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Intrapartum Fetal Heart Rate Monitoring: Nomenclature, Interpretation, and General Management Principles

In the most recent year for which data are available, approximately 3.4 million fetuses (85% of approximately 4 million live births) in the United States were assessed with electronic fetal monitoring (EFM), making it the most common obstetric procedure (1). Despite its widespread use, there is controversy about the efficacy of EFM, interobserver and intraobserver variability, nomenclature, systems for interpretation, and management algorithms. Moreover, there is evidence that the use of EFM increases the rate of cesarean deliveries and operative vaginal deliveries. The purpose of this document is to review nomenclature for fetal heart rate assessment, review the data on the efficacy of EFM, delineate the strengths and shortcomings of EFM, and describe a system for EFM classification.

This Practice Bulletin was developed by the ACOG Committee on Practice Bulletins with the assistance of George A. Macones, MD. The information is designed to aid practitioners in making decisions about appropriate obstetric and gynecologic care. These guidelines should not be construed as dictating an exclusive course of treatment or procedure. Variations in practice may be warranted based on the needs of the individual patient, resources, and limitations unique to the institution or type of practice.

THE AMERICAN COLLEGE OF OBSTETRICIANS AND GYNECOLOGISTS
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Background

A complex interplay of antepartum complications, suboptimal uterine perfusion, placental dysfunction, and intrapartum events can result in adverse neonatal outcome. Known obstetric conditions, such as hypertensive disease, fetal growth restriction, and preterm birth, predispose fetuses to poor outcomes, but they account for a small proportion of asphyxial injury. In a study of term pregnancies with fetal asphyxia, 63% had no known risk factors (2).

The fetal brain modulates the fetal heart rate through an interplay of sympathetic and parasympathetic forces. Thus, fetal heart rate (FHR) monitoring can be used to determine if a fetus is well oxygenated. It was used among 45% of laboring women in 1980, 62% in 1988, 74% in 1992, and 85% in 2002 (1).

Despite the frequency of its use, limitations of EFM include poor interobserver and intraobserver reliability, uncertain efficacy, and a high false-positive rate.

Fetal heart rate monitoring may be performed externally or internally. Most external monitors use a Doppler device with computerized logic to interpret and count the Doppler signals. Internal FHR monitoring is accomplished with a fetal electrode, which is a spiral wire placed directly on the fetal scalp or other presenting part.

Guidelines for Nomenclature and Interpretation of Electronic Fetal Heart Rate Monitoring

In 2008, the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development partnered with the American College of Obstetricians and Gynecologists and the Society for Maternal–Fetal Medicine to sponsor a workshop focused on electronic FHR monitoring (3). This 2008 workshop gathered a diverse group of investigators with expertise and interest in the field to accomplish three goals: 1) to review and update the definitions for FHR pattern categorization from the prior workshop; 2) to assess existing classification systems for interpreting specific FHR patterns and make recommendations about a system for use in the United States; and 3) to make recommendations for research priorities for EFM. A complete clinical understanding of EFM necessitates discussion of uterine contractions, baseline FHR rate and variability, presence of accelerations, periodic or episodic decelerations, and the changes in these characteristics over time. A number of assumptions and factors common to FHR interpretation in the United States are central to the proposed system of nomenclature and interpretation (3). Two such assumptions are of particular importance. First, the definitions are primarily developed for visual interpretation of FHR patterns, but should be adaptable to computerized systems of interpretation. Second, the definitions should be applied to intrapartum patterns, but also are applicable to antepartum observations.

Uterine contractions are quantified as the number of contractions present in a 10-minute window, averaged over a 30-minute period. Contraction frequency alone is a partial assessment of uterine activity. Other factors such as duration, intensity, and relaxation time between contractions are equally important in clinical practice.

Listed as follows is terminology used to describe uterine activity:

Characteristics of uterine contractions

Normal: five contractions or less in 10 minutes, averaged over a 30-minute window

Tachysystole: more than five contractions in 10 minutes, averaged over a 30-minute window

- The terms hyperstimulation and hypercontractility are not defined and should be abandoned.
- Tachysystole should always be qualified as to the presence or absence of associated FHR decelerations.
- The term tachysystole applies to both spontaneous and stimulated labor. The clinical response to tachysystole may differ depending on whether contractions are spontaneous or stimulated.

Table 1 provides EFM definitions and descriptions based on the 2008 National Institute of Child Health and Human Development Working Group findings. Decelerations are defined as recurrent if they occur with at least one half of the contractions.

Classification of Fetal Heart Rate Tracings

A variety of systems for EFM interpretation have been used in the United States and worldwide (4–6). Based on careful review of the available options, a three-tiered system for the categorization of FHR patterns is recommended (see box). It is important to recognize that FHR tracing patterns provide information only on the current acid–base status of the fetus. Categorization of the FHR tracing evaluates the fetus at that point in time; tracing patterns can and will change. An FHR tracing may move back and forth between the categories depending on the clinical situation and management strategies used.

Category I FHR tracings are normal. Category I FHR tracings are strongly predictive of normal fetal acid–base status at the time of observation. Category I FHR tracings may be monitored in a routine manner, and no specific action is required.

Category II FHR tracings are indeterminate. Category II FHR tracings are not predictive of abnormal fetal acid–base status, yet presently there is not adequate evidence to classify these as Category I or Category III. Category II FHR tracings require evaluation and continued surveillance and reevaluation, taking into account the entire associated clinical circumstances. In some circumstances, either ancillary tests to ensure fetal well-being or intrauterine resuscitative measures may be used with Category II tracings.

Category III FHR tracings are abnormal. Category III tracings are associated with abnormal fetal acid–base status at the time of observation. Category III FHR tracings require prompt evaluation. Depending on the clinical situation, efforts to expeditiously resolve the

Table 1. Electronic Fetal Monitoring Definitions

Pattern	Definition
Baseline	• The mean FHR rounded to increments of 5 beats per minute during a 10-minute segment, excluding: —Periodic or episodic changes —Periods of marked FHR variability —Segments of baseline that differ by more than 25 beats per minute • The baseline must be for a minimum of 2 minutes in any 10-minute segment, or the baseline for that time period is indeterminate. In this case, one may refer to the prior 10-minute window for determination of baseline. • Normal FHR baseline: 110–160 beats per minute • Tachycardia: FHR baseline is greater than 160 beats per minute • Bradycardia: FHR baseline is less than 110 beats per minute
Baseline variability	• Fluctuations in the baseline FHR that are irregular in amplitude and frequency • Variability is visually quantitated as the amplitude of peak-to-trough in beats per minute. —Absent—amplitude range undetectable —Minimal—amplitude range detectable but 5 beats per minute or fewer —Moderate (normal)—amplitude range 6–25 beats per minute —Marked—amplitude range greater than 25 beats per minute
Acceleration	• A visually apparent abrupt increase (onset to peak in less than 30 seconds) in the FHR • At 32 weeks of gestation and beyond, an acceleration has a peak of 15 beats per minute or more above baseline, with a duration of 15 seconds or more but less than 2 minutes from onset to return. • Before 32 weeks of gestation, an acceleration has a peak of 10 beats per minute or more above baseline, with a duration of 10 seconds or more but less than 2 minutes from onset to return. • Prolonged acceleration lasts 2 minutes or more but less than 10 minutes in duration. • If an acceleration lasts 10 minutes or longer, it is a baseline change.
Early deceleration	• Visually apparent usually symmetrical gradual decrease and return of the FHR associated with a uterine contraction • A gradual FHR decrease is defined as from the onset to the FHR nadir of 30 seconds or more. • The decrease in FHR is calculated from the onset to the nadir of the deceleration. • The nadir of the deceleration occurs at the same time as the peak of the contraction. • In most cases the onset, nadir, and recovery of the deceleration are coincident with the beginning, peak, and ending of the contraction, respectively.
Late deceleration	• Visually apparent usually symmetrical gradual decrease and return of the FHR associated with a uterine contraction • A gradual FHR decrease is defined as from the onset to the FHR nadir of 30 seconds or more. • The decrease in FHR is calculated from the onset to the nadir of the deceleration. • The deceleration is delayed in timing, with the nadir of the deceleration occurring after the peak of the contraction. • In most cases, the onset, nadir, and recovery of the deceleration occur after the beginning, peak, and ending of the contraction, respectively.
Variable deceleration	• Visually apparent abrupt decrease in FHR • An abrupt FHR decrease is defined as from the onset of the deceleration to the beginning of the FHR nadir of less than 30 seconds. • The decrease in FHR is calculated from the onset to the nadir of the deceleration. • The decrease in FHR is 15 beats per minute or greater, lasting 15 seconds or greater, and less than 2 minutes in duration. • When variable decelerations are associated with uterine contractions, their onset, depth, and duration commonly vary with successive uterine contractions.
Prolonged deceleration	• Visually apparent decrease in the FHR below the baseline • Decrease in FHR from the baseline that is 15 beats per minute or more, lasting 2 minutes or more but less than 10 minutes in duration. • If a deceleration lasts 10 minutes or longer, it is a baseline change.
Sinusoidal pattern	• Visually apparent, smooth, sine wave-like undulating pattern in FHR baseline with a cycle frequency of 3–5 per minute which persists for 20 minutes or more.

Abbreviation: FHR, fetal heart rate.

Macones GA, Hankins GD, Spong CY, Hauth J, Moore T. The 2008 National Institute of Child Health and Human Development workshop report on electronic fetal monitoring: update on definitions, interpretation, and research guidelines. Obstet Gynecol 2008;112:661–6.

Three-Tiered Fetal Heart Rate Interpretation System

Category I

- Category I FHR tracings include all of the following:
- Baseline rate: 110–160 beats per minute
- Baseline FHR variability: moderate
- Late or variable decelerations: absent
- Early decelerations: present or absent
- Accelerations: present or absent

Category II

Category II FHR tracings includes all FHR tracings not categorized as Category I or Category III. Category II tracings may represent an appreciable fraction of those encountered in clinical care. Examples of Category II FHR tracings include any of the following:

Baseline rate

- Bradycardia not accompanied by absent baseline variability
- Tachycardia

Baseline FHR variability

- Minimal baseline variability
- Absent baseline variability with no recurrent decelerations
- Marked baseline variability

Accelerations

- Absence of induced accelerations after fetal stimulation

Periodic or episodic decelerations

- Recurrent variable decelerations accompanied by minimal or moderate baseline variability
- Prolonged deceleration more than 2 minutes but less than10 minutes
- Recurrent late decelerations with moderate baseline variability
- Variable decelerations with other characteristics such as slow return to baseline, overshoots, or "shoulders"

Category III

Category III FHR tracings include either

- Absent baseline FHR variability and any of the following:
  - –Recurrent late decelerations
  - –Recurrent variable decelerations
  - –Bradycardia
- Sinusoidal pattern

Abbreviation: FHR, fetal heart rate

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abnormal FHR pattern may include but are not limited to provision of maternal oxygen, change in maternal position, discontinuation of labor stimulation, treatment of maternal hypotension, and treatment of tachysystole with FHR changes. If a Category III tracing does not resolve with these measures, delivery should be undertaken.

Guidelines for Review of Electronic Fetal Heart Rate Monitoring

When EFM is used during labor, the nurses or physicians should review it frequently. In a patient without complications, the FHR tracing should be reviewed approximately every 30 minutes in the first stage of labor and every 15 minutes during the second stage. The corresponding frequency for patients with complications (eg, fetal growth restriction, preeclampsia) is approximately every 15 minutes in the first stage of labor and every 5 minutes during the second stage. Health care providers should periodically document that they have reviewed the tracing. The FHR tracing, as part of the medical record, should be labeled and available for review if the need arises. Computer storage of the FHR tracing that does not permit overwriting or revisions is reasonable, as is microfilm recording.

Clinical Considerations and Recommendations

▶ *How efficacious is intrapartum electronic fetal heart rate monitoring?*

The efficacy of EFM during labor is judged by its ability to decrease complications, such as neonatal seizures, cerebral palsy, or intrapartum fetal death, while minimizing the need for unnecessary obstetric interventions, such as operative vaginal delivery or cesarean delivery. There are no randomized clinical trials to compare the benefits of EFM with any form of monitoring during labor (7). Thus, the benefits of EFM are gauged from reports comparing it with intermittent auscultation.

A meta-analysis synthesizing the results of the randomized clinical trials comparing the modalities had the following conclusions (8):

- The use of EFM compared with intermittent auscultation increased the overall cesarean delivery rate (relative risk [RR], 1.66; 95% confidence interval [CI], 1.30–2.13) and the cesarean delivery rate for abnormal FHR or acidosis or both (RR, 2.37; 95% CI, 1.88–3.00).

- The use of EFM increased the risk of both vacuum and forceps operative vaginal delivery (RR, 1.16; 95% CI, 1.01–1.32).
- The use of EFM did not reduce perinatal mortality (RR, 0.85; 95% CI, 0.59–1.23).
- The use of EFM reduced the risk of neonatal seizures (RR, 0.50; 95% CI, 0.31–0.80).
- The use of EFM did not reduce the risk of cerebral palsy (RR, 1.74; 95% CI, 0.97–3.11).

There is an unrealistic expectation that a nonreassuring FHR tracing is predictive of cerebral palsy. The positive predictive value of a nonreassuring pattern to predict cerebral palsy among singleton newborns with birth weights of 2,500 g or more is 0.14%, meaning that out of 1,000 fetuses with a nonreassuring FHR pattern, only one or two will develop cerebral palsy (9). The false-positive rate of EFM for predicting cerebral palsy is extremely high, at greater than 99%.

Available data, although limited in quantity, suggest that the use of EFM does not result in a reduction in cerebral palsy (8). This is consistent with data that suggest that the occurrence of cerebral palsy has been stable over time, despite the widespread introduction of EFM (10). The principal explanation for why the prevalence of cerebral palsy has not diminished despite the use of EFM is that 70% of cases occur before the onset of labor; only 4% of cases of encephalopathy can be attributed solely to intrapartum events (11, 12).

Given that the available data do not show a clear benefit for the use of EFM over intermittent auscultation, either option is acceptable in a patient without complications. Logistically, it may not be feasible to adhere to guidelines for how frequently the heart rate should be auscultated. One prospective study noted that the protocol for intermittent auscultation was successfully completed in only 3% of the cases (13). The most common reasons for unsuccessful intermittent auscultation included the frequency of recording and the requirements for recording.

Intermittent auscultation may not be appropriate for all pregnancies. Most of the clinical trials that compare EFM with intermittent auscultation have excluded participants at high risk of adverse outcomes, and the relative safety of intermittent auscultation in such cases is uncertain. The labor of women with high-risk conditions (eg, suspected fetal growth restriction, preeclampsia, and type 1 diabetes) should be monitored with continuous FHR monitoring.

There are no comparative data indicating the optimal frequency at which intermittent auscultation should be performed in the absence of risk factors. One method is to evaluate and record the FHR at least every 15 minutes in the active phase of the first stage of labor and at least every 5 minutes in the second stage (14).

▶ *What is the interobserver and intraobserver variability of intrapartum electronic fetal heart rate monitoring assessment?*

There is high interobserver and intraobserver variability in the interpretation of FHR tracings. For example, when four obstetricians examined 50 cardiotocograms, they agreed in only 22% of the cases (15). Two months later, during the second review of the same 50 tracings, the clinicians interpreted 21% of the tracings differently than they did during the first evaluation. In another study, five obstetricians independently interpreted 150 cardiotocograms (16). The obstetricians interpreted the tracings similarly in 29% of the cases, suggesting poor interobserver reliability.

The interpretation of cardiotocograms is more consistent when the tracing is normal (17). With retrospective reviews, the foreknowledge of neonatal outcome may alter the reviewer's impressions of the tracing. Given the same intrapartum tracing, a reviewer is more likely to find evidence of fetal hypoxia and criticize the obstetrician's management if the outcome was poor versus good (18). Therefore, reinterpretation of the FHR tracing, especially if neonatal outcome is known, may not be reliable.

▶ *When should the very preterm fetus be monitored?*

The decision to monitor the very preterm fetus requires a discussion between the obstetrician, pediatrician, and patient concerning the likelihood of survival or severe morbidity of the preterm child (based on gestational age, estimated fetal weight, and other factors) and issues related to mode of delivery. If a patient undergoes a cesarean delivery for indications related to a preterm fetus, continuous monitoring should be used rather than intermittent auscultation. The earliest gestational age that this will occur may vary.

Nonreassuring FHR patterns may occur with up to 60% of women with preterm labor, with the most common abnormality being deceleration and bradycardia, followed by tachycardia and minimal or absent baseline variability (19). Variable decelerations are more common among preterm (55–70%) deliveries than term (20–30%) deliveries (20). If FHR abnormalities are persistent, intrauterine resuscitation, ancillary tests to ensure fetal well-being, and possibly delivery should be undertaken (21).

▶ *What medications can affect the fetal heart rate?*

Fetal heart rate patterns can be influenced by the medications administered in the intrapartum period. Most often, these changes are transient, although they sometimes lead to obstetric interventions.

Epidural analgesia with local anesthetic agents (ie, lidocaine, bupivacaine) can lead to sympathetic blockade, maternal hypotension, transient uteroplacental insufficiency, and alterations in the FHR. Parenteral narcotics also may affect the FHR. A randomized trial comparing epidural anesthesia with 0.25% of bupivacaine and intravenous meperidine reported that the variability was decreased, and FHR accelerations were significantly less common with parenteral analgesia compared with regional analgesia (22). The rates of decelerations and cesarean delivery for "nonreassuring" FHR tracings were similar for the two groups. A systematic review of five randomized trials and seven observational studies also noted that the rate of cesarean delivery for nonreassuring FHR was similar between those who did and those who did not receive epidural analgesia during labor (23).

Concern has been raised about combined spinal–epidural anesthesia during labor. An intent-to-treat analysis of 1,223 laboring women randomized to combined spinal–epidural anesthesia (10 mcg of intrathecal sufentanil, followed by epidural bupivacaine and fentanyl at the next request for analgesia) or intravenous meperidine (50 mg on demand, maximum 200 mg in 4 hours) noted a significantly higher rate of bradycardia and emergent cesarean delivery for abnormal FHR in the group randomized to combined spinal–epidural anesthesia (24). Neonatal outcome, however, was not significantly different between the two groups. There are some methodological concerns with this study. Another randomized controlled trial compared the occurrence of FHR tracing abnormalities in laboring women who received combined spinal–epidural anesthesia (n=41) to epidural anesthesia (n=46). In this study, FHR abnormalities were more common in women receiving combined spinal–epidural anesthesia (25). Additional trials are necessary to determine the potential safety and efficacy of the combined spinal–epidural technique.

Other medications that influence FHR tracing have been studied (see Table 2). Of note, multiple regression analysis indicated that decreased variability attributed to the use of magnesium sulfate was related to early gestational age but not the serum magnesium level (26). Studies report different findings with regard to the effect of magnesium on FHR patterns. Some show no independent effect; others show small changes in baseline or variability. In general, however, caution should be used in ascribing unfavorable findings on EFM to the use of magnesium alone.

Transient sinusoidal FHR patterns occurred in 75% of patients who received butorphanol during labor, but this was not associated with adverse outcomes (27). Fetuses exposed to cocaine did not exhibit any characteristic changes in the heart rate pattern, although they did have frequent contractions even when labor was unstimulated (28). As determined by computer analysis of cardiotocograms, a randomized trial reported that compared with meperidine, nalbuphine used for intrapartum analgesia decreased the likelihood of two 15-second accelerations over 20 minutes (29). In antepartum patients, administration of morphine decreased not only the fetal breathing movement but also the number of accelerations (30).

The effect of corticosteroids, which are used to enhance pulmonary maturity of fetuses during preterm labor, on FHR has been studied (Table 2). Among twins (31) and singletons (32, 33), the use of betamethasone transiently decreased the FHR variability, which returned to pretreatment status by the fourth to seventh day. There also may be a decrease in the rate of accelerations with the use of betamethasone. These changes, however, were not associated with increased obstetric interventions or with adverse outcomes (31). The biologic mechanism of this is unknown. Computerized analysis of the cardiotocograms indicates that use of dexamethasone is not associated with a decrease in the FHR variability (33).

▶ *What findings on EFM are consistent with normal fetal acid–base status?*

The presence of FHR accelerations generally ensures that the fetus is not acidemic. The data relating FHR variability to clinical outcomes, however, are sparse. Results of an observational study suggest that moderate FHR variability is strongly associated with an arterial umbilical cord pH higher than 7.15 (34). One study reported that in the presence of late or variable decelerations, the umbilical arterial pH was higher than 7.00 in 97% of the cases if the FHR tracing had normal variability (35). In another retrospective study, most cases of adverse neonatal outcome demonstrated normal FHR variability (36). This study is limited because it did not consider other characteristics of the FHR tracing, such as the presence of accelerations or decelerations. However, in most cases, normal FHR variability provides reassurance about fetal status and the absence of metabolic acidemia.

Table 2. Effects of Commonly Used Medications on Fetal Heart Rate Patterns

Medications	Comments	References
Narcotics	At equivalent doses, all narcotics (with or without added antiemetics) have similar effects: a decrease in variability and a decrease in the frequency of accelerations 75 mg meperidine = 10 mg morphine = 0.1 mg fentanyl = 10 mg nalbuphine	1–7
Butorphanol	Transient sinusoidal FHR pattern, slight increased mean heart rate compared with meperidine	8, 9
Cocaine	Decreased long-term variability	10, 11
Corticosteroids	Decrease in FHR variability with beta-methasone but not dexamethasone, abolishment of diurnal fetal rhythms, increased effect at greater than 29 weeks of gestation	12–15
Magnesium sulfate	A significant decrease in short-term variability, clinically insignificant decrease in FHR, inhibits the increase in accelerations with advancing gestational age	16, 17
Terbutaline	Increase in baseline FHR and incidence of fetal tachycardia	18, 19
Zidovudine	No difference in the FHR baseline, variability, number of accelerations, or decelerations	20

Abbreviation: FHR, fetal heart rate.

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▶ *Are there ancillary tests that can aid in the management of Category II or Category III fetal heart rate tracings?*

There are some ancillary tests available that help to ensure fetal well-being in the face of a Category II or Category III FHR tracing, thereby reducing the high false-positive rate of EFM.

In the case of an EFM tracing with minimal or absent variability and without spontaneous acceleration, an effort should be made to elicit one. A meta-analysis of 11 studies of intrapartum fetal stimulation noted that four techniques are available to stimulate the fetus: 1) fetal scalp sampling, 2) Allis clamp scalp stimulation, 3) vibroacoustic stimulation, and 4) digital scalp stimulation (37). Because vibroacoustic stimulation and digital scalp stimulation are less invasive than the other two methods, they are the preferred methods. When there is an acceleration following stimulation, acidemia is unlikely and labor can continue.

When a Category III FHR tracing is persistent, a scalp blood sample for the determination of pH or lactate may be considered. However, the use of scalp pH assessment has decreased (38), and this test may not even be available at some tertiary hospitals (39). There are likely many reasons for this decrease, including physician experience, difficulty in obtaining and processing an adequate sample in a short amount of time, and the need for routine maintenance and calibration of laboratory equipment that may be used infrequently. More importantly, scalp stimulation, which is less invasive, provides similar information about the likelihood of fetal acidemia as does scalp pH.

In one study, the sensitivity and positive predictive value of a low scalp pH (defined in the study as less than 7.21 because it is the 75th percentile) to predict umbilical arterial pH less than 7.00 was 36% and 9%, respectively (40). More importantly, the sensitivity and positive predictive value of a low scalp pH to identify a newborn with hypoxic–ischemic encephalopathy was 50% and 3%, respectively. However, the greater utility of scalp pH is in its high negative predictive value (97–99%). There are some data to suggest that fetal scalp lactate levels have higher sensitivity and specificity than scalp pH (40). However, a recent large randomized clinical trial that compared the use of scalp pH assessment to scalp lactate level assessment in cases of intrapartum fetal distress did not demonstrate a difference in the rate of acidemia at birth, Apgar scores, or neonatal intensive care unit admissions (41). Although scalp stimulation has largely replaced scalp pH and scalp lactate assessment in the United States, if available, these tests may provide additional information in the setting of a Category III tracing.

Pulse oximetry has not been demonstrated to be a clinically useful test in evaluating fetal status (42–44).

▶ *Are there methods of intrauterine resuscitation that can be used for Category II or Category III tracings?*

A Category II or Category III FHR tracing requires evaluation of the possible causes. Initial evaluation and treatment may include the following:

- Discontinuation of any labor stimulating agent
- Cervical examination to determine umbilical cord prolapse, rapid cervical dilation, or descent of the fetal head
- Changing maternal position to left or right lateral recumbent position, reducing compression of the vena cava and improving uteroplacental blood flow
- Monitoring maternal blood pressure level for evidence of hypotension, especially in those with regional anesthesia (if present, treatment with volume expansion or with ephedrine or both, or phenylephrine may be warranted)
- Assessment of patient for uterine tachysystole by evaluating uterine contraction frequency and duration

Supplemental maternal oxygen commonly is used in cases of an indeterminate or abnormal pattern. There are no data on the efficacy or safety of this therapy. Often, the FHR patterns persist and do not respond to change in position or oxygenation. In such cases, the use of tocolytic agents has been suggested to stop uterine contractions and perhaps avoid umbilical cord compression. A meta-analysis reported the pooled results of three randomized clinical trials that compared tocolytic therapy (terbutaline, hexoprenaline, or magnesium sulfate) with untreated controls in the management of a suspected nonreassuring FHR tracing (45). Compared with no treatment, tocolytic therapy more commonly improved the FHR tracing. However, there were no differences in rates of perinatal mortality, low 5-minute Apgar score, or admission to the neonatal intensive care unit between the groups (possibly because of the small sample size). Thus, although tocolytic therapy appears to reduce the number of FHR abnormalities, there is insufficient evidence to recommend it.

Tachysystole with associated FHR changes can be successfully treated with β_2-adrenergic drugs (hexoprenaline or terbutaline). A retrospective study suggested that 98% of such cases respond to treatment with a β-agonist (46).

When the FHR tracing includes recurrent variable decelerations, amnioinfusion to relieve umbilical cord compression may be considered (47). A meta-analysis of 12 randomized trials that allocated patients to no treatment or transcervical amnioinfusion noted that placement of fluid in the uterine cavity significantly reduced the rate of decelerations (RR, 0.54; 95% CI, 0.43–0.68) and cesarean delivery for suspected fetal distress (RR, 0.35; 95% CI, 0.24–0.52) (48). Because of the lower rate of cesarean delivery, amnioinfusion also decreased the likelihood that either the patient or the newborn will stay in the hospital more than 3 days (48). Amnioinfusion can be done by bolus or continuous infusion technique. A randomized trial compared the two techniques of amnioinfusion and concluded that both have a similar ability to relieve recurrent variable decelerations (49).

Another common cause of a Category II or Category III FHR pattern is maternal hypotension secondary to regional anesthesia. If maternal hypotension is identified and suspected to be secondary to regional anesthesia, treatment with volume expansion or intravenous ephedrine or both is warranted.

Summary of Recommendations and Conclusions

The following recommendations and conclusions are based on good and consistent scientific evidence (Level A):

- The false-positive rate of EFM for predicting cerebral palsy is high, at greater than 99%.
- The use of EFM is associated with an increased rate of both vacuum and forceps operative vaginal delivery, and cesarean delivery for abnormal FHR patterns or acidosis or both.
- When the FHR tracing includes recurrent variable decelerations, amnioinfusion to relieve umbilical cord compression should be considered.
- Pulse oximetry has not been demonstrated to be a clinically useful test in evaluating fetal status.

The following conclusions are based on limited or inconsistent scientific evidence (Level B):

- There is high interobserver and intraobserver variability in interpretation of FHR tracing.
- Reinterpretation of the FHR tracing, especially if the neonatal outcome is known, may not be reliable.
- The use of EFM does not result in a reduction of cerebral palsy.

The following recommendations are based on expert opinion (Level C):

- A three-tiered system for the categorization of FHR patterns is recommended.
- The labor of women with high-risk conditions should be monitored with continuous FHR monitoring.
- The terms hyperstimulation and hypercontractility should be abandoned.

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The MEDLINE database, the Cochrane Library, and ACOG's own internal resources and documents were used to conduct a literature search to locate relevant articles published between January 1985 and January 2009. The search was restricted to articles published in the English language. Priority was given to articles reporting results of original research, although review articles and commentaries also were consulted. Abstracts of research presented at symposia and scientific conferences were not considered adequate for inclusion in this document. Guidelines published by organizations or institutions such as the National Institutes of Health and the American College of Obstetricians and Gynecologists were reviewed, and additional studies were located by reviewing bibliographies of identified articles. When reliable research was not available, expert opinions from obstetrician–gynecologists were used.

Studies were reviewed and evaluated for quality according to the method outlined by the U.S. Preventive Services Task Force:

I	Evidence obtained from at least one properly designed randomized controlled trial.
II-1	Evidence obtained from well-designed controlled trials without randomization.
II-2	Evidence obtained from well-designed cohort or case–control analytic studies, preferably from more than one center or research group.
II-3	Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments also could be regarded as this type of evidence.
III	Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.

Based on the highest level of evidence found in the data, recommendations are provided and graded according to the following categories:

Level A—Recommendations are based on good and consistent scientific evidence.

Level B—Recommendations are based on limited or inconsistent scientific evidence.

Level C—Recommendations are based primarily on consensus and expert opinion.

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