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# Electronic Fetal Heart Rate Monitoring

## *Where Are We Now?*

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**ABSTRACT**

Electronic fetal heart rate monitoring (EFM) continues to be the primary method utilized for fetal assessment in the United States. Standardization of nomenclature associated with this perinatal technology has evolved over the past 40 years such that the current nomenclature recommended by the National Institute of Child Health and Human Development (NICHD) has been adopted by professional perinatal organizations as the agreed-upon method for professional communication and documentation. Current research continues to focus on the optimal management of intrapartum fetal heart rate tracings. The clinical controversies and challenges related to electronic fetal heart rate monitoring continue to evolve.

**Key Words:** electronic fetal heart rate monitoring, management, NICHD, nomenclature

Electronic fetal heart rate monitoring (EFM) for antepartum and intrapartum evaluation of fetal status has been utilized for the last 40 years. It continues to be the most commonly used adjunct in the care of the approximately 4.2 million women who give birth in the United States each year.[1]

It is not possible to consider where we are now regarding EFM without an appreciable understanding of where we have been. As such, a brisk walk through EFM history is integral to the celebration of the *Journal of Perinatal and Neonatal Nursing*'s 25th anniversary issue regarding this subject. This brief review will focus on the historical highlights of the clinical application of EFM and discuss present and future expectations for EFM regarding the following: nomenclature systems that have been proposed and adopted over time, interpretation and documentation of data derived from EFM, research related to management algorithms that have been proposed for consideration to further identify the fetus who has a greater likelihood for the development of significant fetal acidemia, and recommendations regarding selected issues in EFM.

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## EVOLUTION OF EFM NOMENCLATURE

Early work in EFM nomenclature focused primarily on the research of 3 pioneer clinicians. In 1958, Edward Hon, MD, developed a method for continuous fetal heart rate (FHR) recording and described 3 patterns of decelerations: early, variable, and late, which were related to head compression, cord compression, and uteroplacental insufficiency, respectively.[2] Subsequently, in 1963, Hon improved the quality of FHR recording with the introduction of a fetal scalp electrode. Caldeyro-Barcia in 1966 defined the significance of similar FHR decelerations, named them type 1 and type II "dips," and proposed, for the first time, the concept of long- and short-term variability.[3] Also, in 1966, Hammacher first suggested that neonates demonstrating FHR late decelerations had lower Apgar scores after delivery and a higher stillbirth rate.[4] Finally, in 1969, Hammacher linked FHR accelerations to fetal well-being and further proposed a slightly different definition of variability but focused more on the significance of its association with the term "fetal distress."[4] Each of these researchers published reports on their respective observations of FHR patterns over years of study. As international interest grew, the first International Conferences for common nomenclature were convened in New Jersey in 1971 and in Amsterdam in 1972, where general agreement was accepted for a common nomenclature for periodic changes (early, late, and variable).[4]

Fast forward to the next chapter in the EFM nomenclature discussion. In an effort to improve

Table 1. **Definition of terms: NICHD 1997 (Ref 5)**

**Acceleration:** A visually apparent abrupt increase (defined as onset of acceleration to peak in <30 seconds) in FHR (fetal heart rate) above the baseline. The increase is calculated from the most recently determined portion of the baseline. The acme is ≥15 bpm 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 bpm above baseline, and a duration of ≥10 seconds. Prolonged acceleration is of duration ≥2 minutes and <10 minutes. Accelerations of ≥10 minutes in duration is a baseline change.

**Baseline** (FHRB)**:** The approximate mean FHR rounded to increments of 5 bpm during a 10-minute segment, excluding periodic or episodic changes, periods of marked FHR variability or segments of the baseline, which differ by >25 bpm. In any 10-minute window, the minimum baseline duration must be at least 2 minutes; otherwise, the baseline for that period is indeterminate.

**Baseline fetal heart rate variability:** Fluctuations in the baseline FHR of 2 cycles per minute or greater. The fluctuations are irregular in amplitude and frequency and are visually quantitated as the amplitude of the peak-to-trough in bpm as follows:

- Amplitude range undetectable—**absent** FHR variability
- Amplitude range > undetectable ≤ 5 bpm—**minimal** FHR variability:
- Amplitude range 6–25 bpm—**moderate** FHR variability
- Amplitude range >25 bpm–**marked** FHR variability

**Bradycardia:** Fetal heart rate baseline less than 110 bpm for at least 10 minutes.

**Decelerations**

**Early deceleration (early):** A visually apparent gradual decrease (defined as onset of deceleration to nadir ≥30 seconds) and return to baseline FHR associated with a uterine contraction. The decrease is determined from the most recently determined portion of the baseline. The nadir of the deceleration occurs at the same time as the peak of the contraction.

**Late deceleration (late):** A visually apparent gradual decrease (defined as onset of deceleration to nadir ≥30 seconds) and return to baseline FHR associated with a uterine contraction. The decrease is determined from the most recently determined potion of the baseline. The deceleration is delayed in timing, with the nadir of the deceleration occurring after the peak of the contraction.

**Prolonged deceleration:** A visually apparent decrease in FHR at least 15 bpm below the baseline, lasting ≥2 minutes but <10 minutes from onset to return to baseline.

**Variable deceleration (variable):** Visually apparent abrupt decrease (defined as onset of deceleration to beginning of nadir <30 seconds) in FHR below the baseline. The decrease in FHR (below the baseline) is at least 15 bpm below the baseline, lasting ≥15 seconds and ≤2 minutes from onset to return to baseline.

**Periodic pattern:** FHR changes, either accelerations or decelerations from the baseline lasting less than 10 minutes.

**Tachycardia:** baseline FHR greater than 160 bpm lasting for 10 minutes or longer.

communication between physicians and nurses responsible for the interpretation of EFM data, updated terminology and a new category system of assessment were introduced in the mid-1990s as a result of meetings with invited subject matter experts convened to discuss the issue. This initiative evolved from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) workshops whose goals were to develop standardized definitions for use in the interpretation of FHR tracings generated from continuous EFM. Their recommendations for FHR terminology were published in 1997 and are defined in Table 1.[5]

This nomenclature has since been endorsed by the American College of Obstetricians and Gynecologists, the Association of Women's Health Obstetric and Neonatal Nurses, and the American College of Nurse Midwives.[6–9]

Several years later, in 2004, the Joint Commission issued *Sentinel Event Alert No. 30, July 21, 2004: Preventing infant death and injury during delivery.* It specifically recommended that institutions should develop clear guidelines for fetal monitoring of potential high-risk patients, including protocols for the interpretation of fetal heart rate tracings and educate nurses, residents, nurse midwives, and physicians to use standardized terminology to communicate abnormal fetal heart rate tracings.[10]

A new NICHD workgroup (NICHD II) convened in 2008.[11] This group reviewed, affirmed, and refined the earlier EFM terminology for FHR decelerations noted in Table 1. The definition of sinusoidal FHR (a visually apparent, smooth, sine wavelike undulating pattern in the FHR with a cycle frequency of 3 to 5 per minute, which persists for 20 minutes or more) was added to previous descriptions and is depicted in Figure 1.

Pseudosinusoidal patterns were not defined. In addition, this group categorized FHR patterns for interpretation in clinical practice into 3 categories, which are depicted in Table 2. This 3-tiered nomenclature system utilizes categories I, II, and III to describe tracings that range from "normal" (category I), which is thought to rule out fetal metabolic acidemia, to the opposite end

Table 2. **Guideline: Fetal heart rate and uterine activity monitoring**[4–9,11,12,14]

**Level: Interdependent**

Guideline objectives

- Define FHR (fetal heart rate) patterns for visual interpretation that have been produced from either a direct fetal electrode detecting the fetal electrocardiogram or an external Doppler device detecting the fetal heart rate events with use of the autocorrelation technique.
- Define parameters for auditory assessment of the FHR in low-risk women during childbirth.
- To provide a format for evaluation of FHR patterns in context with gestational age, prior results of fetal assessment, medications, maternal medical, and fetal conditions (eg, growth restriction, known congenital anomalies, fetal anemia, arrhythmia, etc).
- Outline the management of FHR information obtained from auditory and/or electronic fetal monitoring assessments.

I. Methods of fetal heart rate monitoring

A. Auscultation—Generally involves intermittent assessment of the FHR and may be accomplished by Doppler, ultrasound transducer, or fetoscope. The FHR is auscultated for a full 60 seconds and the rate is counted in beats per minute. If the patient is in labor, the FHR is auscultated before, during, and after a uterine contraction at the appropriate time intervals. Intermittent auscultation may not be appropriate for all pregnancies (eg, laboring women with "risk" factors).

B. Electronic fetal monitoring may be accomplished by the following 2 methods

1. External appliances
   a. Doppler ultrasound transducer permits evaluation of baseline FHR, baseline variability (FHRV), and the presence or absence of periodic patterns.
   b. Tocodynamometer permits evaluation of uterine contraction (UC) frequency and approximate duration. Intensity of the UC and resting tone must be estimated by abdominal palpation.
2. Internal appliances
   a. Direct fetal electrode (FECG) detecting the fetal electrocardiogram permits evaluation of baseline FHR, FHRV and the presence or absence of periodic patterns.
   b. Intrauterine pressure catheter (IUPC) permits evaluation of contraction frequency, intensity, duration and uterine resting tone. Uterine activity may also be quantified by calculation of Montevideo units (MVU). Research indicates that 180–250 MVUs should allow normal progression along labor curves.

II. Assessment Parameters

A. Auscultation

1. FHR assessment includes the following:
   a. Rate in beats per minute
   b. Presence/absence of audible decelerations or accelerations
2. Uterine activity assessment may be completed at the time of FHR assessment and includes palpation of frequency, duration and intensity of uterine contractions, along with palpation of uterine resting tone.
3. 1:1 nurse to patient ratio should be provided

B. EFM (Electronic fetal heart rate monitoring)—during intermittent or continuous EFM, the following parameters are assessed:

1. FHR
   a. Baseline rate
   b. Baseline variability
   c. Presence/absence or periodic patterns (accelerations or decelerations)
2. Uterine activity
   a. Frequency, duration and intensity of uterine contractions
   b. Uterine resting tone

III. Frequency of Assessment during the Intrapartum Period

A. Auscultation

1. Active first stage of labor—every 15 minutes
2. Second stage of labor—every 5 minutes

B. EFM

| | "Low Risk" Status | "High Risk" Status |
|---|---|---|
| Active phase | Q 30 minutes | Q 15 minutes |
| Second stage | Q 15 minutes | Q 5 minutes |

IV. Interpretation of data

A. Auscultation

1. Reassuring FHR
   Baseline rate between 110 and 160 bpm
   Presence of audible accelerations
   Absence of audible decelerations
   Regular rhythm

(*continues*)

Table 2. (***Continued***)

| | |
|---|---|
| 2. Nonreassuring FHR<br>Abnormal baseline rate <110 bpm or >160 bpm<br>Audible decelerations with or without uterine activity<br>Irregular rhythm | |
| B. EFM—3-tier system | |
| Category I *Normal* | √ Strongly predictive of normal fetal acid base status at the time of observation<br>Baseline rate 110–160 bpm<br>Baseline FHR variability moderate<br>Late or variable decelerations absent<br>Early decelerations present or absent<br>Accelerations present or absent |
| Category II *Indeterminate* | √ Not predictive of abnormal fetal acid-base status; not adequate evidence to classify into category I or III<br>Bradycardia or tachycardia not accompanied by absent baseline variability<br>Minimal or marked baseline variability<br>Absent baseline variability without recurrent decelerations<br>Absence of induced accelerations after fetal stimulation<br>Recurrent variable decelerations accompanied by minimal or moderate baseline variability<br>Prolonged deceleration<br>Recurrent late decelerations with moderate baseline variability<br>Variable decelerations with other characteristics such as slow return to baseline, overshoots or shoulders |
| Category III *Abnormal* | √ Predictive of abnormal fetal acid base status at the time of observation<br>Absent baseline FHR variability and any of the following:<br>Recurrent late decelerations<br>Recurrent variable decelerations<br>Bradycardia<br>Sinusoidal pattern |
| V. Management Considerations | |
| A. Auscultation | |
| 1. Normal FHR responses—Continue assessment at appropriate intervals | |
| 2. Indeterminate FHR responses—Initiate continuous EFM. Further interventions are dependent upon subsequent EFM assessment, diagnosis, gestational age of the fetus, and maternal status. | |
| B. EFM—3-tier system | |
| Category I<br>*Normal* | Action<br>Routine management |
| Category II<br>*Indeterminate* | Action<br>Continue surveillance<br>Intrauterine fetal supportive techniques may include, but are not limited to<br>maternal lateral positioning<br>maternal oxygen administration<br>intravenous fluid bolus of 500–1000 mL Lactated Ringers solution<br>reduce uterine activity by decreasing or discontinuing uterine stimulants (eg, oxytocin, cervical ripening agents) if indicated<br>alleviate umbilical cord compression evidenced by variable decelerations or FHR bradycardia with initiation of amnioinfusion, elevate presenting part if indicated while preparing for operative delivery<br>If no improvement or FHR tracing progresses to Category III, consider delivery |

(*continues*)

Table 2. (***Continued***)

| | |
|---|---|
| Category III<br>*Abnormal* | Action<br>Prepare for delivery<br>Intrauterine fetal supportive techniques |
| VI. Consultation with the primary care provider should be considered for the following:<br>Significant maternal system assessment findings<br>Sustained BP readings >140/90 or <80/40<br>Sustained maternal heart rate >120 or <60<br>Maternal temperature >100.4<br>Vaginal bleeding greater than bloody show<br>Pain unrelieved by prescribed therapy<br>Imminent delivery<br>Cord prolapse<br>Category II FHR patterns not resolved with intrauterine fetal supportive techniques<br>Category III/abnormal FHR patterns | |
| VII. Patient/family education<br>Plan of care<br>Unit routine<br>Method of fetal monitoring<br>Interventions | |

of the spectrum (category III) with tracings considered to be "abnormal" and most consistently associated with fetal acidemia.[11]

Category II is the largest of the 3 categories and represents those patterns whose characteristics meet neither category I nor category III criteria. As such, it is referred to as "indeterminate," because it is inconsistently associated with fetal acidemia.[11] Examples of each category can be found in Figure 2. While this 3-tiered template addresses a majority of EFM categories, it is important to note that it does not specifically address all patterns that may be seen in clinical practice or a "requirement" for the presence of accelerations of the FHR throughout labor.

The NICHD II committee further recommended that descriptive terms for uterine activity such as "hyperstimulation" and "hypercontractility" not be used, because both are imprecise and nonspecific. Rather, the term "tachysystole" is recommended for use to describe uterine activity (contractions) that exceeds normal intervals (*greater than 5 contractions in a 10-minute window, evaluated more than 3 consecutive 10-minute*

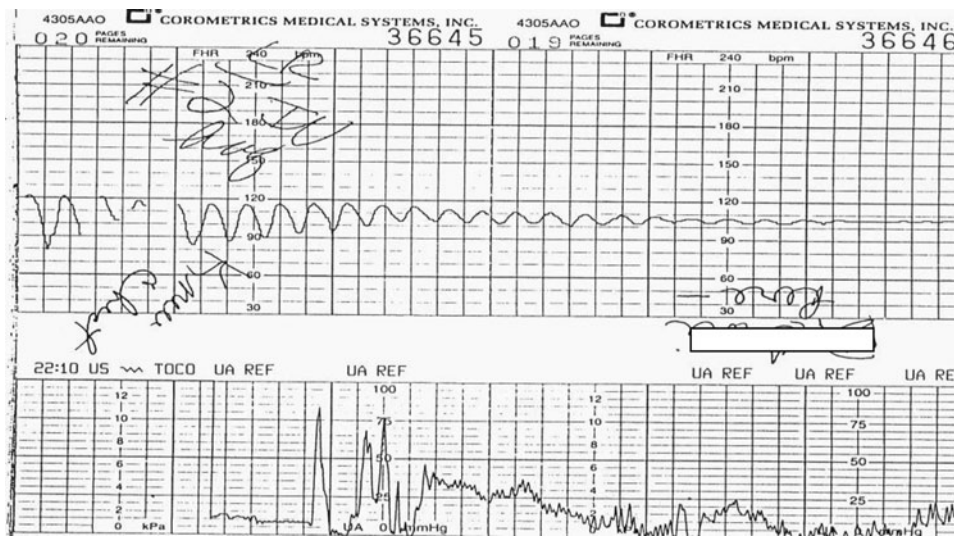
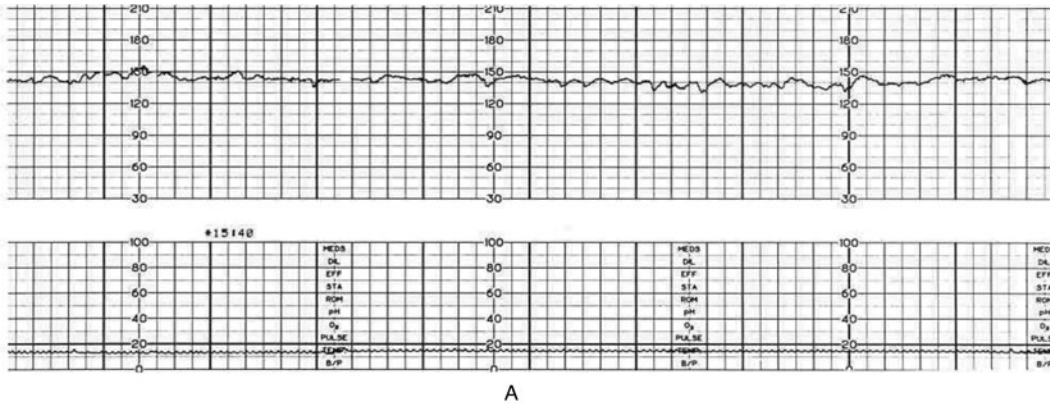



**Figure 1.** Sinusoidal fetal heart rate.



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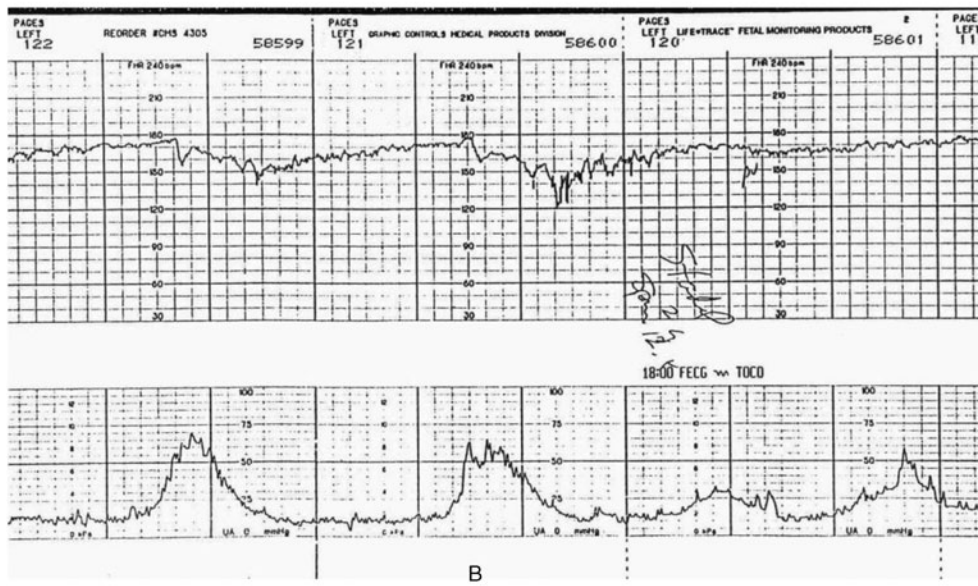


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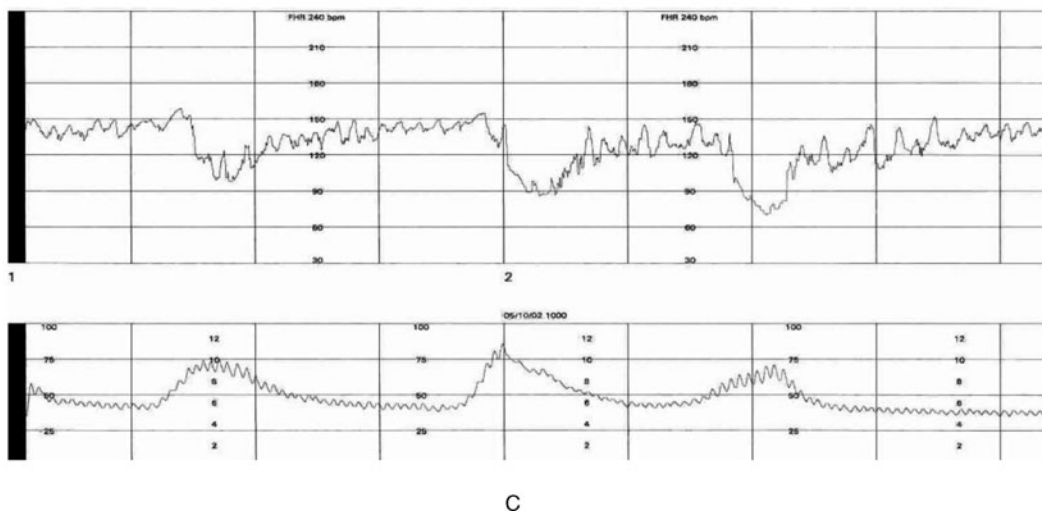

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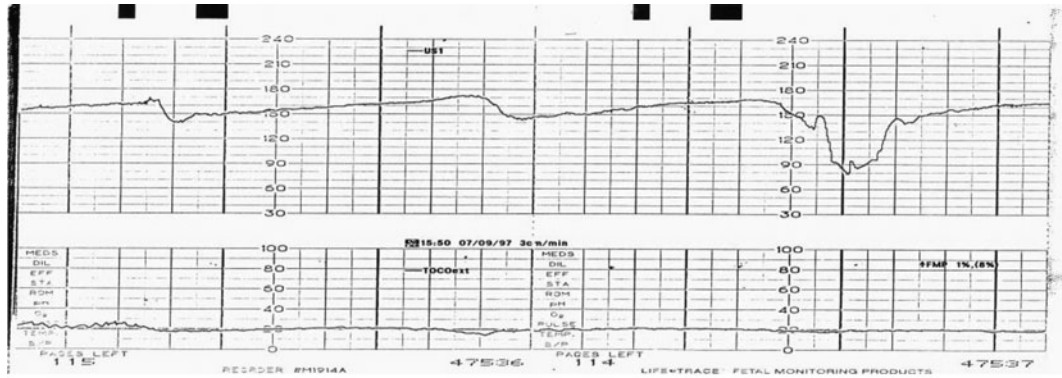
**Figure 2.** Examples of category I, II, III fetal heart rate strips. **A,** Category I. Normal interpretation: Normal baseline rate with moderate variability. **B,** Category II. Indeterminate interpretation: Fetal tachycardia with moderate variability and late decelerations. **C,** Category II. Indeterminate interpretation: Normal baseline rate, moderate variability with recurrent variable decelerations. **D,** Category III. Abnormal interpretation: Absent baseline variability with recurrent prolonged decelerations. **E,** Category III. Abnormal interpretation: Absent baseline variability with recurrent late decelerations.

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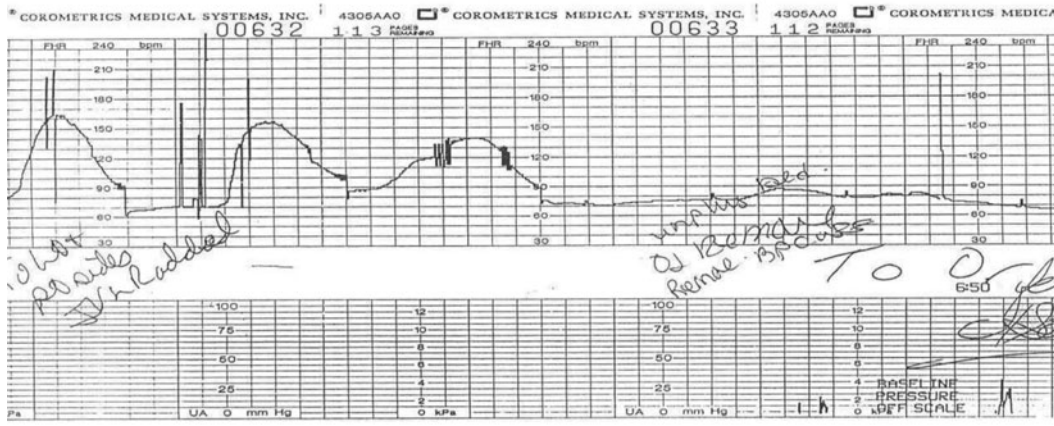


E

**Figure 2.** (*Continued*)

*windows*).[11] In addition, when tachysystole is identified, an associated change or lack of change in the FHR should be noted, as depicted in Figure 3.

Finally, decelerations are to be described in general as "repetitive" if they occur with greater than 50% of uterine contractions and "intermittent" if they occur with less than 50% of uterine contractions in any 20-minute window.[11]

## CLINICAL MANAGEMENT

Despite numerous attempts in the past 30 years by the obstetric community to define and classify EFM parameters, interobserver variability remains with providers debating interpretation and management of various patterns.[12,13] In 2007, Parer and Ikeda identified 134 FHR patterns, which were classified by baseline rate, baseline variability, and type of deceleration and evaluated each pattern for the risk of associated acidemia. The findings were color-coded such that green was associated with no threat of acidemia (no intervention required) to the color red suggesting a severe threat of acidemia (rapid delivery recommended).[12] The 3 intermediate categories (blue, yellow, and orange) typify what is commonly encountered in clinical practice as the largest population of patients, represented by NICHD category II, who may require escalating levels of potential intervention depending upon the FHR tracing assessment, and the logistics, facilities, and personnel available.

In a recent publication, American College of Obstetricians and Gynecologists Practice Bulletin 116 reviewed the management of heart rate patterns on the basis of the NICHD 3-tiered classification system and discussed not only the category designation, but also suggested response(s) to tracings in each respective category as described in Table 2.[14] However, controversy remains regarding management of category II patterns, which represent approximately 80% of all variant patterns. Category II contains a broad spectrum of heterogeneous EFM patterns, based on variations in baseline rate, variability, and decelerations, some of which cause higher concern for the potential of fetal acidemia and progression to category III. As such, absent further subdivision of category II, management guidance remains imprecise and vague leaving the management of category II

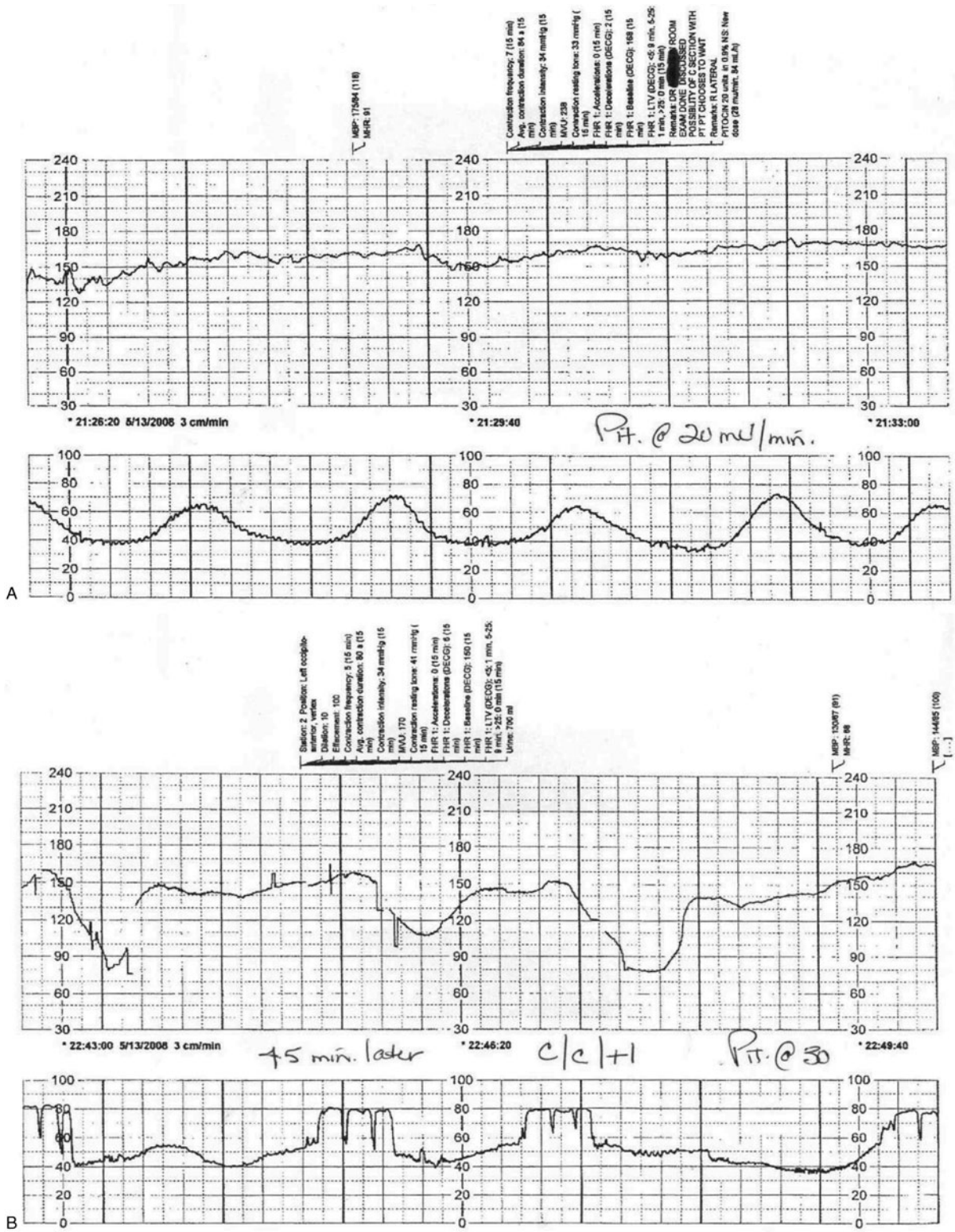


**Figure 3. A,** Uterine activity: Tachysystole: FHR: Category II. **B,** Uterine tachysystole: Fetal heart rate: Category III.

patterns up to the nurse and physician's judgment.[15] Therefore, some have questioned the 3-tiered system's ability to relate certain EFM patterns to degrees of acidemia and fetal damage, and support the use of a 5-tiered system with the subdivision of category II patterns.[15] A similar system has been described and utilized in Japan.[15]

If there is a question or concern regarding interpretation and/or management of EFM tracings, providers have a clearly defined escalation policy (chain of command) that may be followed to clarify interpretation and plan of care. Documentation regarding pattern specific intrauterine fetal supportive techniques implemented, the fetal response, and provider communication are integral to this process. Lastly, a qualified provider, who could intervene in case of an emergent situation and need for rapid response, may be identified (eg, an obstetrician) and communicated to the attending staff.[16]

## OTHER EFM CLINICAL CONSIDERATIONS

### Signal ambiguity

There has been recent attention drawn to the concept of signal ambiguity following unexpected outcome with external fetal heart rate monitoring. Improved sensitivity of electronic fetal monitors has resulted in an understandable decreased use of the internal fetal scalp electrode and greater reliance on external transducers. As a consequence, rare cases have been reported in which the fetal signal has been replaced by an alternative signal from the mother or a second (or more) fetus without the usual recognizable transition associated with such signal source shifting as demonstrated in Figure 4.

Masking of the fetal condition, without attending staff being alerted to the loss of fetal signal has occurred with and without adverse fetal outcome. For example, maternal tachycardia may be present with excursions of the maternal heart rate depicted in the fetal heart rate range despite the fact that the fetus actually has an abnormal FHR. As well, a depiction of what appear to be FHR accelerations during second stage labor bearing down efforts are most likely a representation of the maternal signal as a result of the maternal Valsalva maneuver and not that of the fetus (Figure 5 ). Because the fetal monitor's internal logic determines which signal is displayed as fetal, and when the mother's heart rate appears more like that of the fetus, the logic may cause a switch in the display.[17]

In addition, in a twin (or higher order) pregnancy, the monitor attempts to discriminate between multifetal heart rate signals and that of the mother. Examples of clinical situations where there may be a question of fetal versus maternal signal origin commonly include second stage labor with active pushing, use of beta mimetic medications, maternal anxiety, and maternal fever. To promote clinical confidence that the signal source is indeed fetal in origin, palpation of the maternal pulse in comparison to the FHR and/or ultrasound should be considered. While there is neither evidence for nor standards supporting the practice for routine utilization of additional technology such as placement of a fetal scalp electrode on the presenting fetus, maternal pulse oximetry monitoring or maternal electrocardiographic monitoring, these modalities are available as adjuncts in situations of potential signal ambiguity.[17]

### Artifact tolerance

Fetal surveillance via external means is frequently associated with periods of apparent absent tracing and/or artifact displayed on the tracing (despite the presence of audible FHR data). This is a common clinical occurrence and may result from maternal or fetal movement, in association with clinical intervention, transducer displacement, or electively as a result of the clinical decision to allow undisturbed maternal rest.[18] Occasionally, in medical-legal situations, the presence of what appears to be absent FHR tracing or artifact is alleged to represent the absence of clinician attention to monitoring of the FHR. In fact, this is often a clinical inevitability of external antepartum and intrapartum FHR monitoring that does not necessarily represent clinical disregard nor ability to audibly appreciate the FHR. The question often arises: How much artifact is acceptable to meet the standard of care? To make this decision, providers rely on an evidence-based approach, which incorporates exigencies of the individual clinical situation, clinical expertise, individualized needs of the woman, and current recommendations for best practice. Management may also be based on recent fetal surveillance, audible findings, maternal/fetal risk status, stage of labor, gestational age, and/or medication use.

### EFM of the preterm fetus

Monitoring fetal status can present challenges when caring for women during preterm labor. One challenge is the routine physician/midwife order for "continuous electronic fetal monitoring". As previously discussed, the nurse may have difficulty maintaining a continuous FHR tracing due to fetal size in early gestation, activity of the fetus, maternal body habitus, or positioning. The resulting signal loss requires frequent adjustments of external monitoring devices; it increases acuity and may limit maternal rest and comfort. In addition, stabilization of the mother's preterm labor status may occur and decrease frequency of assessment requirements and the need for continuous electronic fetal monitoring. Nurses

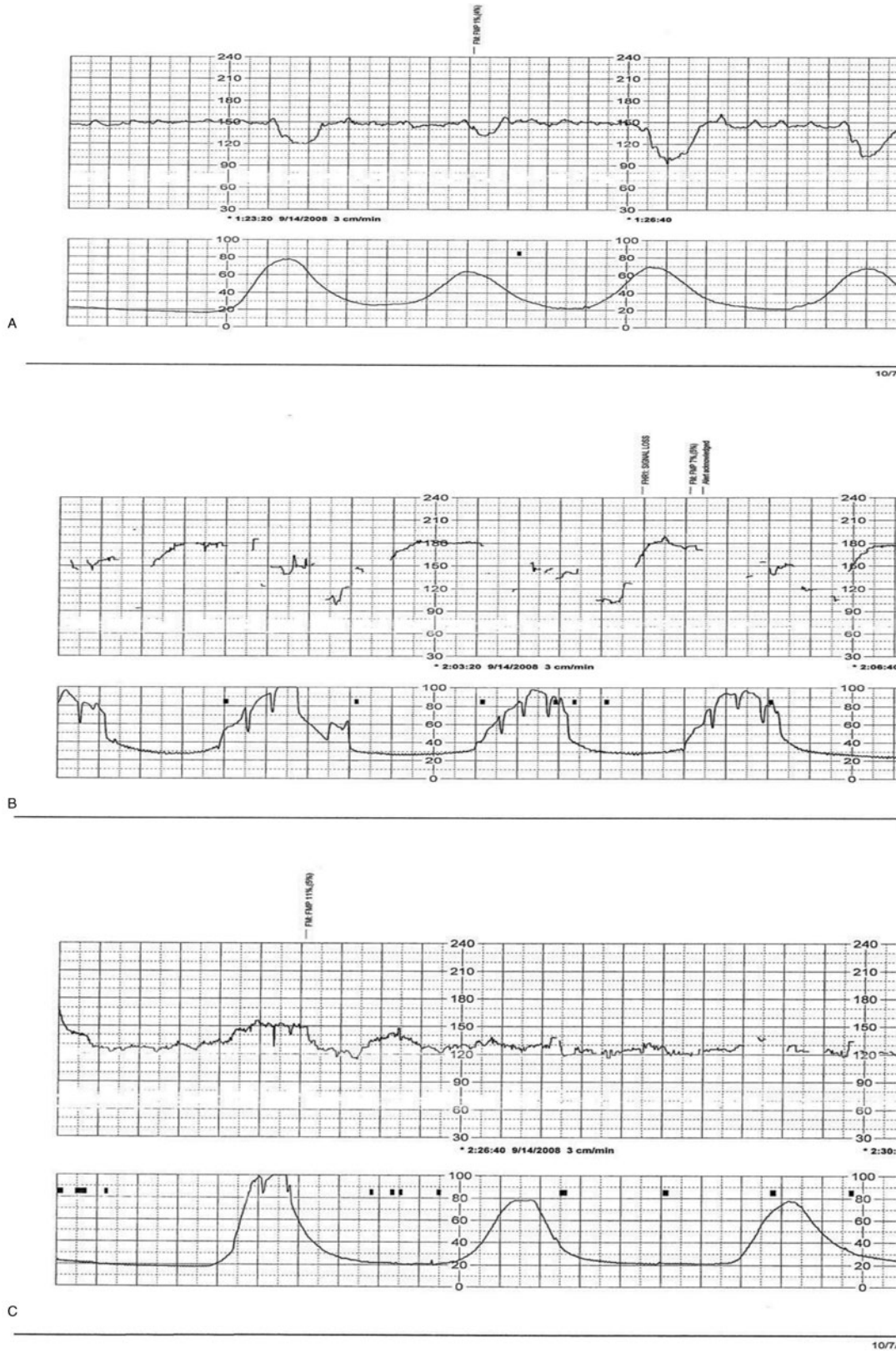


**Figure 4.** Maternal heart rate versus fetal heart rate. **A,** Fetal heart rate: Category II. **B,** Fetal heart rate: Category III. **C,** Conversion to maternal heart rate.

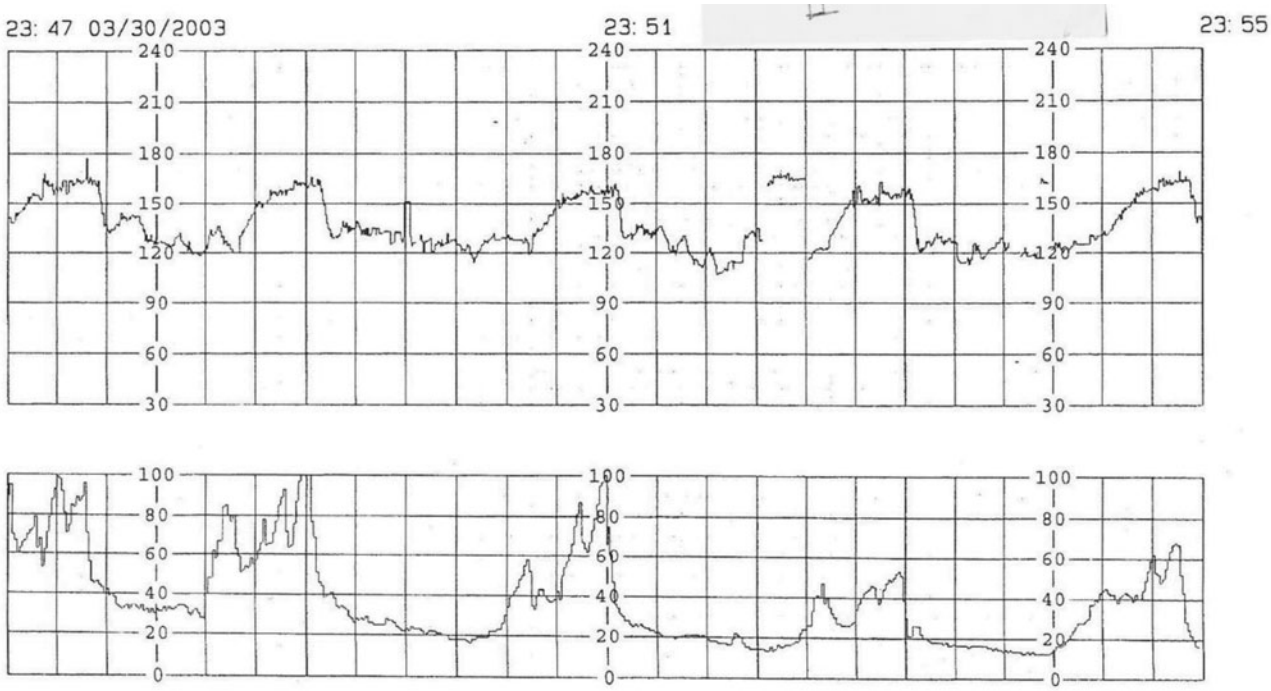


**Figure 5.** Signal ambiguity: Maternal heart rate: Second stage.

and physicians should construct a reasonable, individualized plan of care to balance maternal/fetal assessment requirements with maternal needs.

With the exception of accelerations, all other definitions of assessment parameters remain unchanged for the preterm fetus. Before 32 weeks' gestation, accelerations are defined as having an acme greater than 107nbsp;bpm above baseline, and a duration of greater than 10 seconds.[5] Accelerations in the preterm fetus may also be less frequent.[4] Therefore, time limits for nonstress testing may be extended up to 90 minutes. Even though physiologic development allows the sympathetic nervous system to dominate until approximately 28 weeks' gestation, baseline FHR normal range remains between 110 and 160 beats per minute. If fetal tachycardia occurs, providers should investigate potential causes such as hypoxia, maternal fever, intra-amniotic infection, or medication effects such as terbutabline.[17]

There is an increase in the occurrence of variable decelerations in the preterm fetus, even in the absence of uterine contractions. During labor and birth, there is an incidence of approximately 70% to 75% compared to the term fetus of approximately 30% to 50%.[19] In the presence of variable decelerations, the preterm FHR baseline variability may decrease at a more rapid rate. The combination of both variable decelerations and absent variability has been associated with lower Apgar scores and fetal acidosis at birth.[20] However, it is important to note that the Apgar score was intended as an assessment tool in the term neonate and is not a reliable indicator of metabolic acidemia in the preterm neonate.[4]

Medications given during episodes of preterm labor may influence observed FHR characteristics as well. Magnesium sulfate may cause a decrease in baseline variability and fewer accelerations.[21–23] Corticosteroids may cause increased fetal movement resulting in accelerations for up to 24 hours after administration. This may be followed by nonpathologic periods of decreased fetal movement and accelerations during the next 96 hours.[24,25] Lastly, pain medications or sedatives for sleep may decrease baseline variability and the occurrence of FHR accelerations.

## Monitoring multiples

The increase in the incidence of multifetal gestations over the last 20 years has intensified the clinical challenge to electronically monitor multiple fetuses. Approximately 5% of pregnancies among women aged 35 to 44 years, and more than 20% of women aged 45 years and older (many due to the use of assisted reproductive technologies), result in multiple gestations.[26] As previously discussed, EFM attempts to discriminate between multiple fetal heart rates. Ultrasound may be utilized to locate each fetus and maximize the likelihood of securing independent tracings. Designation of "Twin A" is usually for the fetus in the lowest portion of the pelvis.

Dual-channel electronic fetal monitors allow simultaneous heart rate recordings, which display each FHR in a different color and/or one in a bold line and the other in a faint line. Some electronic monitors utilize discrimination technology that uses printing of signal marks on the tracing, separate monitoring scales, or artificial separation of single-scale tracings into 2 separate tracings.[27] Each FHR should be clearly labeled to correlate with the monitoring method and allow differentiation between or among fetuses to avoid the phenomenon of fetal synchronicity associated with monitoring multiples. Documentation should include a description of each fetal heart rate tracing. There is no standard requiring separate EFM monitors to evaluate each fetus.

### Interprofessional education

Training to qualify providers for appropriate and consistent interpretation of EFM patterns should be standardized and cross all disciplines.[23] Most clinical agencies require nursing providers to attend continuing education courses or provide evidence of competency in EFM interpretation and management. However, physicians and midwives may not have the same requirement for credentialing privileges. Providers may attend dissimilar education programs with differing curriculum and course faculty. The program may have a specific focus for one group of providers. All of these scenarios increase the likelihood for variances. From a patient safety perspective, an interprofessional training program would standardize and increase knowledge, skills, and attitudes for interpretation and management of EFM patterns. There are many interactive online EFM training programs and certifications available.[16] Agency-specific training provides opportunity for "team building" and enhanced provider communication. However achieved, comprehensive, uniform training that incorporates standard terminology and management needs to occur. Demonstration of skills through simulation, testing, or credentialing/certification; ongoing collaborative strip review sessions; and mentoring may also be utilized by some clinical agencies to advance or maintain skills.

## SUMMARY

Electronic fetal heart rate monitoring interpretation has evolved now with standard, defined nomenclature for assessment parameters. Utilization of the defined terms across all disciplines optimizes interprofessional communication and documentation. However, other challenges in the interpretation of fetal heart rate monitoring data remain such as electronic monitoring of preterm and multiple gestations, reconciling tracing artifact, and recognizing maternal versus FHR in labor.

Electronic fetal heart rate monitoring interpretation and management, in the context of assessment of maternal status, is a multidisciplinary responsibility. Future NICHD task force recommendations will assist the provider to determine management strategies for indeterminate (category II) FHR patterns.

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