

## FETAL HEALTH SURVEILLANCE IN LABOUR

*This guideline was developed by the Working Group on Fetal Health Surveillance in Labour and approved by Executive and Council of the Society of Obstetricians and Gynaecologists of Canada.*

*It has also been reviewed by the Maternal-Fetal Medicine Committee, the Clinical Practice Obstetrics Committee, the ALARM Committee, and the Canadian Medical Protective Association.*

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### Abstract

**Objective:** This guideline defines the standards pertaining to the application and documentation of fetal surveillance in labour that will decrease the incidence of birth asphyxia while maintaining the lowest possible rate of obstetrical intervention. Both high- and low-risk obstetrical populations are considered. It is intended that this guideline could be used by all persons providing intrapartum care in Canada, including nurses, physicians, and midwives.

**Options:** Consideration has been given to methods of fetal surveillance currently available in Canada, including intermittent auscultation, electronic fetal monitoring (alone and when paired with vibro-acoustic or scalp stimulation and fetal scalp blood sampling), the "admission strip," computerized heart rate analysis, fetal oxygen saturation monitoring, fetal electrocardiogram analysis, and near-infrared spectroscopy.

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

**Evidence:** A comprehensive review of randomized controlled trials performed from 1995 to date and a search of the literature using Medline and the Cochrane Database of all new studies on fetal surveillance. The level of evidence has been determined using the criteria described by the Canadian Task Force on the Periodic Health Examination.

### Recommendations:

#### Part I: Standard Fetal Surveillance in Labour

1. Women in active labour should receive continuous close support from an appropriately trained professional. One-to-one nursing is recommended. (I-A)
2. Intermittent auscultation following an established protocol of surveillance and response (Figure 1) is the preferred method of fetal surveillance in healthy pregnancies in the active phase of labour. (I-A)
3. Labour induction requires close monitoring of uterine activity and fetal heart rate. (III-B)
4. In the presence of abnormal fetal heart rate characteristics detected by intermittent auscultation and unresponsive to resuscitative measures, increased surveillance by continuous electronic fetal monitoring or fetal scalp sampling or delivery should be instituted. (I-A)
5. Continuous intrapartum electronic fetal monitoring is recommended:
  - a) for pregnancies where there is an increased risk of perinatal death, cerebral palsy, or neonatal encephalopathy (III-C)
  - b) when oxytocin is being used for augmentation of labour (I-A)
  - c) when oxytocin is being used for induction of labour (III-C).
6. With respect to continuous electronic fetal monitoring, all professionals must be familiar with the paper speed used in each case to avoid misinterpretation. The correct time should be recorded on the electronic fetal monitoring record. (III-C)

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FOR INFORMATION ON THE SELF-DIRECTED LEARNING EXERCISE SEE PAGE 277.

7. Electronic fetal monitoring records should be inspected and documented every 15 minutes in the active phase of labour and at least every 5 minutes in the second stage of labour. (III-C)
8. The timing of electronic fetal monitoring patterns should be determined in association with uterine contractions. The contraction frequency, duration, intensity, and resting tone should be assessed and documented. Abdominal palpation, a tocodynamometer, or an intrauterine pressure catheter may be used to facilitate the assessment. (III-C)
9. Practitioners should use standard terminology when describing fetal heart rate characteristics of an electronic fetal monitoring record. (III-C)
10. Fetal scalp blood sampling is recommended in association with electronic fetal monitoring patterns that are uninterpretable or non-reassuring, such as sustained minimal or absent variability, uncorrectable late decelerations, increasing fetal tachycardia, and abnormal FHR characteristics on auscultation. (II-3B)
11. The limited knowledge available on the use of labour admission tests warrants further research to establish the usefulness of this screening approach. (III-C)

#### Part II: New Technologies for Fetal Surveillance in Labour

12. The use of computer-based algorithms alone to interpret fetal heart rate patterns is not recommended as a standard of care at the present time. (III-D)
13. Fetal pulse oximetry as an adjunct to electronic fetal heart monitoring in patients with non-reassuring HR status is not recommended as a standard of care at the present time. (III-D)
14. ST waveform analysis technology is under development but is not recommended as a standard of care at this time. (III-C)
15. Near-infrared spectroscopy as an adjunct to electronic fetal monitoring is currently not recommended as there is insufficient evidence to assess its efficacy in fetal surveillance. (III-D)
16. Further study of fetal pulse oximetry, ST waveform analysis, and near-infrared technology in clinical research settings is encouraged. (III-B)

**Validation:** This guideline was reviewed by the SOGC Clinical Practice Obstetrics Committee, Maternal Fetal Medicine Committee, and ALARM Committee, as well as by the Canadian Medical Protective Association.

**Sponsor:** The Society of Obstetricians and Gynaecologists of Canada.

## PART I: STANDARD FETAL SURVEILLANCE IN LABOUR

### INTRODUCTION

Asphyxia is a condition of impaired gas exchange, which when persistent, leads to progressive hypoxemia and hypercapnia.<sup>1</sup> During normal labour, uterine contractions cause temporary reductions in gas exchange. After the contraction, fetal compensation occurs with self-resuscitation, followed by normal perfusion until the next contraction occurs. If these natural physiologic compensatory mechanisms are overwhelmed, hypoxic acidemia ensues. Hypoxic acidemia of a sufficient degree and duration can cause brain damage with resultant neu-

rological sequelae in surviving children, other organ system damage, or intrapartum or neonatal death.<sup>1,2</sup>

The diagnosis of intrapartum hypoxic acidemia requires an umbilical cord blood gas analysis with evidence of metabolic acidosis (pH < 7.0 and base deficit > 16 mmol/L) (Table 1).<sup>3-6</sup> Fetal cord blood sampling provides a measure of the severity of metabolic acidosis, but not the duration. A certain proportion of hypoxic acidemia occurs just prior to delivery and is brief in duration. This is very unlikely to cause morbidity or mortality. However, metabolic acidosis may be accompanied by specific neonatal findings, which indicate an asphyxic episode of sufficient intensity that it is likely to cause harm. These indications include multi-organ system dysfunction, neonatal neurologic sequelae, and Apgar scores of 0 to 3 for 5 minutes or longer.

The aim of intrapartum fetal surveillance is to improve fetal outcomes by identifying fetuses with hypoxic acidemia at a point when the process is still completely reversible by intrauterine resuscitation or expedited delivery. This document reviews the science behind, and the clinical evidence of, the effectiveness of various surveillance methods available today.

Research has shown improvements in fetal outcomes that are very difficult to document due to variations in the interpretation of these tests, especially electronic fetal heart rate monitoring. Complicating the issue are variable responses in terms of the interventions applied and the lack of standardization of the important outcomes. The incidence of metabolic acidosis is reported as being between 0.5% and 2.0%.<sup>1</sup> Fortunately, fetal neurologic damage is also very rare.<sup>7</sup> These low prevalences make proving a statistical benefit in clinical trials quite difficult. It is also important to remember that less than 20% of neurologic deficits in children are caused by intrapartum asphyxia.<sup>8,9</sup>

Over the past two decades, research has challenged the clinical value of electronic fetal heart rate monitoring.<sup>10-12</sup> Meta-analysis of these data has led to two significant observations.<sup>13,14</sup> Electronic fetal monitoring (EFM) compared with intermittent

TABLE 1  
CRITERIA FOR INTRAPARTUM ASPHYXIA

The essential criteria of the newborn response to asphyxia of such a degree as to be likely to cause harm are:

- Apgar score 0 to 3 for  $\geq 5$  minutes;<sup>6</sup>
- neonatal neurologic sequelae (e.g., hypotonia, seizures, coma);<sup>6</sup>
- evidence of multi-organ system dysfunction in the immediate neonatal period;<sup>6</sup>
- umbilical cord arterial pH < 7.0;<sup>4,6</sup> and
- umbilical cord arterial base deficit > 16 mmol/L.<sup>1</sup>

All of these conditions must be present. In cases where such evidence is lacking, one cannot conclude that hypoxic acidemia existed or had the potential to cause neurologic deficits.

TABLE 2 QUALITY OF EVIDENCE ASSESSMENT <sup>21</sup>	CLASSIFICATION OF RECOMMENDATIONS
<p>The quality of evidence reported in these guidelines has been described using the Evaluation of Evidence criteria outlined in the Report of the Canadian Task Force on the Periodic Health Exam.</p> <p>I: Evidence obtained from at least one properly randomized controlled trial.</p> <p>II-1: Evidence from well-designed controlled trials without randomization.</p> <p>II-2: Evidence from well-designed cohort (prospective or retrospective) or case-control studies, preferably from more than one centre or research group.</p> <p>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.</p> <p>III: Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.</p>	<p>Recommendations included in these guidelines have been adapted from the ranking method described in the Classification of Recommendations found in the Report of the Canadian Task Force on the Periodic Health Exam.</p> <p>A. There is good evidence to support the recommendation that the condition be specifically considered in a periodic health examination.</p> <p>B. There is fair evidence to support the recommendation that the condition be specifically considered in a periodic health examination.</p> <p>C. There is poor evidence regarding the inclusion or exclusion of the condition in a periodic health examination, but recommendations may be made on other grounds.</p> <p>D. There is fair evidence to support the recommendation that the condition not be considered in a periodic health examination.</p> <p>E. There is good evidence to support the recommendation that the condition be excluded from consideration in a periodic health examination.</p>

auscultation (IA) has not been shown to improve fetal or neonatal outcomes as measured by a decrease in morbidity or mortality.<sup>13,14</sup> Secondly, EFM is associated with an increase in inappropriate interventions, including Caesarean section, vaginal operative delivery, and the use of anesthesia.<sup>13,15</sup>

This guideline updates the role of intermittent auscultation and electronic fetal monitoring for fetal health surveillance,<sup>16</sup> including new technological advances: computerized fetal heart rate analysis,<sup>17</sup> fetal oxygen saturation monitoring,<sup>18</sup> fetal electrocardiogram analysis,<sup>19</sup> and near-infrared spectroscopy.<sup>20</sup> It also provides an assessment of the quality of the available evidence and indicates the class of each recommendation (Table 2).<sup>21</sup> The aim of this document is to provide guidelines for persons providing intrapartum care that will lead to the best possible fetal outcomes (in terms of birth asphyxia) while maintaining the lowest possible rates of intervention. When using any option for fetal surveillance, there should be discussion with the woman about her wishes, concerns, and questions regarding the benefits, limitations, and risks of the procedure. She and her partner should be involved in the decision-making process regarding the selection of fetal health surveillance methods and all aspects of care.<sup>22</sup>

### **INTERMITTENT AUSCULTATION**

Auscultation of the fetal heart during labour became a universal "standard of care" during the first half of the 20th century. Professional bodies representing perinatal caregivers in the United Kingdom (Royal College of Obstetricians and Gynaecologists<sup>23</sup>) and in North America (American College of Obstetricians and

Gynecologists,<sup>24</sup> Association of Women's Health, Obstetric and Neonatal Nurses<sup>25</sup>) all recommend surveillance of the fetal heart during active labour as a standard of care.

There is no good data on which to base a recommendation for fetal heart observation during the latent phase of labour. Most women will pass through the latent phase of labour with family support at home. If, in low-risk patients, a change in the woman's condition should occur during the latent phase, such as rupture of the membranes, development of bleeding, or other concerning clinical events, the fetal heart rate should be documented on a regular basis.

The fetal heart may be auscultated by a variety of instruments, including a fetal stethoscope, a hand-held Doppler ultrasound instrument, and by the intermittent use of the external ultrasound transducer of an electronic monitor. Some hand-held Doppler instruments will provide an instantaneous read-out of the heart rate and amplify the fetal heart sound. Ultrasound technology allows the sharing of the auscultated sounds, and avoids the occasional auscultation difficulty encountered with a fetoscope.

A number of trials have compared intermittent auscultation with continuous EFM.<sup>10-12,26-34</sup> The protocol used in each trial is listed in Table 3. On the basis of this information, a reasonable protocol for fetal heart auscultation would seem to be: "immediately after a contraction for 1 minute, every 15 to 30 minutes in active labour, and every 5 minutes in the active portion of the second stage." (III-B) Even though this frequency of auscultation in the second stage has been promoted, there are no studies comparing 5 vs. 10 vs. 15 minutes between aus-

TABLE 3  
AUSCULTATION METHODS IN SELECTED  
RANDOMIZED TRIALS

Study	Method
Renou <i>et al.</i> , 1975 <sup>26</sup>	not described
Haverkamp <i>et al.</i> , 1978 <sup>27</sup>	for 30 seconds after contraction
Kelso <i>et al.</i> , 1978 <sup>28</sup>	one full minute during or after contraction
Haverkamp <i>et al.</i> , 1979 <sup>29</sup>	30 seconds after contractions
Wood <i>et al.</i> , 1981 <sup>30</sup>	not described
McDonald <i>et al.</i> , 1985 <sup>10</sup>	counted for 60 seconds
Leveno <i>et al.</i> , 1986 <sup>11</sup>	not described
Luthy <i>et al.</i> , 1987 <sup>12</sup>	between contractions and at least 30 seconds immediately after contractions
Shy <i>et al.</i> , 1990 <sup>31</sup>	between contractions and at least 30 seconds immediately after contractions
Vintzileos <i>et al.</i> , 1993 <sup>32</sup>	between contractions
Morrison <i>et al.</i> , 1993 <sup>33</sup>	during and for 30 seconds after contractions
Mahomed <i>et al.</i> , 1994 <sup>34</sup>	before and after a contraction

cultation in the second stage.

In addition to observation of the fetal heart rate, practitioners must have the knowledge of what is a reassuring fetal heart rate and what is non-reassuring. In addition, they must be aware of the actions required in such circumstances and be capable of managing these actions in a timely manner. Table 4 defines the normal characteristics of the fetal heart rate on auscultation. Table 5 describes the response to an abnormal fetal heart rate on auscultation.

Evidence suggests that the ongoing presence of a trained support person during labour and delivery significantly reduces the likelihood of operative delivery and the use of analgesia, as well as the likelihood of 5-minute Apgar scores being less than 7.0, and increases the mother's satisfaction, suggesting that such care should be a priority.<sup>35</sup>

Once the active phase of labour is entered, the guidelines for fetal surveillance in active labour apply. A number of trials<sup>10-12,26-30,32</sup> have compared intermittent auscultation (IA) with continuous electronic fetal monitoring (EFM). Intermittent auscultation is associated with a reduced incidence of operative intervention, with no difference in fetal or neonatal outcome in the groups studied.<sup>10,11,26-30</sup> However, one large trial<sup>10</sup> reported an increased incidence of neonatal seizures

among babies whose mothers experienced prolonged labour and were intermittently auscultated, compared to those who were monitored with EFM. This suggests that women requiring augmentation for dysfunctional or arrested labour might benefit from continuous EFM (I-A). Prior to initiating oxytocin, assessment of fetal well-being by fetal heart rate monitoring is recommended (III-C). Labour induction requires close monitoring of uterine activity and fetal heart rate, and one-to-one nursing care is recommended (III-B).<sup>36</sup> Each obstetric department should establish guidelines for oxytocin use for labour induction.

Because trials<sup>10-12,26-30,32</sup> comparing IA to EFM have included both healthy women with normal pregnancies and women with complications of pregnancy, and have found both methods comparable with respect to neonatal outcome, there is no good evidence to limit IA to "normal" pregnancy. However, these trials included women with a heterogeneous group of "risk factors." The relative merits of IA against EFM have not been evaluated with respect to such individual risk factors.

#### RECOMMENDATIONS

1. Women in active labour should receive continuous close support from an appropriately trained professional. One-to-one nursing recommended. (I-A)
2. Intermittent auscultation following an established protocol of surveillance and response (Figure 1) is the preferred method of fetal surveillance in healthy women in the active phase of labour. (I-A)
3. Labour induction requires close monitoring of uterine activity and fetal heart rate. (III-B)

#### ELECTRONIC FETAL MONITORING

##### WHY AND WHEN TO PERFORM

##### ELECTRONIC FETAL MONITORING

EFM is appropriate to assess fetal well-being in labour if institutions are not able to provide intermittent auscultation (IA), or when IA is available but suggests a non-reassuring fetal heart rate (FHR) pattern.

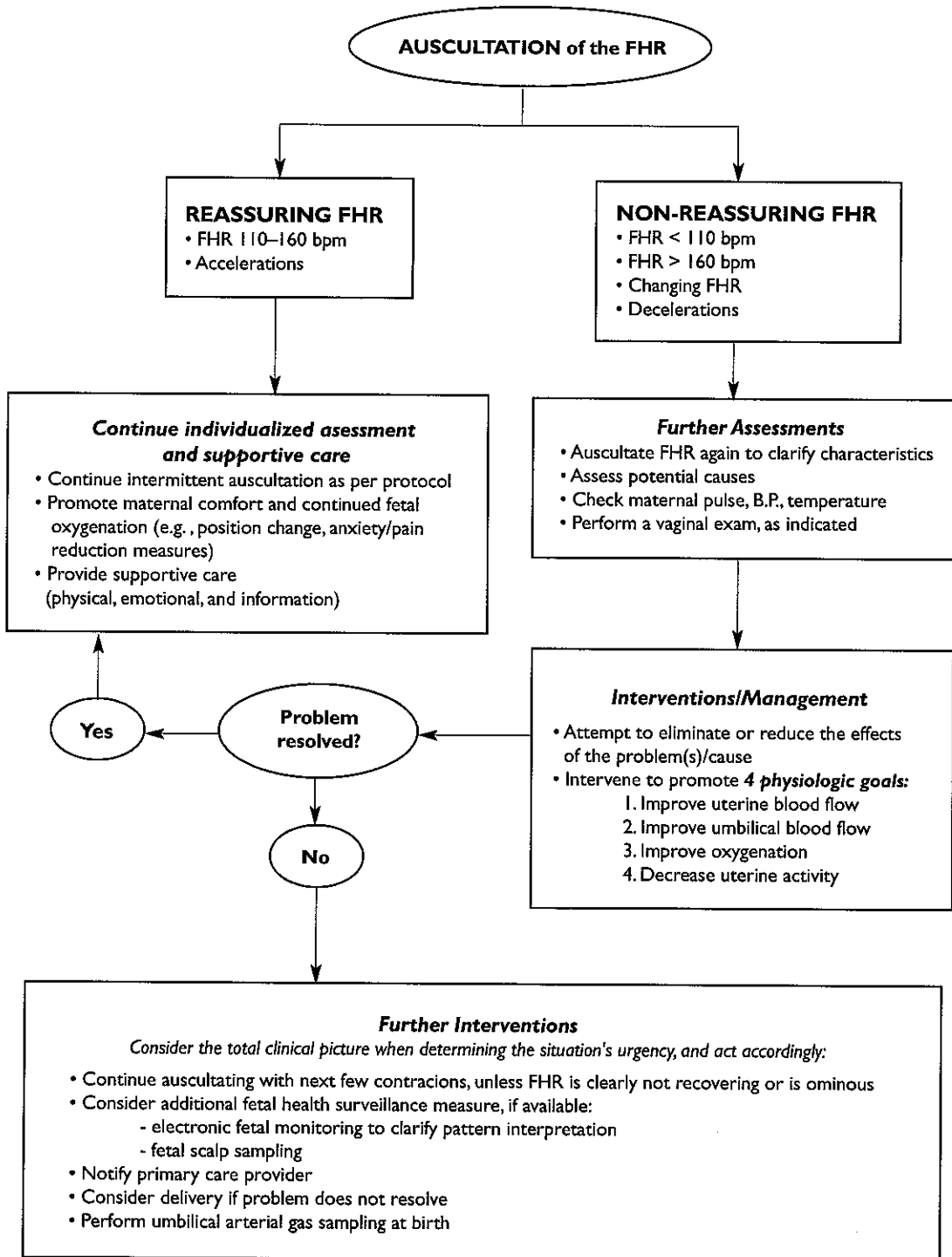
The Canadian Task Force on the Periodic Health Examination concluded that there is fair evidence to exclude EFM from intrapartum care in low-risk pregnancies if IA is possible.<sup>37</sup> Although this report found little scientific evidence to support the use of EFM in high-risk pregnancies, the authors 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. EFM may be considered an appropriate alternative in monitoring high-risk patients.

There is insufficient evidence to suggest which specific high-risk patients require EFM as opposed to IA. Thacker *et al.*<sup>14</sup> performed a meta-analysis of randomized clinical trials comparing IA to continuous EFM. These trials included both

FIGURE 1

**CLINICAL DECISION MAKING - FETAL HEALTH SURVEILLANCE IN LABOUR**

Adapted from the Ottawa Hospital Maternal Newborn Program



Adapted from: Feinstein NF, Sprague A, & Trépanier MJ. (2000). Fetal heart rate auscultation. AWHONN. Sprague, A. (1995). Auscultation of FHR - Decision-tree. PPEESO.

TABLE 4 CHARACTERISTICS OF THE AUSCULTATED FETAL HEART	
Reassuring	Non-reassuring
<ul style="list-style-type: none"> <li>• Normal baseline heart rate: 110–160 beats/min</li> </ul>	<ul style="list-style-type: none"> <li>• Abnormal baseline heart rate               <ul style="list-style-type: none"> <li>a) tachycardia – fetal heart rate &gt;160 beats/min</li> <li>b) bradycardia – fetal heart rate &lt;110 beats/min</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>• Presence of accelerations</li> </ul>	<ul style="list-style-type: none"> <li>• Presence of decelerations</li> </ul>
Adapted from: ACOG, Intrapartum fetal heart rate monitoring <sup>24</sup> Adapted from: Feinstein NF, Sprague A, Trépanier MJ. Fetal heart rate auscultation. Washington 2000: AWHONN (Association of Women's Health, Obstetric and Neonatal Nurses) <sup>25</sup>	

low-risk and high-risk patients. Their findings demonstrated that the only clinical benefit of continuous EFM was a reduction in neonatal seizures (in trials using scalp sampling), with an associated observation of an increase in operative vaginal

delivery and Caesarean delivery. 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.<sup>38</sup> There is no evidence from randomized trials to suggest that the use of EFM will reduce the rate of cerebral palsy,<sup>14</sup> and one study found an increased frequency of cerebral palsy among infants who were continuously monitored during labour.<sup>31</sup>

An association between factors complicating pregnancy and labour and the development of neonatal encephalopathy, cerebral palsy, and perinatal death has been described.<sup>7,9,39-43</sup> These factors include hypertension, abruptio, fetal growth restriction, multiple pregnancy, 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 consider EFM in these situations, as has been recommended by the Royal College of Obstetricians and Gynaecologists (Table 6).<sup>23</sup> While use of EFM is associated with a reduced likelihood of neonatal seizures when augmentation is required for dysfunctional labour,<sup>10</sup> there is insufficient evidence on which to base a firm recommendation when labour

TABLE 5 MANAGEMENT OF ABNORMAL FETAL HEART RATE BY INTERMITTENT AUSCULTATION	
<b>TACHYCARDIA</b>	<ul style="list-style-type: none"> <li>• Reposition patient to increase uteroplacental perfusion or alleviate cord compression</li> <li>• Rule out fever, dehydration, drug effect, prematurity</li> <li>• Correct maternal hypovolemia, if present, by increasing IV fluids</li> <li>• Check maternal pulse and blood pressure</li> </ul>
<b>DECELERATIONS</b>	<ul style="list-style-type: none"> <li>• Reposition patient</li> <li>• Examine patient for passage of meconium</li> <li>• Correct hypotension, if present</li> <li>• Stop oxytocin</li> <li>• Administer oxygen at 8 to 10 L/min</li> </ul>
<b>BRADYCARDIA</b>	<ul style="list-style-type: none"> <li>• Reposition patient to increase uteroplacental perfusion or alleviate cord compression</li> <li>• Discontinue oxytocin infusion</li> <li>• Perform vaginal exam to assess for prolapsed cord or relieve cord compression</li> <li>• Administer oxygen at 8 to 10 L/min</li> <li>• Correct maternal hypovolemia, if present, by increasing IV fluids</li> <li>• Check maternal pulse and blood pressure</li> </ul>
<b>ADDITIONAL MEASURES</b>	<ul style="list-style-type: none"> <li>• Continue to auscultate FHR to clarify and document components of FHR</li> <li>• Consider initiation of electronic fetal monitoring (EFM) to clarify and document components of the FHR</li> <li>• If abnormal findings persist despite corrective measures, and ancillary tests are not available or desirable, expedited delivery should be considered</li> </ul>
<b>TECHNICALLY INADEQUATE AUDIBLE FHR</b>	<ul style="list-style-type: none"> <li>• Initiate electronic fetal heart rate monitoring (EFM)</li> </ul>
Adapted from: Feinstein NF, Sprague A, Trépanier MJ. Fetal heart rate auscultation. Washington 2000: AWHONN (Association of Women's Health, Obstetric and Neonatal Nurses) <sup>25</sup>	

is induced. Nevertheless, the need for induction implies a situation which is not physiological, and uterine stimulation increases the likelihood of hypercontractility. EFM should therefore be considered when labour is induced (III-C).<sup>44</sup>

#### METHODS OF ELECTRONIC FETAL HEART MONITORING

EFM may be performed with an external or internal monitor. The external monitor is a Doppler ultrasound transducer that monitors Doppler shift that is interpreted by a computer into a fetal heart rate. Internal monitoring is performed with a spiral electrode attached to the fetal scalp or other presenting part. A cardiac signal is transmitted, tracing a fetal electrocardiogram.

#### DEFINITIONS OF TERMS AND SYSTEMATIC INTERPRETATION OF EFM TRACING

A recent NIH workshop was convened to develop standardized and unambiguous definitions for fetal heart rate tracings.<sup>45</sup> This requires an adequate tracing of the FHR as well as the recording of uterine contractions. It is important to both analyze and interpret the FHR. Analysis refers to defining and measuring the characteristics of the tracing, while interpretation refers to the clinical meaning to the collection of these measurements.<sup>45,46</sup>

A full description of FHR tracing requires an assessment

of maternal risk factors and a qualitative and quantitative description of uterine activity characteristics (frequency, duration, intensity of contractions, and resting tone); baseline fetal heart rate; baseline fetal heart rate variability; presence of accelerations; periodic or episodic decelerations; and changes or trends of FHR patterns over time.<sup>45,46</sup>

#### Baseline Fetal Heart Rate

Baseline FHR is the mean FHR rounded to increments of 5 beats per minute during a 10-minute segment, excluding periodic changes and periods of marked FHR variability (segments of the baseline that differ by more than 25 beats per minute).<sup>45</sup> If the baseline FHR is less than 110 beats per minute, it is termed bradycardia. If a baseline FHR is greater than 160 beats per minute, it is termed tachycardia.

#### Baseline Fetal Heart Rate Variability

Variability has been defined as FHR fluctuations in the baseline FHR over 1 minute.<sup>45</sup> These fluctuations are variable in amplitude and frequency and are visually identified as the amplitude of the peak to trough in beats per minute. If the amplitude is not detectable, then it is described as absent FHR variability; if the amplitude is detectable, but less than

TABLE 6

#### PREGNANCY FACTORS ASSOCIATED WITH INCREASED RISK OF ADVERSE FETAL OUTCOME\*

<b>Antenatal maternal conditions</b>	<ul style="list-style-type: none"> <li>• Hypertension/pre-eclampsia</li> <li>• Diabetes</li> <li>• Antepartum hemorrhage</li> <li>• Other maternal medical disease</li> </ul>
<b>Antenatal fetal conditions</b>	<ul style="list-style-type: none"> <li>• Growth-restricted fetus</li> <li>• Prematurity</li> <li>• Oligohydramnios</li> <li>• Abnormal umbilical artery Doppler velocimetry</li> <li>• Isoimmunization</li> <li>• Multiple pregnancy</li> <li>• Breech presentation</li> </ul>
<b>Intrapartum maternal conditions</b>	<ul style="list-style-type: none"> <li>• Vaginal bleeding in labour</li> <li>• Intrauterine infection</li> </ul>
<b>Labour</b>	<ul style="list-style-type: none"> <li>• Previous Caesarean section</li> <li>• Prolonged membrane rupture</li> <li>• Induced labour</li> <li>• Augmented labour</li> <li>• Hypertonic uterus</li> </ul>
<b>Fetal conditions</b>	<ul style="list-style-type: none"> <li>• Meconium staining of the amniotic fluid</li> <li>• Suspicious fetal heart rate on auscultation</li> <li>• Post-term pregnancy</li> </ul>

\* 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.<sup>23</sup>

6 beats per minute, then it is defined as minimal FHR variability; if amplitude ranges from 6 to 25 beats per minute, then this is moderate FHR variability; if amplitude is greater than 25 beats per minute, then this is marked FHR variability.

In addition, the presence of a sinusoidal FHR pattern should also be noted. Sinusoidal pattern differs from variability in that it has a smooth sine wave pattern of regular frequency and amplitude.<sup>46</sup>

### Acceleration

Acceleration is defined as an abrupt increase in the FHR, 15 beats per minute above the baseline, lasting for at least 15 seconds and less than 2 minutes.<sup>46</sup> Before 32 weeks' gestation, accelerations are defined as greater than 10 beats per minute above the baseline for a duration of greater than 10 seconds. Prolonged acceleration is defined as an increase in the fetal heart rate for greater than 2 minutes, but less than 10 minutes (acceleration of  $\geq 10$  minutes is a baseline change).

### Periodic or Episodic Decelerations

*Early deceleration* is defined as a gradual decrease in the FHR (defined as onset of deceleration to nadir  $\leq 30$  seconds) and return to baseline associated with uterine contraction. The onset, nadir, and recovery of the decelerations are coincident with the beginning, peak, and ending of the contraction, respectively.

*Variable deceleration* is defined as an abrupt decrease in the FHR with the onset of the deceleration to the nadir usually of less than 30 seconds.<sup>45</sup> 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 felt to be a response of the FHR to cord compression and are the most common decelerations seen in labour. Variable decelerations may be further divided into reassuring decelerations and non-reassuring or atypical variable decelerations.<sup>46</sup> Atypical features include:

- deceleration to less than 70 bpm lasting more than 60 seconds
- loss of variability in the baseline FHR and in the trough of 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 a baseline at a lower level than prior to the deceleration
- the presence of fetal tachycardia

*Late decelerations* are defined as a gradual decrease in the FHR and return to baseline with the onset of the deceleration to the nadir usually of greater than 30 seconds.<sup>45</sup> The onset, nadir, and recovery of the decelerations occur after the begin-

ning, peak, and ending of the contraction, respectively.

In describing FHR patterns, it is important to document baseline FHR, variability, the presence of periodic or episodic accelerations, and periodic or episodic decelerations. In addition to this description, it is important to provide an interpretation such as reassuring fetal heart rate tracing or non-reassuring FHR tracing, and any clinical action taken.

### CHANGES OR TRENDS OF FETAL HEART RATE PATTERNS OVER TIME

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 (Table 7).<sup>45-47</sup>

Where a non-reassuring pattern emerges, the usual clinical action would be threefold:

- 1) remove aggravating conditions, such as the use of oxytocin augmentation
- 2) institute intrauterine resuscitation techniques
- 3) take additional measures to assess fetal well-being, such as scalp stimulation or fetal scalp blood sampling.<sup>46</sup>

Intrauterine resuscitation may include any or all of the following:

- change maternal position
- stop uterine stimulation
- hydrate
- modify pushing technique
- reduce anxiety and modify breathing techniques
- give maternal oxygen by mask

These actions seek to:

- 1) improve uterine blood flow, by a maternal position change, hydration, medication adjustment, or anxiety reduction (lessening catecholamine impact)
- 2) improve umbilical circulation, by vaginal manipulation, maternal position change, or amnioinfusion
- 3) improve oxygen saturation, by maternal position changes, maternal oxygen, and breathing techniques
- 4) reduce uterine activity, by adjusting medication, maternal position changes, adequate hydration, or modifying pushing techniques.

If the pattern becomes reassuring, labour can continue without the added stress of emergency operative delivery, which will be necessary where interventions have failed to apply a correction.



TABLE 7

ELECTRONIC FETAL HEART RATE PATTERNS, ASSOCIATIONS, AND CLINICAL ACTIONS<sup>15-17</sup>

Pattern Definition	Associations or Potential Causes	Clinical Actions
<b>Bradycardia:</b> Baseline FHR < 110 bpm	<b>Maternal:</b> <ul style="list-style-type: none"> <li>hypotension</li> <li>drug responses</li> <li>maternal position</li> <li>connective tissue diseases with congenital heart block (e.g., systemic lupus erythematosus)</li> </ul> <b>Fetal:</b> <ul style="list-style-type: none"> <li>umbilical cord occlusion</li> <li>fetal hypoxia</li> <li>vagal stimulation such as with chronic head compression or with vertex presentation, occipital posterior or transverse position</li> <li>fetal hypothermia</li> <li>fetal acidosis</li> <li>fetal cardiac conduction or structural defect</li> </ul>	<ol style="list-style-type: none"> <li>Maternal pulse</li> <li>Differentiate fetal from maternal heart rate</li> <li>Vaginal exam (elevate presenting part if cord prolapse)</li> <li>Intrauterine resuscitation (see text)</li> <li>Discontinue oxytocics</li> <li>May decrease uterine activity (tocolysis)</li> <li>If cause is not obvious or correctable, consider intrapartum U/S to evaluate arrhythmia</li> <li>If persistently severe (&lt;100 bpm), and associated with other borderline patterns of concern, consider expediting delivery</li> </ol>
<b>Tachycardia:</b> Baseline FHR > 160 bpm	<b>Maternal:</b> <ul style="list-style-type: none"> <li>fever</li> <li>infection</li> <li>dehydration</li> <li>hyperthyroidism</li> <li>endogenous adrenaline or anxiety</li> <li>medication or drug response</li> <li>anemia</li> </ul> <b>Fetal:</b> <ul style="list-style-type: none"> <li>infection</li> <li>prolonged fetal activity or stimulation</li> <li>chronic hypoxemia</li> <li>cardiac abnormalities</li> <li>congenital anomalies</li> <li>anemia</li> </ul>	<ol style="list-style-type: none"> <li>Maternal temperature</li> <li>Decrease maternal temperature (if elevated)</li> <li>Intrauterine resuscitation (see text)</li> <li>Discontinue oxytocics</li> <li>Assess medications or drugs</li> <li>Reassess for duration of rupture of membranes (ROM), positive vaginal culture, especially group B streptococcus (GBS)</li> <li>If cause is not obvious or correctable, consider intrapartum U/S to evaluate arrhythmia</li> <li>If persistent, consider expediting delivery</li> </ol>
<b>Accelerations:</b> Periodic increases in the FHR >15 bpm lasting >15 seconds (<32 weeks gestation increase in the FHR >10 bpm lasting >10 seconds).	<ul style="list-style-type: none"> <li>Normal fetal heart rate response to increased fetal activity</li> <li>Direct sympathetic stimulation of the fetus</li> <li>Occlusion of umbilical vein only</li> </ul>	No action (normal response). May be due to occlusion of umbilical vein only, as in association with variable decelerations (see text).
<b>Early decelerations:</b> Gradual decrease and return to baseline in the FHR that is coincident in timing with the nadir of the deceleration occurring at the same time as the peak of the contraction	Reflex vagal response secondary to head compression. This FHR pattern is not normally associated with fetal acidemia.	No action (normal response).
<b>Variable decelerations:</b> Abrupt decrease in the FHR, >15 bpm below the baseline lasting for at least 15 seconds but less than 2 minutes. They may be described as atypical or non-reassuring if they are persistent to less than 70 bpm, and lasting more than 60 seconds; associated with prolonged return to baseline, loss of pre and post deceleration shoulders, the presence of post deceleration smooth overshoots, rising baseline, and absence or loss of variability in baseline FHR and the trough of the deceleration.	<ul style="list-style-type: none"> <li>Associated with vagal stimulation due to cord compression, or head compression in the second stage of labour</li> <li>Non-reassuring variable decelerations may be associated with fetal acidemia.</li> </ul>	<ul style="list-style-type: none"> <li>Variable without atypical features – reassuring pattern.</li> <li>No action (normal response)</li> <li>Very common. They occur in more than half of second stages.</li> </ul> Variable with atypical features a non-reassuring pattern: <ol style="list-style-type: none"> <li>Intrauterine resuscitation</li> <li>Amnioinfusion may ameliorate</li> <li>Confirm fetal well-being, directly or indirectly (FSS, VAS, FSBS)</li> <li>Consider expediting operative delivery by forceps or vacuum extraction (if feasible), or emergency Caesarean section, especially if fetal well-being has not been "confirmed"</li> </ol>
<b>Late decelerations:</b> Gradual decrease and return to baseline FHR in association with a uterine contraction. The onset, nadir and recovery of the deceleration occur after the beginning, peak, and end of the contraction. The nadir of the deceleration is delayed 30 seconds beyond the peak of the contraction.	<ul style="list-style-type: none"> <li>Altered maternal blood flow to the placenta (e.g., maternal hypotension)</li> <li>Reduced maternal arterial oxygen saturation</li> <li>Placental changes altering maternal-fetal gas exchange (e.g., placental insufficiency, uterine hypertonus or tachysystole)</li> <li>May be associated with fetal acidemia</li> </ul>	When occasional, may be a normal response  When persistent and repetitive, it is mandatory to act upon this pattern: <ol style="list-style-type: none"> <li>Intrauterine resuscitation</li> <li>Confirm fetal well-being, directly or indirectly (FSS, VAS, FSBS)</li> <li>Consider expediting operative delivery by forceps or vacuum extraction (if feasible), or emergency Caesarean section, especially if fetal well-being not "confirmed"</li> </ol>
<b>Inadequate tracing for interpretation</b>		<ol style="list-style-type: none"> <li>Ensure that equipment is working properly.</li> <li>If external monitor is in use, reposition to obtain a clear continuous signal.</li> <li>Anticipate need for internal monitoring, if unable to maintain a technically adequate tracing despite interventions using external monitoring.</li> <li>With internal EFM, confirm presence of fetal heart sounds by auscultation and note the fetal heart rate.</li> <li>Confirm uterine activity pattern and uterine resting tone by abdominal palpation.</li> </ol>

## VIBRO-ACOUSTIC AND SCALP STIMULATION

Additional measures to evaluate fetal well-being may include an indirect assessment of acid-base status. A reactive response to stimuli may be indicative of a normoxic fetus.<sup>48,49</sup> The stimulus may be vibro-acoustic<sup>50</sup> or scalp stimulation per vagina.<sup>51</sup> 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., reassuring) and very high sensitivity with regard to the absence of fetal acidosis.<sup>48-51</sup> It has been generally accepted that a reactive response is associated with a scalp pH of greater than 7.20.<sup>48-51</sup> However, it must be realized that, although a reactive response is consistent with a reasonable likelihood of fetal well-being, the absence of this response does not predict fetal compromise.<sup>48-51</sup> Where there is a lack of response, further assessment may be necessary, such as direct<sup>48-51</sup> assessment by fetal scalp blood sampling to determine pH.

Five observational studies<sup>48,50,52-54</sup> examined the ability of vibro-acoustic stimulation (VAS) to predict acidotic fetal blood pH. All 5 studies examined prediction at a pH of 7.25 and there was considerable variation in sample size.<sup>48,50,52-54</sup> In all studies, the specificity was poor at about 65% to 80%, but the sensitivity was high at 90% to 100%. However, no RCT has been performed to assess the effect of using VAS in reducing the need for fetal scalp blood sampling (FSBS). Five other studies<sup>49,51,55-57</sup> examined the ability of VAS or fetal scalp stimulation (FSS) to evoke accelerative responses in the fetus and thus enhance the ability to predict subsequent pH. Similarly, these tests had good sensitivity (80–100%) but poor specificity (16–59%).<sup>49,51,55-57</sup> All these studies<sup>49,51,55-57</sup> included small numbers of acidotic babies, and the power of the studies may have affected their ability to perform well. Also, they were used in conjunction with EFM, which has poor specificity itself. There was no reduction in Caesarean delivery rates in any of the studies.<sup>49,51,55-57</sup>

## FETAL SCALP BLOOD SAMPLING

There is an absence of agreement on the indications for fetal scalp blood sampling (FSBS), but a reasonable set of circumstances was suggested by Freeman *et al*,<sup>58</sup> including:

- 1) a non-reassuring pattern on EFM, with elements suggestive of fetal hypoxia
- 2) a sustained flat EFM pattern without periodic changes

- 3) uncorrectable late decelerations with moderate or average variability.

However, further research is necessary.

## LIMITATIONS

Technical limitations include skill of operator, anatomical difficulties associated with the procedure, pain to the woman, and the fact that FSBS usually is performed on multiple occasions as a single sample may be of limited use, unless the pH is 7.20 or less, at which level authorities suggest delivery should be undertaken because of the risk of fetal acidemia.<sup>23,59</sup> Although there are differences of opinion concerning the delineation between acidemia and non-acidemia, when an abnormal pattern persists, it is important to use the value from scalp blood sampling in terms of a trend. In these circumstances, the clinician must evaluate whether it is improving or deteriorating. In addition, the pH alone is much less useful in interpretation, than in conjunction with base deficit. However, base deficit often cannot be obtained from scalp blood samples due to the lack of availability of the more sophisticated equipment required for this measurement.

Although FSBS is used as the gold standard to assess fetal acid-base status where fetal surveillance is non-reassuring, there are differences of opinion as to how to respond to borderline results and the clinical interpretation of pH values. Freeman *et al*.<sup>58</sup> suggested that if the pH was greater than 7.25, one could continue to observe with continuous EFM. However, with persistent non-reassuring signs, one would be obliged to repeat the FSBS at no longer than 30 minutes later. Additional sampling may take place, with no evidence to limit the number, although repeated sampling is uncomfortable for the mother, and repeated scalp puncture causes trauma to and bleeding from the fetal scalp. Zalar and Quilligan<sup>60</sup> in 1979 recommended that if the scalp pH was 7.20 or less, intervention and delivery were indicated. As previously mentioned, national authorities concur.<sup>23,59</sup> The Royal College of Obstetricians and Gynaecologists' guidelines on "The Use of Electronic Fetal Monitoring" re-affirmed these criteria for intervention (Table 8).<sup>23</sup>

Strict adherence to a critical scalp pH value may compromise fetal health because it may tend to mask early recognition of hypoxic acidosis, since changes in fetal scalp blood pH and fetal reactivity occur later than ominous EFM patterns (II-2C).<sup>61</sup>

TABLE 8

### CLASSIFICATION OF FETAL SCALP BLOOD SAMPLE RESULTS<sup>23</sup>

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

## **CORD BLOOD ANALYSIS**

In accordance with the SOGC's *Attendance at Labour and Delivery Guidelines*, cord blood gases should be routinely obtained; doing so may help in providing appropriate care to the newborn at birth and in planning subsequent management.<sup>61</sup>

## **DOCUMENTATION OF FETAL HEALTH SURVEILLANCE**

As recommended by the SOGC,<sup>16</sup> one must accurately document all fetal health assessments along with the clinical actions taken. Standard charting practices are to be encouraged among all caregivers.<sup>16</sup> Documentation may consist of narrative notes or the use of comprehensive flow sheets detailing the periodic assessments. Whatever method is used, the following should be included:

- 1) Fetal heart rate (FHR) data:
  - numerical baseline rate (in bpm)
  - rhythm – if auscultation (regular or irregular)
  - variability – if EFM
  - nature of the changes (gradual or abrupt acceleration, deceleration, and type of deceleration if EFM)
- 2) Uterine activity characteristics obtained by palpation:
  - frequency
  - duration
  - intensity
  - relaxation between contractions
- 3) Documentation of the interpretation as reassuring or non-reassuring and specific actions taken when changes in FHR occur
- 4) Other maternal observations and assessments
- 5) Maternal and fetal responses to interventions
- 7) Subsequent return to normal findings.

## **RECOMMENDATIONS**

4. **In the presence of abnormal fetal heart rate characteristics detected by intermittent auscultation and unresponsive to resuscitative measures, increased surveillance by continuous electronic fetal monitoring or fetal scalp sampling or delivery should be instituted. (I-A)**
5. **Continuous intrapartum electronic fetal monitoring is recommended:**
  - a) **for pregnancies where there is an increased risk of perinatal death, cerebral palsy, or neonatal encephalopathy (III-C)**
  - b) **when oxytocin is being used for augmentation of labour (I-A)**
  - c) **when oxytocin is being used for induction of labour (III-C).**
6. **With respect to continuous electronic fetal monitoring, all professionals must be familiar with the paper speed used in each case to avoid misinterpretation. The correct time**

**should be recorded on the electronic fetal monitoring record. (III-C)**

7. **Electronic fetal monitoring records should be inspected and documented every 15 minutes in the active phase of labour and at least every 5 minutes in the second stage of labour. (III-C)**
8. **The timing of electronic fetal monitoring patterns should be determined in association with uterine contractions. The contraction frequency, duration, intensity, and resting tone should be assessed and documented. Abdominal palpation, a tocodynamometer, or an intrauterine pressure catheter may be used to facilitate the assessment. (III-C)**
9. **Practitioners should use standard terminology when describing fetal heart rate characteristics of an electronic fetal monitoring record. (III-C)**
10. **Fetal scalp blood sampling is recommended in association with electronic fetal monitoring patterns that are uninterpretable or non-reassuring, such as sustained minimal or absent variability, uncorrectable late decelerations, increasing fetal tachycardia, and abnormal FHR characteristics on auscultation. (II-3B)**

## **LABOUR ADMISSION MONITORING TEST**

A survey of family-centred care practices in Canadian hospitals indicated that 65% of hospitals routinely use EFM for a short interval, such as 20 minutes at the time of admission,<sup>63</sup> with a higher rate of this initial monitoring found in hospitals having more than 1000 live births per year (81%) than among hospitals with less than 300 births per year (56%). The rationale for evaluation of fetal well-being on admission is to identify those fetuses who might benefit from intensive fetal heart (FHR) surveillance, or fetal blood sampling (FBS) for acid-base analysis, upon or at some other time during labour. It is further felt that this approach might identify pre-labour acidosis, help to prioritize use of EFM where instruments are limited, and help to reassure mothers and care providers so that they might take a less technological, more personal approach to labour.

However, when EFM was carried out some hours to days prior to labour onset, the literature regarding antepartum cardiotocographical screening,<sup>64</sup> as well as experience with antenatal FHR testing in the Canadian Post-Term Pregnancy Trial,<sup>65</sup> does not present encouraging results. Although the labour admission monitoring test is performed at a time of uterine activity, and thus might be expected to be a better method of identifying labours likely to be complicated by fetal acidosis, there has been surprisingly little vigorous assessment of this approach. "Admission strips" were evaluated by Ingemarsson *et al.*<sup>66</sup> in a small number of patients, and when classified as reactive or normal, were found to have a very low association with subsequent fetal asphyxia. One percent of women had an ominous fetal heart rate strip, and this was associated with a greater likelihood of fetal asphyxia, but was

poorly sensitive for fetal acidemia.<sup>66</sup> Other investigators have evaluated the use of admission FHR strips in high-risk patients, but according to this guideline, these women should have continuous monitoring regardless of the admission strip.<sup>67,68</sup>

## RECOMMENDATIONS

### 11. The limited knowledge available on the use of labour admission tests warrants further research to establish the usefulness of this screening approach. (III-C)

*This Clinical Practice Guideline, Fetal Health Surveillance in Labour (Part I, Standard Fetal Surveillance in Labour, and Part II, New Technologies for Fetal Surveillance in Labour) supersedes the previous guidelines on Fetal Health Surveillance published in 1995/1996.*

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