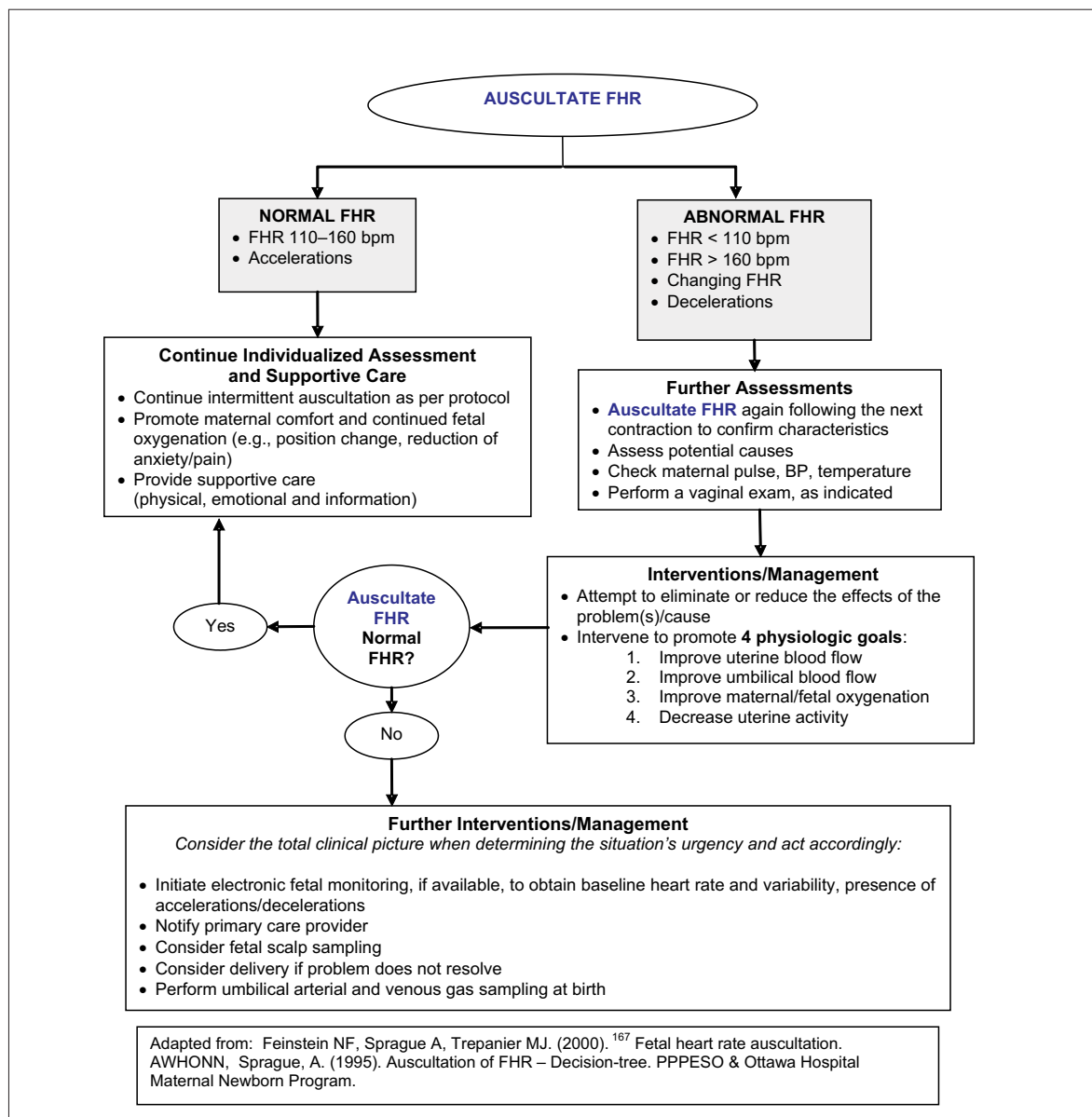
the actions required in such circumstances and be capable of managing these actions in a timely manner. Figure 7 depicts the normal and abnormal characteristics of an auscultated fetal heart rate as well as clinical decision making associated with these characteristics. Management of specific abnormal findings is depicted in Table 11.

Benefits and limitations of auscultation

There are a number of benefits and limitations of fetal auscultation and, depending on the woman's preferences and the practitioner's viewpoints, some aspects may fit in either category. On the benefit side, the technique is less costly, less constricting, freedom of movement is increased, and assessments of the fetal heart rate can be done with the woman immersed in water. On the limitation side, it may be difficult to hear a fetal heart rate in very large women when using a fetoscope, and some women may feel the technique is more intrusive because of the frequency of assessment. Interestingly, the results from one RCT comparing women's responses to auscultation and to EFM during labour revealed no difference between the two groups in their labour experience on the basis of type of monitoring used.¹⁷³

Both forms of intrapartum fetal surveillance require appropriate indication, and must be performed by knowledgeable practitioners according to national and local standards of

Figure 7. Decision support tool—intermittent auscultation in labour for healthy term women without risk factors for adverse perinatal outcome



surveillance documentation and response. It is a misconception that not providing a continuous record of the fetal heart characteristics provides either legal benefit or limitation.

Common indications/contraindications for intermittent auscultation

There is general agreement in the professional literature that auscultation is an appropriate technique for fetal surveillance when a woman experiences a healthy pregnancy and birth.^{7,153,174} The use of auscultation in pregnancies with risk factors for adverse outcomes is more controversial. Questions may arise about whether it is appropriate to use auscultation as a primary fetal surveillance method in specific clinical situations, such as when labour is preterm,

when labour is postdates, during epidural analgesia and during labour, or when a woman is planning a vaginal birth after Caesarean section.

Preterm labour and intermittent auscultation

Although trials suggest that there is no benefit of EFM compared with IA, the incidence of other pathologies is increased in preterm labour and the incidence of adverse outcome is increased. Therefore at this time, EFM is recommended in preterm fetuses below 36 weeks' gestation.

Postdates labour and intermittent auscultation

Intermittent auscultation is the preferred method of fetal surveillance for *spontaneous* labour with no risk factors, up to 41+3 weeks' gestation. From 41+3 weeks' gestation,

intermittent auscultation is the preferred method of fetal surveillance *provided* that NSTs and amniotic fluid volume have been normal. Post-term pregnancy, (> 42 weeks' gestation), is associated with an increased risk of adverse fetal outcome and EFM is the preferred method of fetal surveillance.

Epidural analgesia and intermittent auscultation

The theoretical concern with epidural analgesia is the risk of maternal hypotension that can cause maternal and fetal circulation problems. RCOG⁷ includes epidural analgesia as an indication for continuous EFM. Grant and Halpern¹⁴⁵ recommend using EFM for 30 to 60 minutes following initiation of the epidural to facilitate prompt treatment should FHR decelerations occur. There is little research to suggest best practice after this initial period of EFM monitoring, and "in general, epidural or spinal anaesthesia in the absence of maternal hypotension or uterine hypertonus causes minimal changes in the FHR."¹⁷⁵ In some institutions, IA is used following the initial period of electronic monitoring. In British Columbia since 2000, the provincial recommendation for fetal surveillance following insertion of an epidural in a healthy term woman without risk factors has been IA. Practice recommendations include assessments every five minutes for 30 minutes following the initial epidural dose and after any additional bolus top-ups of concentrated local anaesthetic (greater than 0.125% bupivacaine or equivalent). PCEA is considered to be different from intermittent bolus technique with concentrated local anaesthetic agents, because it is used with dilute local anaesthetic and opioid solution (less than or equal to 0.125% bupivacaine or equivalent). PCEA has been proven to be safe for ambulation in labour, and there is no evidence supporting the need for maternal vital signs to be taken after a self-administered bolus, as hypotension does not occur.^{176,177} Since maternal hemodynamics are stable with PCEA, there is no need to monitor the FHR after each self-administered PCEA top-up, which means that IA is acceptable and should be done according to usual obstetrical protocols, and that use of EFM should be based upon obstetrical considerations.

Vaginal birth after Caesarean section and intermittent auscultation

For women attempting VBAC, there is little controversy. All professional jurisdictions recommend continuous electronic fetal monitoring.^{7,173,174}

Recommendation 9: Intermittent Auscultation in Labour

1. Intrapartum fetal surveillance for healthy term women in spontaneous labour in the absence of risk factors for adverse perinatal outcome.

Intermittent auscultation following an established protocol of surveillance and response is the recommended method of fetal surveillance; compared with EFM, it has lower intervention rates without evidence of compromising neonatal outcome. (I-B)

2. Epidural analgesia and intermittent auscultation.

Intermittent auscultation may be used to monitor the fetus when epidural analgesia is used during labour, provided that a protocol is in place for frequent IA assessment (e.g., every 5 minutes for 30 minutes after epidural initiation and after bolus top-ups as long as maternal vital signs are normal). (III-B)

C. Admission Cardiotocography

A systematic review¹⁸⁰ was conducted to assess the effectiveness of admission fetal heart tracings in preventing adverse outcomes, compared with auscultation only, and to assess the test's prognostic value in predicting adverse outcomes. Three randomized controlled trials including 11 259 women and 11 observational studies including 5831 women were reviewed. The authors' conclusion follows.

Meta-analyses of the controlled trials found that women randomized to the labour admission test were more likely to have minor obstetric interventions like epidural analgesia [relative risk (RR) 1.2, 95% CI 1.1–1.4], continuous electronic fetal monitoring (RR 1.3; 95% CI 1.2–1.5) and fetal blood sampling (RR 1.3; 95% CI 1.1–1.5) compared with women randomized to auscultation on admission. There were no significant differences in any of the other outcomes. From the observational studies, prognostic value for various outcomes was found to be generally poor. There is no evidence supporting that the labour admission test is beneficial in women with no risk factors for adverse perinatal outcome.

SOGC Clinical Tip

Manual palpation of the uterus and intermittent auscultation of the fetal heart are recommended for healthy women with pregnancies at term who have no risk factors for adverse perinatal outcomes and who are not in active labour and are likely to return home or be discharged instead of admitted in labour. There is no evidence to support the completion of a fetal heart admission tracing, and it should not be used to determine if a woman is in true labour.

Table 12. Antenatal and intrapartum conditions associated with increased risk of adverse fetal outcome* where intrapartum electronic fetal surveillance may be beneficial

Antenatal	
Maternal	Hypertensive disorders of pregnancy Pre-existing diabetes mellitus/Gestational diabetes Antepartum hemorrhage Maternal medical disease: cardiac, anemia, hyperthyroidism, vascular disease and renal disease Maternal MVA/trauma Morbid obesity
Fetal	Intrauterine growth restriction Prematurity Oligohydramnios Abnormal umbilical artery Doppler velocimetry Isoimmunization Multiple pregnancy Breech presentation
Intrapartum	
Maternal	Vaginal bleeding in labour Intrauterine infection/chorioamnionitis Previous Caesarean section Prolonged membrane rupture > 24 hours at term Induced labour Augmented labour Hypertonic uterus Preterm labour Post-term pregnancy (> 42 weeks)
Fetal	Meconium staining of the amniotic fluid Abnormal fetal heart rate on auscultation

*Adverse fetal outcome: cerebral palsy, neonatal encephalopathy, and perinatal death.

Adapted from RCOG Evidence-based Clinical Guideline Number 8, May 2001. The use of electronic fetal monitoring.⁷

Recommendation 10: Admission Fetal Heart Test

1. Admission fetal heart tracings are not recommended for healthy women at term in labour in the absence of risk factors for adverse perinatal outcome, as there is no evident benefit. (I-A)
2. Admission fetal heart tracings are recommended for women with risk factors for adverse perinatal outcome. (III-B)

D. Electronic Fetal Monitoring

Why and when to perform electronic fetal monitoring

Using the criteria of the Canadian Task Force on Preventative Health Care, it can be concluded that there is fair evidence to exclude EFM from intrapartum care in low-risk pregnancies (healthy, women with term pregnancies with no risk factors for adverse perinatal outcome) if IA is

possible.¹⁸¹ Evidence suggests that compared with IA, continuous EFM in labour is associated with an increase in the rates of Caesarean sections and instrumental vaginal births. Continuous EFM during labour is associated with a reduction in neonatal seizures but with no significant differences in cerebral palsy, infant mortality, or other standard measures of neonatal well-being.¹⁴⁶ Although this report found little scientific evidence to support the use of EFM in high-risk pregnancies, the authors point out that this does not mean that in high-risk pregnancies EFM is not beneficial, but rather that there is insufficient evidence to recommend or not recommend its use. There is insufficient evidence to suggest which specific high-risk patients require EFM as opposed to IA. Thacker et al.¹⁴⁴ performed a meta-analysis of randomized clinical trials comparing IA with continuous EFM. These trials included both low-risk and high-risk patients. Their findings demonstrated that the

Table 13. EFM Quality of Signal Acquisition

	Associations or potential causes	Clinical actions
Inadequate tracing for interpretation	<p>Maternal:</p> <ul style="list-style-type: none"> High BMI (abdominal adipose tissue) Polyhydramnios Oligohydramnios Detecting maternal pulse Maternal movement <p>Fetal:</p> <ul style="list-style-type: none"> Very active fetus Fetal position (e.g., posterior position) Intrauterine death Cardiac dysrhythmias 	<ol style="list-style-type: none"> 1. Ensure that equipment is working properly. 2. If external monitor is in use, reposition to obtain a clear continuous signal. 3. Anticipate need for internal monitoring, if unable to maintain a technically adequate tracing despite interventions using external monitoring. 4. With internal EFM, confirm presence of fetal heart sounds by auscultation and note the fetal heart rate. 5. Confirm uterine activity pattern and uterine resting tone by abdominal palpation.

only clinical benefit of continuous EFM was a reduction in neonatal seizures (in trials using scalp sampling) and an associated observation of an increase in operative vaginal delivery and delivery by Caesarean section. In the trial in which a higher seizure rate was noted, newborns were reassessed at the age of four years, and no increased rate of complications was found.¹⁸² There is no evidence from randomized trials to suggest that the use of EFM will reduce the rate of cerebral palsy,¹⁴⁴ and one study found an increased frequency of cerebral palsy among infants who were continuously monitored during labour.¹⁸³

An association between factors complicating pregnancy and labour and the development of neonatal encephalopathy, cerebral palsy, and perinatal death has been described.¹⁸⁴⁻¹⁹⁰ These factors include hypertension, placental abruption, fetal growth restriction, multiple pregnancies, prematurity (less than 32 weeks), postmaturity, and chorioamnionitis. Not surprisingly, these factors are also associated with an increased incidence of fetal heart rate abnormalities. Although, as stated above, there is insufficient evidence to suggest in which specific situations, if any, use of EFM results in a better outcome than IA, it seems reasonable to recommend the use of EFM in these situations, as has been recommended by the Royal College of Obstetricians and Gynaecologists (Table 12).⁷

The use of EFM is associated with a reduced likelihood of neonatal seizures when augmentation with oxytocin is required for dysfunctional labour.¹⁴¹ Accordingly, electronic fetal monitoring is recommended when oxytocin augmentation is required. There is insufficient evidence, however, on which to base a firm recommendation as to which type of fetal surveillance is preferable when labour is induced. Induction implies a situation that is not physiological, and exogenous uterine stimulation increases the

likelihood of hypercontractility and impaired fetal/maternal gaseous exchange. On this basis (and in spite of the lack of clear evidence), the Royal College of Obstetricians and Gynaecologists⁷ and The Royal Australian and New Zealand College of Obstetricians and Gynaecologists⁶ have recommended the use of EFM when induction is undertaken.⁷ Given the lack of evidence and the potential for uterine hyperstimulation with the use of oxytocin, we concur with other jurisdictions and recommend use of EFM during oxytocin induction for postdates pregnancy. However, once the infusion rate is stable, and provided the fetal heart tracing is normal, it is reasonable to allow periods of up to 30 minutes without EFM for ambulation, personal care, and hydrotherapy.

The situation is even more unclear with regard to evidence on which to make recommendations about fetal health surveillance when cervical ripening is undertaken. The most common form of cervical ripening is the use of prostaglandin gel. It is common practice in Canada to administer the gel on an outpatient basis, particularly if the induction is being undertaken in a postdates pregnancy (between 41 and 42 weeks' gestation) to prevent post maturity. Most protocols for prostaglandin gel use suggest continuous EFM for one to two hours after administration of the gel and discharge from hospital after that time provided mother and the fetus are in satisfactory condition and that the uterus is not contracting. It would seem reasonable to advise women to return to hospital with the onset of regular uterine contractions for fetal assessment. If a woman returns in active labour as a result of such ripening, it would seem reasonable to offer her fetal surveillance utilizing intermittent auscultation provided other risk factors for adverse fetal outcome are not present. However, if she returns for oxytocin stimulation, practitioners should follow local

guidelines. If any other risk factors are present (Table 13), EFM is recommended. When a cervical insert providing slow continuous release of prostaglandin is in place, the American College of Obstetrics and Gynecologists recommend that continuous EFM should be in place as long as the insert is in place and for 15 minutes after its removal.¹⁹¹ A number of jurisdictions in Canada are using such inserts on an outpatient basis, discharging women from hospital after an initial period of one to two hours of monitoring provided regular uterine activity has not commenced. Although the outpatient use of cervical prostaglandin inserts is widespread in Europe and is increasing in Canada, there is at this time insufficient evidence to provide a recommendation around fetal surveillance in this situation.

Recommendation 11: Intrapartum Fetal Surveillance for Women with Risk Factors for Adverse Perinatal Outcome

1. Electronic fetal monitoring is recommended for pregnancies at risk of adverse perinatal outcome. (II-A)

Methods of Electronic Fetal Monitoring

EFM may be performed with an external or internal monitor. The external monitor is an ultrasound transducer that detects Doppler shift that a computer can interpret as a fetal heart rate. Advantages of the external monitor include the fact that it is non-invasive and does not require cervical dilatation or rupture of membranes. Among its disadvantages are the need for readjustment with maternal or fetal movements and the following: the transducer may record the maternal pulse, it may be difficult to obtain a clear tracing in obese women or those with polyhydramnios, artifact may be recorded, and there may be doubling or halving of the fetal heart rate when it is outside of the normal range. The external tocotransducer is a pressure-sensitive device that detects changes in surface pressure. Although it is non-invasive, the amplitude displayed on the tracing has *no* relationship to the intensity of the contractions. Nevertheless, the tracing will approximate when the contraction starts and finishes and therefore allows demonstration of the relationship between contractions and fetal heart decelerations.

Internal fetal heart rate monitoring is performed with a spiral electrode inserted through the maternal vagina and cervix and attached to the fetal scalp or other presenting part. Internal monitoring may be indicated when the external tracing is inadequate for accurate interpretation. Contraindications for internal fetal scalp monitoring include placenta previa, face presentation, unknown presentation, HIV seropositivity, or active genital herpes.

Internal uterine activity monitoring is done via an IUPC. This device is placed through the cervix into the uterine cavity and transmits pressure changes in mmHg via a strain

gauge transducer or a solid sensor tip. IUPC monitoring accurately records uterine resting tone, intensity, duration, and frequency of contractions and generally allows the woman greater mobility than does external contraction monitoring. It may be useful in case of dysfunctional labour or obesity, when uterine palpation may be difficult or impossible. IUPC use should be carefully weighed in terms of relative risks and benefits in the circumstances of undiagnosed vaginal bleeding or intrauterine infection.

Systematic interpretation of electronic fetal monitoring and definitions of terms

The National Institute of Child Health and Human Development has developed standardized definitions for fetal heart rate tracings.⁶³ Correct application of these definitions requires a systematic approach to the analysis and interpretation of the FHR and uterine contractions. Analysis refers to defining and measuring the characteristics of the tracing, and interpretation refers to the clinical meaning attributed to the collection of these measurements.^{63,192} The steps in a systematic interpretation are as follows:

1. **Assess the quality of the signal acquisition.** The quality of the tracing of both the FHR and uterine activity channels must allow for accurate interpretation. If there is insufficient duration, breaks in the recording, artifact, or a general poor quality tracing, then it must be continued until interpretable data are obtained (see Table 13).
2. **Determine the paper speed and graph range.** There is no evidence suggesting a particular universal paper speed is preferable, but there should be consistency within each institution and ideally within regions / perinatal catchment areas to allow for ease and consistency of interpretation in and between facilities.
3. **Determine whether the mode of recording is external or internal.**
4. **Assess the uterine activity pattern, including frequency, duration, and intensity of contraction, and uterine resting tone.** Palpate the fundus for assessment of contraction intensity and resting tone if an external tocotransducer is used.
5. **Assess the baseline fetal heart rate.** Baseline FHR is the approximate mean FHR rounded to increments of 5 beats per minute during a 10-minute segment, excluding periodic or episodic changes or periods of marked FHR variability (segments of the baseline that differ by more than 25 beats per minute).⁶³ Normal baseline rate is between 110 and 160 bpm; bradycardia is defined as a rate less than 110 bpm > 10 minutes; and tachycardia is defined as a rate greater than 160 bpm > 10 minutes.
6. **Assess baseline variability.** Variability refers to the fluctuations in the baseline FHR. It is determined by choosing one

minute of a 10-minute section of the FH tracing with at least 2 cycles/minute (normal is 2 to 4 cycles/minute) that is free from accelerations and decelerations, and measuring the difference between the lowest and highest rate. The difference is the range/amplitude of variability. The terms listed in Table 14 are preferred to the terms “good” or “poor” variability.

Physiologic variability is a normal characteristic of the fetal heart rate. Variability of the fetal heart is largely controlled by the effect of the vagus nerve on the heart. Persistent hypoxia causing acidosis may lead to a decrease in FH rate variability. Other conditions may lead to decreased or absent FH variability. These conditions include fetal sleep, medications, (e.g., narcotics, sedatives, β -blockers, betamethasone), prematurity, fetal tachycardia, and congenital anomalies. Moderate variability suggests that the fetal acid-base status is acceptable. Fetal heart variability is episodic because of fetal sleep cycles. Variability will therefore be minimal intermittently, even in the healthy fetus. The appropriate management in such cases is to extend the observation time. Persistent loss of variability requires further assessment; internal electronic monitoring may be helpful.

7. Assess fetal heart rate accelerations. An acceleration is defined as a visually apparent abrupt increase (defined as onset of acceleration to peak in < 30 seconds) in FHR above the baseline. The acme is ≥ 15 beats/minute above the baseline, and the acceleration lasts ≥ 15 seconds and < 2 minutes from the onset to return to baseline. Before 32 weeks of gestation, accelerations are defined as having an acme ≥ 10 beats/minute above the baseline and a duration of ≥ 10 seconds. Prolonged acceleration is ≥ 2 minutes and < 10 minutes in duration. Acceleration of ≥ 10 minutes is a baseline change. The presence of accelerations is a normal/reassuring finding.

8. Assess periodic or episodic decelerations. *Variable deceleration* is defined as a visually apparent abrupt decrease in the FHR with the onset of the deceleration to the nadir of less than 30 seconds.⁶³ The deceleration should be at least 15 beats below the baseline, lasting for at least 15 seconds, but less than 2 minutes in duration. Variable decelerations are thought to be a response of the FHR to cord compression and are the most common decelerations seen in labour.

Variable decelerations may be divided into two groups.

1. Uncomplicated variable decelerations consist of an initial acceleration, rapid deceleration of the FHR to the nadir, followed by rapid return to the baseline FHR level with secondary acceleration.¹⁹³ Uncomplicated variable decelerations are not consistently shown to be

Table 14. Classification of variability

Range/Amplitude	Terminology
Undetectable	Absent
≤ 5 bpm	Minimal
6 to 25 bpm	Moderate
> 25 bpm	Marked

associated with poor neonatal outcome (reduced 5-minute Apgar scores or metabolic acidosis).⁷

2. Complicated variable decelerations with the following features may be indicative of fetal hypoxia:^{6,193}
 - Deceleration to less than 70 bpm lasting more than 60 seconds
 - Loss of variability in the baseline FHR and in the trough of the deceleration
 - Biphasic deceleration
 - Prolonged secondary acceleration (post deceleration smooth overshoot of more than 20 bpm increase and/or lasting more than 20 seconds)
 - Slow return to baseline
 - Continuation of baseline rate at a lower level than prior to the deceleration
 - Presence of fetal tachycardia or bradycardia

Late deceleration is defined as a visually apparent gradual decrease in the FHR and return to baseline with the onset of the deceleration to the nadir of greater than 30 seconds. The onset, nadir, and recovery of the deceleration occur after the beginning, peak, and ending of the contraction, respectively. Late decelerations are found in association with uteroplacental insufficiency and imply some degree of hypoxia.⁶⁰

Early deceleration is defined as a visually apparent gradual decrease in the FHR (defined as onset of deceleration to nadir ≥ 30 seconds) and return to baseline associated with uterine contraction. The onset, nadir, and recovery of the decelerations coincide with the beginning, peak, and ending of the contraction, respectively. They are associated with fetal head compression during labour and are generally considered benign and inconsequential. This FHR pattern is not normally associated with fetal acidemia.

9. Classify the EFM Tracing as per Table 15. The new classification system for intrapartum EFM tracings uses the terms is “normal,” “atypical,” and “abnormal” (See Table 15).

10. Evaluate overall clinical picture. Assess whether the EFM tracing and classification correlate with the overall clinical

Table 15. Classification of intrapartum EFM tracings

	Normal Tracing Previously "Reassuring"	Atypical Tracing Previously "Non-reassuring"	Abnormal Tracing Previously "Non-reassuring"
Baseline	110–160 bpm	Bradycardia 100–110 bpm Tachycardia > 160 for > 30 min to < 80 min. Rising baseline	Bradycardia < 100 bpm Tachycardia > 160 for > 80 min. Erratic baseline
Variability	6–25 bpm ≤ 5 bpm for < 40 min.	≤ 5 bpm for 40–80 min.	≤ 5 bpm for > 80 min. ≥ 25 bpm for > 10 min. Sinusoidal
Decelerations	None or occasional uncomplicated variables or early decelerations	Repetitive (≥ 3) uncomplicated variable decelerations Occasional late decelerations Single prolonged deceleration > 2 min. but < 3 min.	Repetitive (≥ 3) complicated variables: deceleration to < 70 bpm for > 60 secs. loss of variability in trough or in baseline biphasic decelerations overshoots slow return to baseline baseline lower after deceleration baseline tachycardia or bradycardia Late decelerations > 50% of contractions Single prolonged deceleration > 3 min. but < 10 min.
Accelerations	Spontaneous accelerations present (FHR increases >15 bpm lasting > 15 seconds (< 32 weeks' gestation increase in the FHR > 10 bpm lasting >10 seconds) Accelerations present with fetal scalp stimulation	Absence of acceleration with fetal scalp stimulation	Usually absent*
ACTION	EFM may be interrupted for periods up to 30 min. if maternal-fetal condition stable and/or oxytocin infusion rate stable.	Further vigilant assessment required, especially when combined features present.	ACTION REQUIRED Review overall clinical situation, obtain scalp pH if appropriate/prepare for delivery.

*Usually absent, but if accelerations are present, this does not change the classification of tracing.

picture, including gestational age, history of current pregnancy, presence of risk factors, stage of labour, fetal behavioural state, and other extrinsic factors likely to influence the EFM tracing. Determine whether further fetal assessment and/ or urgent action are required.

Caution should be exercised in attributing abnormal FHR patterns that follow the introduction of an antihypertensive for antihypertensive use. Available data are inadequate to conclude whether oral methyldopa, labetalol, nifedipine, or hydralazine adversely affect the fetal or neonatal heart rate and pattern. Until definitive data are available, FHR changes cannot reliably be attributed to drug effect; they may be due to progression of the underlying maternal or placental disease.¹⁹⁴

11. Document intrapartum EFM tracing characteristics every 15 to 30 minutes.

Intrapartum Fetal Heart Rate Patterns Over Time and Clinical Management

It is important to consider all of the above patterns in relation to previous fetal heart rate patterns. Once a pattern has been defined, the potential causes and other associations can be reasoned by a physiologic understanding of the clinical picture. Hence, as each pattern is interpreted, an appropriate clinical action can be undertaken either to lessen the impact on the fetus or remove it entirely.^{63,192,195}

Recommendation 11: Intrapartum Fetal Surveillance for Women with Risk Factors for Adverse Perinatal Outcome

2. Normal EFM tracings during the first stage of labour. When a normal tracing is identified, it may be appropriate to interrupt the EFM tracing for up to 30 minutes to facilitate periods of ambulation, bathing, or position change, providing that (1) the maternal-fetal condition is stable and (2) if oxytocin is being administered, the infusion rate is not increased. (III-B)

Atypical (Uncertain Significance) Intrapartum EFM Tracing

A number of factors, alone or in combination, may contribute to compromised fetal oxygenation in labour. These include poor maternal oxygen status, excessive uterine activity, placental dysfunction, uterine hypoperfusion, placental separation, and umbilical cord compression. Action in the presence of an atypical fetal heart rate pattern must consider the cause of the insult, the duration of effect, and the reserve (tolerance) of the fetus. Any reversible cause of compromise should be identified and modified (correction of maternal hypotension, treatment of excessive uterine contractility). Further fetal evaluation by means of scalp stimulation (> 34 weeks) is recommended, and fetal scalp blood testing may be considered, if available. Other obstetrical parameters, for example, gestational age, estimated fetal weight, and the phase and stage of the labour, will all affect decision making. Ongoing fetal evaluation is required, and delivery should be considered if the situation persists over time or if the pattern deteriorates.

When an atypical tracing is apparent, intrauterine resuscitation should be commenced to improve uterine blood flow, umbilical circulation, and maternal oxygen saturation. Steps to accomplish this include the following:

- Stop or decrease oxytocin
- Change maternal position of left or right lateral
- Improve hydration with IV fluid bolus¹⁹⁶
- Perform vaginal examination to relieve pressure of presenting part off cord
- Administer oxygen by mask
- Consider amnioinfusion if variable decelerations present
- Reduce maternal anxiety (to lessen catecholamine impact)
- Coach women to modify breathing or pushing techniques.

It should be noted that there is some evidence that prolonged maternal oxygen administration, particularly during

second stage of labour has been associated with deteriorated cord blood gas samples at birth.¹⁹⁷ Caution should be used when administering maternal oxygen, and prolonged use should be avoided.

Abnormal Intrapartum Electronic Fetal Monitoring Tracing

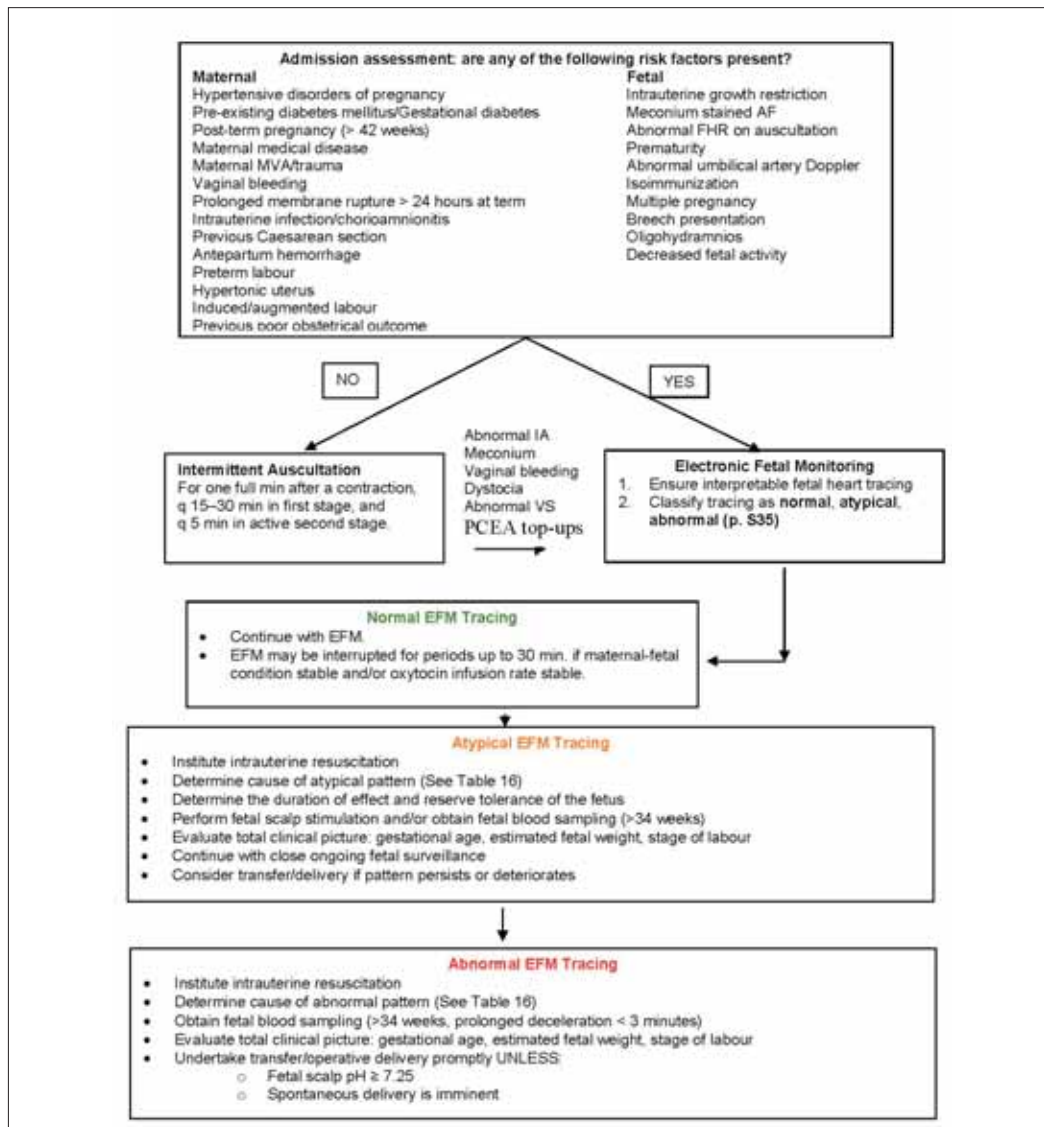
In the presence of an abnormal fetal heart rate pattern, usually operative delivery should be undertaken promptly unless (1) there is clear indication of normal fetal oxygenation by means of scalp pH assessment or (2) spontaneous delivery is imminent. Scalp sampling should not be considered in the case of prolonged deceleration of greater than three minutes. Usual action in the presence of an abnormal tracing includes preparing for operative delivery (operative vaginal delivery or Caesarean section), and notifying pediatric and anaesthetic services. While this is happening, attempts at intrauterine resuscitation should be made. In facilities where operating room capability does not exist, transfer to an appropriate facility should be initiated.

For clinical management strategies, see Algorithm: Clinical Management of Normal, Atypical, and Abnormal EFM (Intrapartum) (Figure 8).

E. Digital Fetal Scalp Stimulation

Digital fetal scalp stimulation during a vaginal exam provides an indirect assessment of acid-base status. The goal is to elicit a sympathetic nerve response, and an acceleratory response to stimuli may be indicative of a normoxic fetus.^{198–201} An acceleration of 15 bpm amplitude with a duration of 15 seconds has been shown to have a very high negative predictive value (i.e., normal tracing) and very high sensitivity with regard to the absence of fetal acidosis.^{198–200} It has been generally accepted that an acceleratory response is associated with a scalp pH of greater than 7.20.^{198–202} However, it must be realized that although an acceleratory response is consistent with a reasonable likelihood of fetal well-being, the absence of this response does not predict fetal compromise.^{198–201} A recent meta-analysis supports gentle digital scalp stimulation as the appropriate stimulation method. The technique may be important, because an aggressive approach using substantial pressure may produce a vagal bradycardia and should therefore be avoided. When there is a lack of acceleration, further assessment may be necessary, such as direct assessment by fetal scalp blood sampling to determine pH.^{198–201} Digital scalp stimulation is best avoided during a deceleration, as the deceleration reflects a vagal response that prevents any sympathetic nerve response during scalp stimulation.¹⁶⁹

Figure 8. Algorithm—clinical management of normal, atypical, and abnormal EFM (intrapartum)



Recommendation 12: Digital Fetal Scalp Stimulation

- Digital fetal scalp stimulation is recommended in response to atypical electronic fetal heart tracings. (II-B)
- In the absence of a positive acceleratory response with digital fetal scalp stimulation,
 - fetal scalp blood sampling is recommended when available. (II-B)
 - if fetal scalp blood sampling is not available, consideration should be given to prompt delivery, depending upon the overall clinical situation. (III-C)

F. Fetal Scalp Blood Sampling

FBS, using a blood sample obtained following a lancet cutaneous puncture, can reduce the increased operative intervention rates associated with EFM only^{7,144} and is indicated

in the presence of atypical and/or abnormal tracings. It is appropriate for gestational ages greater than 34 weeks when delivery is not imminent and resources are available to complete it. It is not recommended in gestations less than 34 weeks, as undue delay in delivery of a high-risk preterm fetus may be associated with adverse neonatal outcomes.^{7,183,203} FBS is contraindicated if there is a family history of hemophilia, a suspected fetal bleeding disorder (suspected fetal thrombocytopenia), or face presentation, or in

SOGC Clinical Tip

For digital fetal scalp stimulation, use gentle stroking of the fetal scalp for 15 seconds during a vaginal exam.

Table 16. Potential causes of atypical/abnormal intrapartum EFM tracings and clinical actions to consider in conjunction with intrauterine resuscitation patterns

Atypical/abnormal intrapartum electronic fetal heart rate patterns, associations and additional clinical actions		
Pattern definition	Association or potential causes	Additional clinical actions
Bradycardia	<p>Maternal:</p> <ul style="list-style-type: none"> Hypotension Drug responses Maternal position Connective tissue diseases with congenital heart block (e.g., systemic lupus erythematosus) <p>Fetal:</p> <ul style="list-style-type: none"> Umbilical cord occlusion Fetal hypoxia/acidosis Vagal stimulation such as with chronic head compression or with vertex presentation, occipital posterior or transverse position Fetal cardiac conduction or structural defect 	<ol style="list-style-type: none"> 1. Assess maternal pulse 2. Differentiate fetal from maternal heart rate 3. Vaginal exam (elevate presenting part if cord prolapse) 4. If cause is not obvious or correctable, consider intrapartum U/S to evaluate dysrhythmia 5. If < 100 bpm, obtain fetal scalp pH if clinically appropriate/prepare for delivery.
Tachycardia	<p>Maternal:</p> <ul style="list-style-type: none"> Fever Infection Dehydration Hyperthyroidism Endogenous adrenaline or anxiety Medication or drug response Anemia <p>Fetal:</p> <ul style="list-style-type: none"> Infection Prolonged fetal activity or stimulation Chronic hypoxemia Cardiac abnormalities Congenital anomalies Anemia 	<ol style="list-style-type: none"> 1. Assess maternal temperature 2. Decrease maternal temperature (if elevated) 3. Assess medications or drugs 4. Reassess for duration of rupture of membranes (ROM), positive vaginal culture, especially group B streptococcus (GBS) 5. If cause is not obvious or correctable, consider intrapartum U/S to evaluate arrhythmia 6. If >160 bpm for > 80 minutes, consider expediting delivery
Minimal/absent Variability	<ul style="list-style-type: none"> Fetal sleep Prematurity Medications (analgesia, sedatives) Hypoxic acidemia 	<p>If < 5 bpm for > 80 minutes; ≥ 25 bpm for >10 minutes or sinusoidal:</p> <ol style="list-style-type: none"> 1. Attach fetal scalp electrode if not already done 2. Obtain fetal scalp pH if clinically appropriate/prepare for delivery
Marked Variability	<ul style="list-style-type: none"> Mild hypoxia Fetal gasping Unknown 	<ol style="list-style-type: none"> 1. Attach fetal scalp electrode if clinically appropriate 2. Obtain fetal scalp pH if clinically appropriate/prepare for delivery
Sinusoidal pattern	<ul style="list-style-type: none"> Severe fetal anemia (Hb < 70) Tissue hypoxia in fetal brain stem 	<ol style="list-style-type: none"> 1. Attach fetal scalp electrode if clinically appropriate 2. Consider APT test or Kleihauer Betke 3. Prepare for delivery
Absent accelerations with fetal scalp stimulation or absent accelerations	<ul style="list-style-type: none"> Hypoxic acidemia Possible fetal abnormality 	<ol style="list-style-type: none"> 1. Attach fetal scalp electrode if not already done 2. Obtain fetal scalp pH if clinically appropriate/prepare for delivery

Table 16 continued. Potential causes of atypical/abnormal intrapartum EFM tracings and clinical actions to consider in conjunction with intrauterine resuscitation patterns

Pattern definition	Association or potential causes	Additional clinical actions
Variable decelerations	<p>Associated with vagal stimulation due to cord compression.</p> <p>Complicated variable decelerations may be associated with fetal acidemia.</p>	<ol style="list-style-type: none"> 1. Observe in early first stage and observe for development of combined patterns or complicated variables. 2. Very common in late first stage and occur in more than half of second stages. No action, as a normal response. <p>Complicated Variables:</p> <ol style="list-style-type: none"> 1. Amnioinfusion may ameliorate 2. Confirm fetal well-being, directly or indirectly (fetal scalp stimulation, fetal blood scalp sampling) 3. Obtain fetal scalp pH if clinically appropriate/prepare for delivery
Late decelerations	<p>Fetal chemoreceptor/vagal result due to decreased PO₂</p> <p>Altered maternal blood flow to the placenta (e.g., maternal hypotension)</p> <p>Reduced maternal arterial oxygen saturation</p> <p>Placental changes altering maternal-fetal gas exchange (e.g., placental insufficiency, uterine hypertonus or tachysystole)</p> <p>May be associated with fetal acidemia</p>	<p>When occasional, ensure mother in left lateral, check maternal vital signs, and continue observing.</p> <p>When repetitive, it is mandatory to act upon this pattern:</p> <ol style="list-style-type: none"> 1. Obtain fetal scalp pH if clinically appropriate/prepare for delivery
Prolonged deceleration	<p>Associated with fetal baroreceptor and chemoreceptor responses to profound changes in the fetal environment due to uterine hypertonus, unresolving umbilical cord compression, maternal hypotension, maternal seizure, rapid fetal descent.</p>	<ol style="list-style-type: none"> 1. Vaginal exam to rule out cord prolapse 2. Prepare for delivery

the presence of maternal infection (HIV, hepatitis viruses, herpes simplex, suspected intrauterine sepsis). Technical limitations include the skill and experience of the operator, cervical dilatation, maternal discomfort, and the need to repeat FBS at intervals. If the pH is 7.20 or less, delivery is indicated because of the risk of fetal acidemia.^{7,204,205} Although there are differences of opinion regarding the delineation between acidemia and non-acidemia, when an abnormal pattern persists, it is important to evaluate the trend of the fetal blood sampling values to determine whether it is improving or deteriorating. In addition to the fetal pH value, it is preferable to obtain a base deficit. However, base deficit often cannot be obtained from scalp blood samples because of the larger sample necessary and the more sophisticated equipment required for this measurement. Although FBS is used as the gold standard to assess fetal acid-base status when fetal surveillance is atypical or abnormal, there are differences of opinion as to how to respond to borderline results and the clinical interpretation of pH values. Freeman et al.²⁰⁶ suggested that observation using continuous EFM is appropriate if the pH is greater than 7.25, but if persistent atypical/abnormal EFM patterns continue, the FBS should be repeated within 30 minutes.

Additional sampling may take place, and there is no evidence to limit the number, although repeated sampling is uncomfortable for the mother, and repeated scalp puncture increases trauma to and bleeding from the fetal scalp.

Recommendation 13: Fetal Scalp Blood Sampling

1. Where facilities and expertise exist, fetal scalp blood sampling for assessment of fetal acid–base status is recommended in women with “atypical/abnormal” fetal heart tracings at gestations > 34 weeks when delivery is not imminent, or if digital fetal scalp stimulation does not result in an acceleratory fetal heart rate response. (III-C)

G. Umbilical Cord Blood Gases

Arterial and venous cord blood gases provide evidence of fetal and placental oxygenation at birth. In accordance with the SOGC “Attendance at Labour and Delivery Guidelines,” arterial and venous cord blood gas analysis is recommended routinely for ALL births, as they may help in providing appropriate care to the newborn at birth and in planning subsequent management.²⁰⁷ They can also assist quality assurance/improvement initiatives. When risk factors for adverse perinatal outcome exist or when intervention for fetal indications occurs, arterial and venous cord gas

testing is strongly recommended. However, if blood gas analysis is not immediately available (e.g., remote facilities), an acceptable alternative is to obtain a clamped segment of cord (approximately 20 cm) and delay analysis. Samples from the umbilical artery are stable for pH and blood gas assessment for up to 60 minutes at room temperature.²⁰⁸ Umbilical arterial blood samples obtained in preheparinized syringes immediately following delivery, placed on ice, and then refrigerated at 2 to 4°C are stable for up to 72 hours following delivery.²⁰⁹

Umbilical artery samples best indicate the state of fetal oxygenation at the time of birth; however, there is evidence that up to 25% of “arterial” samples are venous.²¹⁰ It is therefore recommended that both arterial and venous cord blood samples be collected to ensure the source of the sample is arterial, especially when risk factors for fetal asphyxia are present. If the umbilical artery is not easily found, an arterial sample may be obtained from the fetal (chorionic) side of the placenta. Arteries can be identified there with some ease because they pass over veins.²¹¹ Obtaining two samples of acid-base values (pH, base, deficit, pCO₂, HCO₃, pO₂, O₂ saturation) will also assist in identifying the type (metabolic or respiratory) and severity of fetal acidosis. A number of studies have calculated normal umbilical cord blood pH gas values in term newborns (ACOG, 1995). The results presented here are from Riley et al.²¹¹

Two results are presented²¹⁰ to illustrate the differences between arterial and venous gases (Table 19). The cases have similar arterial values, but different venous values, and have different outcomes. Case A is consistent with metabolic acidosis; the infant required resuscitation at birth and ventilation for 48 hours, and developed cerebral palsy at one year of age. Case B is consistent with respiratory acidosis; the infant had an Apgar score of 8 and no neonatal problems.

Delaying cord clamping until the cord stops pulsing (average 2 minutes) does not interfere with the collection of cord blood gases. If the fetus is depressed, then the baby should be handed over for immediate resuscitation, and cord gases should be drawn. Common practice has been to draw blood directly from the cord after delivery, or to clamp a segment of the cord immediately after the birth from which cord blood samples could be obtained for gas analysis. More recently, the impact of immediate or early cord clamping on the term and preterm infant and the mother has been evaluated. There appears to be sufficient evidence that delay in cord clamping of at least 30 seconds and up to 120 seconds in the preterm population is associated with a decrease in intraventricular hemorrhage, anemia, and the need for transfusions.^{212,213} In term infants, delayed clamping has been evaluated with waits up to 180 seconds after birth

Table 17. Classification of fetal scalp blood sample results⁷

Fetal blood sample (FBS) result (pH)*	Subsequent action
≥ 7.25	FBS should be repeated if the FHR abnormality persists.
7.21–7.24	Repeat FBS within 30 minutes or consider delivery if rapid fall since last sample.
≤ 7.20	Delivery indicated.

*All scalp pH estimations should be interpreted taking into account the initial pH measurement, the rate of progress in labour, and the clinical features of the mother and baby

Table 18. Normal umbilical cord blood PH and blood gas values in term newborns²¹¹ (data are from infants of unselected patients with vaginal deliveries)

Value	Mean (+/- 1SD) (n = 3522)	Range
Arterial blood		
pH	7.27 (0.069)	7.2–7.34
pCO ₂ (mm Hg)	50.3 (11.1)	39.2–61.4
HCO ₃ -(meq/L)	22.0 (3.6)	18.4–25.6
Base excess (meq/L)	-2.7 (2.8)	-5.5–0.1
Venous blood		
pH	7.34 (0.063)	7.28–7.40
pCO ₂ (mm Hg)	40.7 (7.9)	32.8–48.6
HCO ₃ -(meq/L)	21.4 (2.5)	18.9–23.9
Base excess (meq/L)	-2.4 (2)	-4.4–0.4

Table 19. Case analysis²¹⁰

	Case A		Case B	
	Artery	Vein	Artery	Vein
pH	7.03	7.10	7.04	7.32
pCO ₂ (mmHg)	63	50	67	38
pO ₂ (mmHg)	6.8	20.1	3.5	34
BE (mmol/L)	-12.5	-12.6	-11.2	-5.5

without an increase in adverse outcomes and with beneficial increases in iron stores of the infants up to six months later.^{214,215} In addition, there appears to be no evidence to support early cord clamping as a component of active management of the third stage of labour to prevent postpartum hemorrhage.²¹⁶ Acknowledging this lack of supportive data, FIGO and the International Confederation of Midwives have issued a joint statement on the prevention of PPH that advocates delayed cord clamping within their protocol for the active management of the third stage of labour, and they

recommend timing the cord clamping with the cessation of cord pulsation, which occurs between two and three minutes after birth. We are not aware of any studies comparing samples from early clamped cord segment versus delayed. Further research to determine optimum timing of cord clamping and the normal range of cord gases with this delay is needed. However, even with this practice change in timing of clamping, cord blood samples can still be obtained after the cord has been clamped.

Recommendation 14: Umbilical Cord Blood Gases

1. Ideally, cord blood sampling of both umbilical arterial and umbilical venous blood is recommended for ALL births, for quality assurance and improvement purposes. If only one sample is possible, it should preferably be arterial. (III-B)
2. When risk factors for adverse perinatal outcome exist, or when intervention for fetal indications occurs, sampling of arterial and venous cord gases is strongly recommended. (I—insufficient evidence. See Table 1.)

NEW TECHNOLOGIES

The purpose of intrapartum fetal surveillance is to identify the fetus at elevated risk for labour-related hypoxic injury so that clinicians can intervene to prevent or lessen that injury. This implies both diagnosis and intervention. This clinical goal is defined by cumulative performance of four discrete stages as follows:

1. Accurate signal acquisition and display
2. Definition of “normal” or “abnormal” results
 - to achieve satisfactory sensitivity and specificity
 - to provide adequate time for intervention
3. Effective intervention
4. Timely and correct administration of the intervention

The effect at the end of each step depends in part upon the results of the preceding step. Limitations at any one of these junctures influences performance at all subsequent steps. For example, a high rate of sensor failure to acquire a signal severely compromises any potential usefulness of that technique in real clinical practice. Likewise, failure to intervene when the test is positive negates any benefit gained through successful preceding steps.

It is important to appreciate this hierarchy of dependencies when evaluating and comparing techniques of fetal surveillance. This is especially relevant for fetal pulse oximetry and fetal ECG techniques, because they are superimposed upon basic electronic fetal monitoring and depend upon an initial interpretation of the fetal heart rate patterns. Although both techniques have been subjected to prospective randomized

clinical trials, we have few measures of comparative performance at each stage, and some conflicting results.

A. Fetal Pulse Oximetry

Fetal pulse oximetry is a technology²¹⁷ that attempts to continuously monitor intrapartum fetal O₂ saturation. A sensor is placed transvaginally through the cervix to rest against the fetal cheek or temple, requiring cervical dilatation (~ 2 cm or more) and ruptured amniotic membranes with a cephalic presentation. FPO is intended²¹⁸ as an adjunct to electronic continuous FHR monitoring (in the presence of what was formerly referred to as a “non-reassuring” FHR tracing). It is an adaptation of the concept and technology used widely and effectively in intensive care units and operating rooms.

Five RCTs have been published since 2000, from the USA,^{219–221} Germany,²²² and Australia,²²³ involving over 7400 participants. No difference in newborn outcome was identified in any trial. Only the 146-participant German RCT,²²² in which FPO was used as an adjunct after fetal-scalp blood pH sampling, showed a decrease in the overall rate of Caesarean sections. Because of this evidence, FPO is not endorsed as an adjunct to FHR monitoring in general,²²¹ or more particularly in the presence of a non-reassuring pattern.^{219–223}

Limited roles for FPO may still exist. As a complement to intrapartum fetal blood sampling indicated for FHR concerns, FPO may safely decrease frequency of repeat samples, while decreasing operative intervention.^{222,224} Also, in the presence of a fetal arrhythmia^{225–228} (e.g., complete heart block, or supraventricular tachycardia) when FHR intermittent or continuous evaluation is uninterpretable, FPO and fetal blood sampling may allow a safe vaginal delivery attempt.

In summary, there is insufficient evidence to substantiate a recommendation for the use of FPO as an adjunct or independent of electronic fetal surveillance.

Recommendation 15: Fetal Pulse Oximetry

1. Fetal pulse oximetry, with or without electronic fetal surveillance, is not recommended for routine use at this time. (III-C)

B. Fetal Electrocardiogram Analysis

Fetal ECG monitoring is a technique used in combination with standard EFM. A specialized monitor with proprietary software collects both the familiar fetal heart rate and uterine activity signals, and the fetal ECG.²²⁹ Interpretation is based on the observation that the fetal QRS and T wave change in relation to the metabolic state of the fetal heart.²²⁹ By analyzing changes and trends in the ST segment and the T/QRS ratio with computer assistance, in conjunction with a three-level visual classification of the fetal heart rate

patterns, a more precise interpretation regarding the need for intervention can be made.²²⁹

The impact of this type of monitoring compared with standard EFM has been evaluated in three prospective randomized clinical trials.^{229–232} Systematic reviews of these European RCTs, involving more than 8100 participants, have been conducted.²³³ The addition of ST waveform analysis to conventional EFM has resulted in

- fewer babies (RR 0.64; 95% CI 0.41–1.00) with severe metabolic acidosis at birth (cord pH < 7.05 and base deficit more than 12 mmol/L).
- fewer babies with neonatal encephalopathy (RR 0.33; 95% CI 0.11–0.95).
- fewer fetal scalp blood samples obtained during labour (RR 0.76; 95% CI 0.67–0.86).
- fewer operative vaginal deliveries (RR 0.87; 95% CI 0.78–0.96) and all operative deliveries (RR 0.90; 95% CI 0.84–0.98).

There was no difference in the number of Caesarean sections, perinatal deaths, or NICU admissions, or in Apgar scores < 7 at 5 minutes.²³³

A specific and continuing education program for caregivers in analysis and management of fetal ECG findings has been needed to attain the results above.²²⁹ Despite this, up to 10% of monitoring attempts did not achieve a satisfactory recording for interpretation.^{232,234} Although there is growing support in Europe,²³⁵ there has been little North American experience or research publication to date.²³⁴

A Canadian observational prospective cohort study involving a blinded sequential analysis of FHR tracings and ST events, found low positive predictive value and sensitivity for metabolic acidemia at birth when clinical decisions were made without knowledge of ST waveforms.²³⁴ These findings, along with the history of unrealistically high expectations in the introduction of conventional EFM, continue to temper enthusiasm for this very promising adjunct to direct electrode fetal health surveillance in labour, which will soon be available in North America.

Recommendation 16: ST Waveform Analysis

1. The use of ST waveform analysis for the intrapartum assessment of the compromised fetus is not recommended for routine use at this time. (I-A)

C. Intrapartum Fetal Scalp Lactate Testing

In situations where intrapartum fetal monitoring is not reassuring, fetal lactate levels can be used to establish the fetal condition.²³⁶ Fetal scalp blood lactate level correlates well with the umbilical arterial cord blood lactate level.^{237,238} The advantage of lactate over pH are the ability to obtain a result with less blood and the ability to distinguish between benign respiratory acidosis and potentially deleterious metabolic acidosis.²³⁵

Several authors have examined the use of lactate levels to help guide intrapartum management of abnormal fetal heart rate tracings as well as to predict neonatal outcomes.^{236,238,239} In these studies, fetal scalp lactate levels in series of women with abnormal fetal heart rate tracings in labour were evaluated and outcomes measured. The largest trial, by Kruger, examined 326 fetal scalp samples for lactate and pH. Data on low Apgar scores, NICU admission and presence of HIE were collected.²³⁸ On the basis of area under the receiver operator curve, a lactate level of greater than 4.8 mmol/L was associated an increased risk of moderate to severe HIE, compared with a pH of less than 7.21 ($P < 0.001$). The sensitivity was 100% and specificity was 73% for scalp lactate levels compared with 50% and 80%, respectively for pH.²³⁸

Testing can be performed on smaller volumes of blood than scalp pH, leading to a lower failure rate in testing.²³⁹ The test result is vulnerable to poor scalp perfusion because of extensive caput or prolonged second stage, which may lead to falsely elevated lactate levels.²³⁷ Further studies in this area are required before scalp lactate can be recommended for general use.

Recommendation 17: Intrapartum Fetal Scalp Lactate Testing

1. Intrapartum scalp lactate testing is not recommended for routine use at this time. (III-C)

Further study of new technologies is encouraged, including improved sensor performance, critical threshold cutoffs, comparative discrimination and temporal performance in a wide range of conditions similar to those in contemporary Canadian obstetrics.

Maintaining Standards in Antenatal and Intrapartum Fetal Surveillance: Quality Improvement and Risk Management

Basic quality improvement principles must be followed to ensure a standard approach in patient management. These principles form the foundation of a quality improvement program, and their effectiveness (or lack thereof) could determine the program success or failure. Quality control or quality improvement programs based on these principles have been shown to have some effect on the outcome of perinatal and medical care.²⁴⁰ The principles include the provision of the following: a multidisciplinary team approach to care, champion leadership, a no-blame culture, a systems approach to complex organizational structure, a respect for individual confidentiality, a client-focused environment with patient safety being the highest priority, evidence-based care, and a program evaluation and outcome monitoring/reporting system with implementation plans for improvement. Outcome monitoring should include quality performance outcomes and effectiveness and efficiency measures. Examples include monitoring the number of adverse perinatal events, reviewing cases in which fetal surveillance should have been applied and was not, reviewing cases in which fetal surveillance was applied but failed, and reviewing cases in which fetal surveillance was inappropriately applied and resulted in unnecessary intervention. These types of cases should be evaluated and different approaches, improved management, or proposed solutions identified. Then the new solution or different approach should be monitored.

Education through the dissemination of clinical guidelines has also been advocated to facilitate consistency in clinical management²⁴¹ and best practice. However, as education alone has proved insufficient to ensure durable improvement of physicians' behaviour once they have completed their training,^{242,243} multiple approaches to effect and sustain change may be necessary. Management research has identified effective strategies that influence health care professional capacity and change. It is prudent for management to invest time and resources on these known effective measures: continuous and perpetual QI monitoring,²⁴⁴ effective

organization and environment "set-up," use of incentives,^{242,245,246} champion leadership and effective teams,²⁴⁷ and use of technology through data-based information.^{248–250} The effectiveness of, and adherence to, guidelines may be evaluated at the institutional level or at the provincial and national levels via the analysis of perinatal data. Indicators may include cord gas analysis completed for all deliveries, cord gases with pH < 7.0, etc.

Appropriate facility policies are another aspect of quality improvement. Facilities providing intrapartum services should have current policies/guidelines outlining approaches to fetal surveillance, lines of communication, and appropriate responses and actions for all situations. Policies should also address routine admission/discharge electronic fetal monitoring tracings in light of current evidence and recommendations. Facilities should have established mechanisms for having all NSTs read by an appropriately trained and designated individual on a regular basis (ideally within 24 hours of testing).

It is recognized that the provision of quality patient care is dependent on effective multidisciplinary teams. Effective oral and written communication (documentation) is essential, as is a base knowledge of fetal health surveillance.

COMMUNICATION

The SOGC recognizes that perinatal/obstetrical units have many of the characteristics that define HROs. HROs are complex, internally dynamic organizations with safety-oriented cultures that perform exacting tasks under considerable time pressures and have a low incidence of catastrophic failure over the years.²⁵¹ One of the defining characteristics of HROs is the value placed on communication and the role of communication in effective team functioning and the provision of safe patient care. In a report completed by the Joint Commission in the USA on obstetrical error and adverse events, problematic communication within interprofessional teams was identified as a root cause analysis in 72% of adverse perinatal events reported up to 2004.²⁵²

Table 20. CHAT Communication Model

C	Context	What is happening with the patient right now?
H	History	What are the essential facts about the medical history?
A	Assessment	What do you think about the situation?
T	Tentative plan	What do you think should be done right now?

Although there is extensive literature outlining the ingredients of effective communication, it is possible in this guideline only to highlight important points significant to the communication of fetal health surveillance data. The SOGC recommends use of the acronym CHAT (Table 20) to make oral communication clear and unambiguous.

Within this framework, there should be consistency in use of recommended fetal health surveillance terminology and electronic fetal surveillance tracing classification. If the tracing is determined to be atypical or abnormal, and the primary care provider is not present, the RN should orally communicate the findings of each fetal heart parameter in terminology used in this guideline. By doing this, the primary care provider should be able to “paint a picture” of how the tracing or data appear and make subsequent appropriate clinical decisions when not immediately present.

Good, clear, effective communication should be a priority at all times in the clinical area. It is necessary within the health care team and with women and their families during all phases of the perinatal period.

DOCUMENTATION

As recommended by the SOGC,^{253–256} all fetal health assessments, the plan of action, and the clinical actions taken must be accurately documented. Standard documentation practices are to be encouraged among all caregivers.^{253–256} Documentation may consist of narrative notes or the use of comprehensive flow sheets detailing the periodic assessments. The following information should be included.

Intermittent Auscultation

1. Uterine activity characteristics obtained by palpation:
 - Frequency
 - Duration
 - Intensity
 - Relaxation between contractions

2. FHR data:

- Numerical baseline rate (in bpm)
 - Rhythm (regular or irregular)
 - Nature of the changes (gradual or abrupt acceleration or deceleration)
3. Interpretation of findings as normal or abnormal and specific actions taken when changes in FHR occur
 4. Other maternal observations and assessments
 5. Maternal and fetal responses to interventions
 6. Communication with the primary care provider when the findings are abnormal

Electronic Fetal Monitoring

1. The indication for initiating EFM
2. Uterine activity characteristics obtained by external/internal tocotransducer and/or palpation:
 - Frequency
 - Duration
 - Intensity
 - Relaxation between contractions
3. Baseline rate, variability, the presence/absence of accelerations, and the presence and type of decelerations
4. Classification of the tracing as normal, atypical, or abnormal and specific actions taken when the tracing is atypical or abnormal, including documentation of communication with the primary care provider
5. Other maternal observations and assessments
6. Maternal and fetal responses to interventions

Fetal heart rate data and interpretation should be transcribed and documented in the woman’s chart at least hourly in latent labour (every 15 minutes if oxytocin infusing), every 15 to 30 minutes in active labour, and every 5 minutes in active second stage of labour.

Each individual electronic fetal monitoring tracing should have patient identifiers noted on the tracing and should be sequentially identifiable. If maternal data are charted on the tracing, it is important that timing of chart entries be consistent with the timing on the tracings. All tracings are saved as a legal component of the patient medical record and need be stored so as to be readily available.

INTERPROFESSIONAL ROLES AND EDUCATION

For the safe provision of care, it is essential that physicians, midwives, and registered nurses providing intrapartum care have, at minimum, the following:

- Understanding of how IA and EFM monitoring equipment work.
- Knowledge and understanding of underlying fetal physiology and knowledge of hypoxic acidemia
- Ability to interpret and classify IA findings
- Ability to interpret and classify EFM tracings
- Understanding of the benefits and limitations of both IA and EFM
- Knowledge of medical/midwifery/nursing management for normal, atypical, and abnormal fetal heart tracings
- Ability to communicate effectively and to document information using clear and correct terminology

Although the role of the primary care provider in the provision of care is clear, there may be confusion or inconsistency regarding the responsibility of registered nurses performing fetal surveillance via IA or EFM. To clarify, the registered nurse is responsible for the following:

- Assessing the uterine activity pattern and uterine resting tone via palpation and/or tocotransducer
- Obtaining an interpretable heart rate via IA or EFM tracing with both ultrasound and tocotransducer channels
- Assessing the fetal heart via IA or EFM tracing when indicated, and at least every 15 to 30 minutes in active labour
- Interpreting and classifying IA and/or EFM findings
- Appropriate and timely communication with the physician or midwife about surveillance findings
- Documentation of fetal heart rate findings on the mother's chart
- Appropriate emergency nursing interventions in the case of atypical or abnormal findings

Attaining and maintaining the competency required in fetal surveillance techniques is complex. Competence in fetal surveillance requires didactic knowledge as well as critical thinking, decision making and psychomotor skills.²⁵⁷ When electronic fetal monitoring was introduced in clinical practice, the few formalized programs teaching their use. Those that existed were largely in-house programs or programs developed by the manufacturers of monitors, very few of which were subjected to evaluation of effectiveness. Murray,¹⁶⁹ in 1986, reported that there was no standardized nomenclature, standardized tests of certification, or uniform curriculum for education, and there were no standards

of interpretation, and standards of application, interpretation, or paper speed.

Since assessment of fetal status is integral to labour management, and many legal challenges are based on interpretation and actions taken on the basis of fetal surveillance data, institutions expect nurses, physicians, and midwives affiliated with their institution to be competent in using this technology. Knowledge of experience with both intermittent auscultation techniques and electronic fetal monitoring is required as obstetric care providers look after many healthy women without risk factors, as well as women with risk factors due to their medical history, complications during their current pregnancy, or risk factors developing during labour. Specialty organizations such as the Society of Obstetricians and Gynaecologists of Canada, the American College of Obstetricians and Gynecologists, the Accreditation Council for Graduate Medical Education, the American Board of Obstetrics and Gynecology, and the Royal College of Physicians and Surgeons expect all obstetrics-gynaecology residents and maternal-fetal medicine fellows to become proficient in EFM.²⁵⁸ Canadian midwifery education programs and provincial/territorial midwifery regulators have expectations that midwives will be competent in both IA and interpretation of EFM. The Association of Women's Health, Obstetric and Neonatal Nurses of Canada has standards for intrapartum nurses to interpret fetal surveillance data²⁵⁹; however, there is very little research to indicate the best way to attain and maintain the skills, and there is no standardized way to assess competency.

In Canada, several risk management programs, including MORE^{ob} and ALARM offer some content on fetal surveillance in labour for those already comfortable with basic introductory concepts. However, there is no formal fetal surveillance program accepted as the standard for perinatal care providers. In residency programs, some hospitals include formal fetal surveillance training, and some rely on on-the-job experience for learning. Undergraduate midwifery curriculum includes fetal surveillance. For nurses, there is no standard practice. Some participate in hospital-developed programs and others attend more formalized courses.

A standardized program available for the novice and adaptable for the more experienced, is the two-part program titled "Fetal Health Surveillance in Canada" produced by the Canadian Perinatal Regionalization Coalition and endorsed by the SOGC.²⁶⁰ This program consists of an extensive self-learning package and a full-day course and is offered though many of the perinatal programs in Canada. AWHONN has a Fetal Heart Monitoring program,²⁶¹ which many Canadian nurses have completed. This group

also has programs aimed at intermediate and advanced level care providers. A number of instructors for these programs offer them in Canada. The challenge with there being so many courses, and courses based on American content (e.g., the AWHONN program) is inconsistency in use of terminology and application of Canadian guidelines. However the knowledge is obtained, both individual practitioners and facilities providing intrapartum services have a responsibility to ensure that the minimum knowledge outlined in this guideline is attained.

There is little evidence regarding the amount of time required to attain and maintain competency in fetal health surveillance. The same is true for the optimum timing for updates or re-training and how to maintain best practices for clinical integration of the classroom knowledge. Relating to EFM, Trepanier et al.²⁶¹ demonstrated that EFM knowledge and skills deteriorate within a six-month period, indicating that regular updating or practise is essential. Further research about these concepts is required. Although there is little research on the effectiveness of interdisciplinary education, an interprofessional approach to education is recommended. Each facility should organize annual interdisciplinary FHS updates. In light of the fact that knowledge and skills deteriorate over time and that labour and birth care requires effective team functioning, it is recommended that all care providers participate in a fetal health surveillance update course every few years. RANZCOG⁶ indicates that institutions undertaking intrapartum care have a responsibility to ensure that clinicians have an understanding of the pathophysiology of and are able to demonstrate competence in the interpretation of fetal surveillance options. This seems a prudent recommendation from both a patient safety and a risk management perspective.

Recommendation 18: Fetal Health Surveillance Education

1. Regular updating of fetal surveillance skills is required. Although there is no best evidence to indicate how often practitioners should update their knowledge and skills, periodic review is advised. Each facility should ensure that fetal surveillance updates are interprofessional to ensure common terminology and shared understanding and to develop the concept of team responsibility. (III-B)

RISK MANAGEMENT ISSUES

Although the intent of clinical practice guidelines is to provide the best current, evidence-based recommendations on a particular s recognized that guidelines may have limitations. Recommendations made by professional consensus when evidence is not available may be weaker. For various reasons, recommendations may not be appropriate for all patient populations or health care facilities. There may be a

legitimate reason to deviate from a published guideline, but there should be clear justification if doing so. Local institutions should use guidelines appropriate to their setting and model their policies and procedures on recognized national and provincial recommendations when possible.

There are several important risk management issues specific to fetal surveillance. First, there are very few properly randomized trials comparing different modalities of fetal monitoring, aside from those comparing electronic fetal monitoring and auscultation. The recommendations in this guideline therefore, are made on the best evidence and information available to date. Second, interpretation of fetal heart rate is necessarily subjective. There are many articles showing that experts may interpret fetal heart rate quite differently. Barrett¹ demonstrated not only that interobserver agreement on interpretation of fetal heart is poor but also that intraobserver variability exists. He showed the same fetal heart rate tracing to a group of senior consultants, and about 25% disagreed with their own earlier opinion on the fetal heart rate tracing. Zaine et al.²⁶² performed a study in which they took cases with abnormal fetal heart rate tracing and poor outcome. They created sham scenarios for the same cases in which the only difference was that they had a good outcome. Thirty-six obstetricians reviewed two case pairs each for a total of 72 case pairs. When the alleged neonatal outcome was poor, there was a significant tendency to respond that evidence of hypoxia was present ($P = 0.007$) or that the obstetrician had made an incorrect decision ($P < 0.001$). The conclusion was that obstetricians are biased by knowledge of poor neonatal outcome when retrospectively interpreting fetal heart rate tracings and judging appropriateness of obstetric care.

Third, the incidence of false positive findings also presents risk management issues. For example, variable decelerations and even late decelerations are very common in labour, especially in late labour. Sheiner et al.²⁵⁸ demonstrated that 75% of patients have abnormal fetal heart rate patterns in the second stage of labour. Umstad et al.²⁶⁴ showed that the frequency of fetal heart rate abnormalities of any sort throughout labour was high, at a rate of 80%. Since the occurrence rate of intrapartum death due to asphyxia is much lower (1–2/1000), and as the likelihood of a false positive is much higher than the likelihood of a true positive, extreme caution is required so as not to act on a false positive finding.

Despite the inherent limitations and risk management issues, the techniques of fetal surveillance are well embedded in clinical practice. Methods to ameliorate risk have been outlined throughout this guideline. In summary, national guidelines should be adhered to whenever possible, and facilities should incorporate appropriate guidelines into their unit policies and procedures. Clinicians providing

intrapartum care should have knowledge of both IA and EFM techniques, and facilities should offer opportunities for education and ensure the competency of those providing intrapartum care. Institutions providing intrapartum care have a responsibility to ensure that clinicians have an understanding of the pathophysiology of and are able to demonstrate competence in the interpretation of fetal surveillance options. All members of the perinatal team should use a common language with respect to fetal surveillance.

Communication and documentation strategies and skills need to be exemplary. Consistent use of electronic fetal monitoring terminology and classification is crucial. Women should be well informed of recommendations and options for fetal surveillance in pregnancy and during labour. Their choices for fetal surveillance in labour should be respected. Finally, a dynamic and effective quality assurance program should be in effect to assure standards, monitor outcomes, and make systemic changes as indicated.

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