Fetal Well Being

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Course Description:

This course will help the participants identify hypoxemia and acidosis in an unborn fetus based upon fetal heart rate (FHR) monitoring to avoid fetal neurologic injury. The participants will be aware of measures needed to ensure a safe outcome so measures can be rapidly implemented.

Approximate Time to Complete: 60 minutes

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This course will:

- Help participants develop sound clinical judgment in the delivery of health care setting when concerns are suspected in regards to fetal well-being.

- Expand participant's knowledge base on learning theories and their instructional implications regarding health care delivery setting when fetal well-being is questionable.

- Enable participants to develop, implement, and evaluate health care delivery in a practice setting prior to an actual event. This will allow for early recognition of an actual event.

- Enhance participant's ability to put knowledge into active health care delivery. This will allow for rapid implementation of the necessary steps needed when fetal well-being is questionable.

- Prepare participants to address issues and implement changes in the health care unit as necessary to ensure a safe environment. Equipment and supplies needed when fetal well-being is questionable.

The rationale for monitoring the FHR during labor is that heart rate patterns are indirect markers of the fetal cardiac and central nervous system (CNS) response to blood volume changes, acidemia, and hypoxemia, since the brain modulates heart rate.

Nearly all obstetric societies advise monitoring the FHR during labor.

However, this position is chiefly based upon medical and legal opinion with neither continuous electronic fetal monitoring (EFM) or intermittent auscultation proven beneficial in low risk pregnancies.
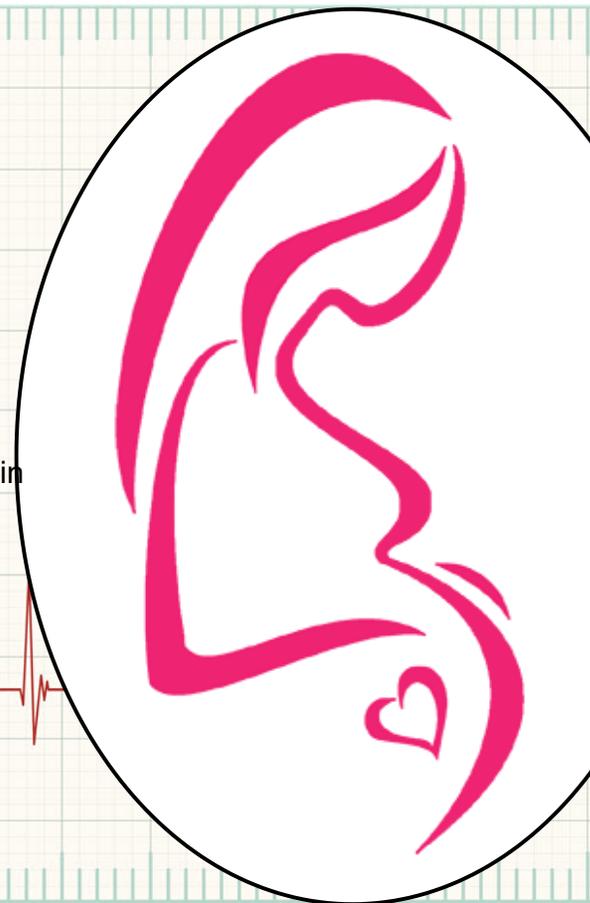
The primary goal of intrapartum FHR monitoring is to identify hypoxemic and acidotic fetuses in whom timely intervention will prevent death. The American College of Obstetricians and Gynecologists (ACOG) recommends antepartum fetal surveillance for pregnancies when risk of fetal demise is increased [1].

These pregnancies include but are not limited to:

✓	Diabetes	✓	Alloimmunization
✓	Hypertensive disorders	✓	Oligohydramnios
✓	Fetal growth restriction	✓	Polyhydramnios
✓	Multiple gestation	✓	Prior fetal demise
✓	Post-term pregnancy	✓	Nonimmune hydrops
✓	Decreased fetal movement	✓	Maternal heart disease
✓	Systemic lupus erythematosus	✓	Poorly controlled maternal hyperthyroidism
✓	Antiphospholipid syndrome	✓	Maternal vascular diseases
✓	Sickle cell disease	✓	Preterm premature rupture of membranes (PPROM)

Other possible health conditions that are indicators for <u>ante</u>natal testing:
- Advanced maternal age
- Obesity
- Major fetal anomalies
- Abnormal first and second trimester screening results [2,3]

Testing should begin when risk of fetal demise is identified. Observational data has shown in non-growth restricted fetuses, that increased risk occurs at 32 to 34 weeks through term pregnancy, so 32 weeks of gestation has become a common time to initiate fetal surveillance [4].

There is no data that recommends daily, every other day, twice weekly, or once weekly fetal monitoring. The decision on frequency is based on expert opinion and clinical experiences. Surveillance may begin weekly, then increase to twice weekly in some situations.

There is some evidence that <u>intra</u>partum fetal monitoring achieves a reduction in intrapartum death [1] but no evidence of a reduction in long-term neurologic impairment [5].

Intrapartum FHR evaluation is achieved through continuous electronic FHR monitoring and intermittent auscultation.

In initial FHR monitoring studies, comparison between intermittent auscultation with no monitoring and intermittent auscultation with monitoring, intermittent auscultation did not demonstrate a decrease in perinatal mortality or neurologic disabilities [6-8].

No trials have compared continuous electronic fetal monitoring with no monitoring.
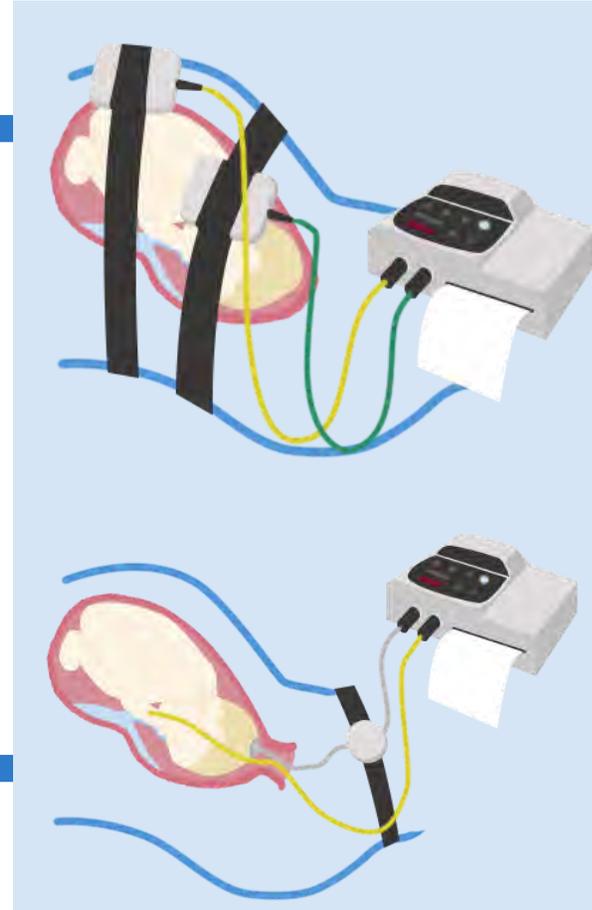
For both low- and high-risk pregnancies, there is no convincing evidence that continuous electronic FHR monitoring performs better than intermittent auscultation and consistent evidence that electronic fetal monitoring has a high false positive rate for predicting adverse outcomes [6-8].

In 2017 a systematic review was published that included 13 randomized controlled trials and >37,000 patients. The study compared continuous electronic FHR monitoring with intermittent auscultation and found no compelling differences between techniques in the following events [8]:
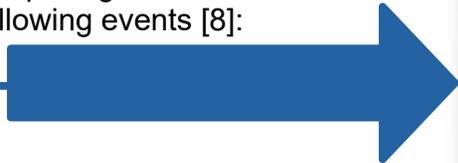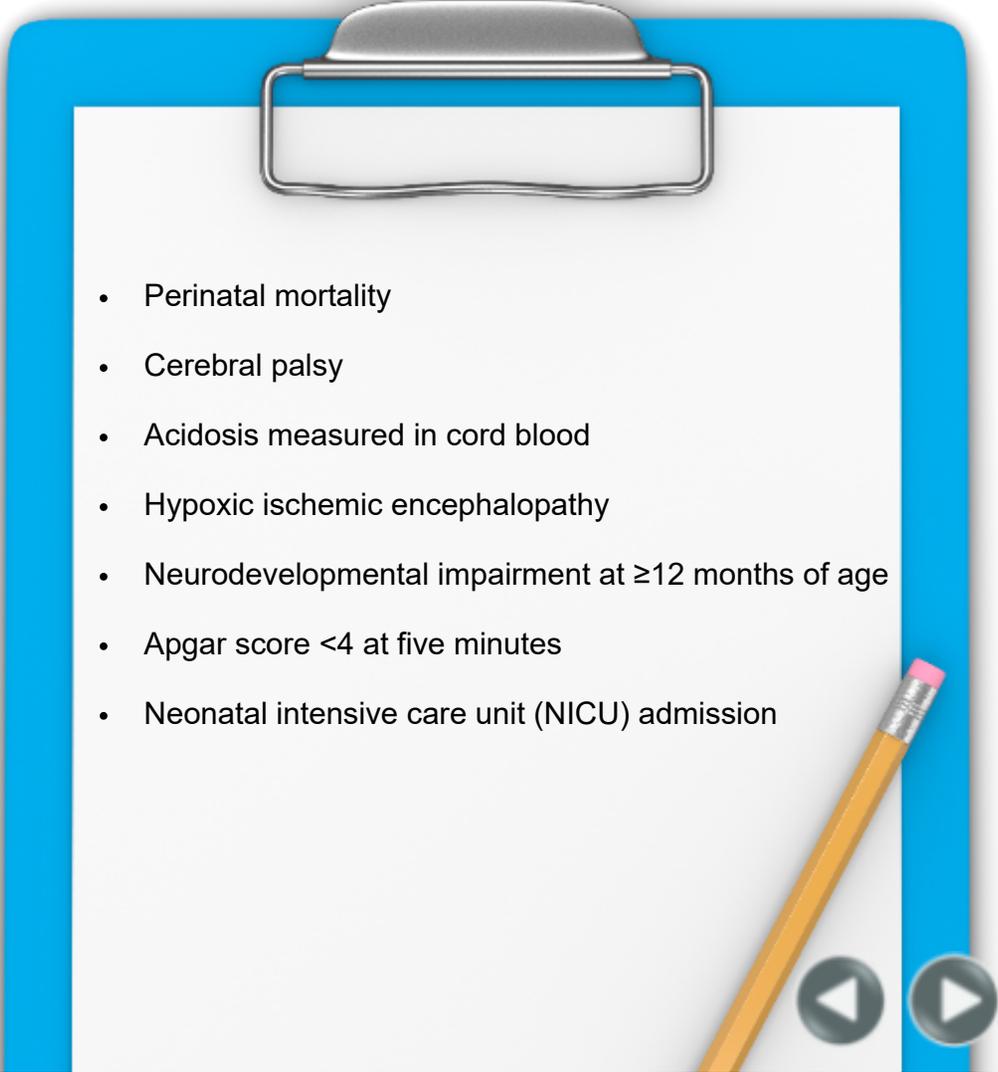
- Perinatal mortality

- Cerebral palsy

- Acidosis measured in cord blood

- Hypoxic ischemic encephalopathy

- Neurodevelopmental impairment at ≥12 months of age

- Apgar score <4 at five minutes

- Neonatal intensive care unit (NICU) admission

There are many reasons why it is difficult to identify a reduction in cerebral palsy:

- Intrapartum interventions are not likely to change the course of cerebral palsy because most cases are due to an antepartum event [6].

- In a study, cerebral palsy was not associated with an abnormal FHR in 99.8 percent of tracing [6].

- Furthermore, a fetal neurologic disorder may be the cause, rather than the result, of FHR abnormalities [10].

Some maternal and fetal conditions have an increased risk of adverse fetal/neonatal outcomes; however, there is no convincing evidence that continuous FHR monitoring reduces this risk.

Nevertheless, some type of FHR monitoring during labor has become routine for all women in the United States and will probably not be abandoned because most patients and clinicians are reassured by normal results and believe there is some value in detecting abnormal patterns.

Most are willing to accept an increase in cesarean and operative vaginal births associated with continuous electronic fetal monitoring, which is estimated to be an extra 12 cesareans and 25 operative deliveries per 1000 births [5].

In addition, economic issues preclude hospitals' ability to provide 1:1 nurse:patient staffing, which is needed for monitoring by intermittent auscultation.
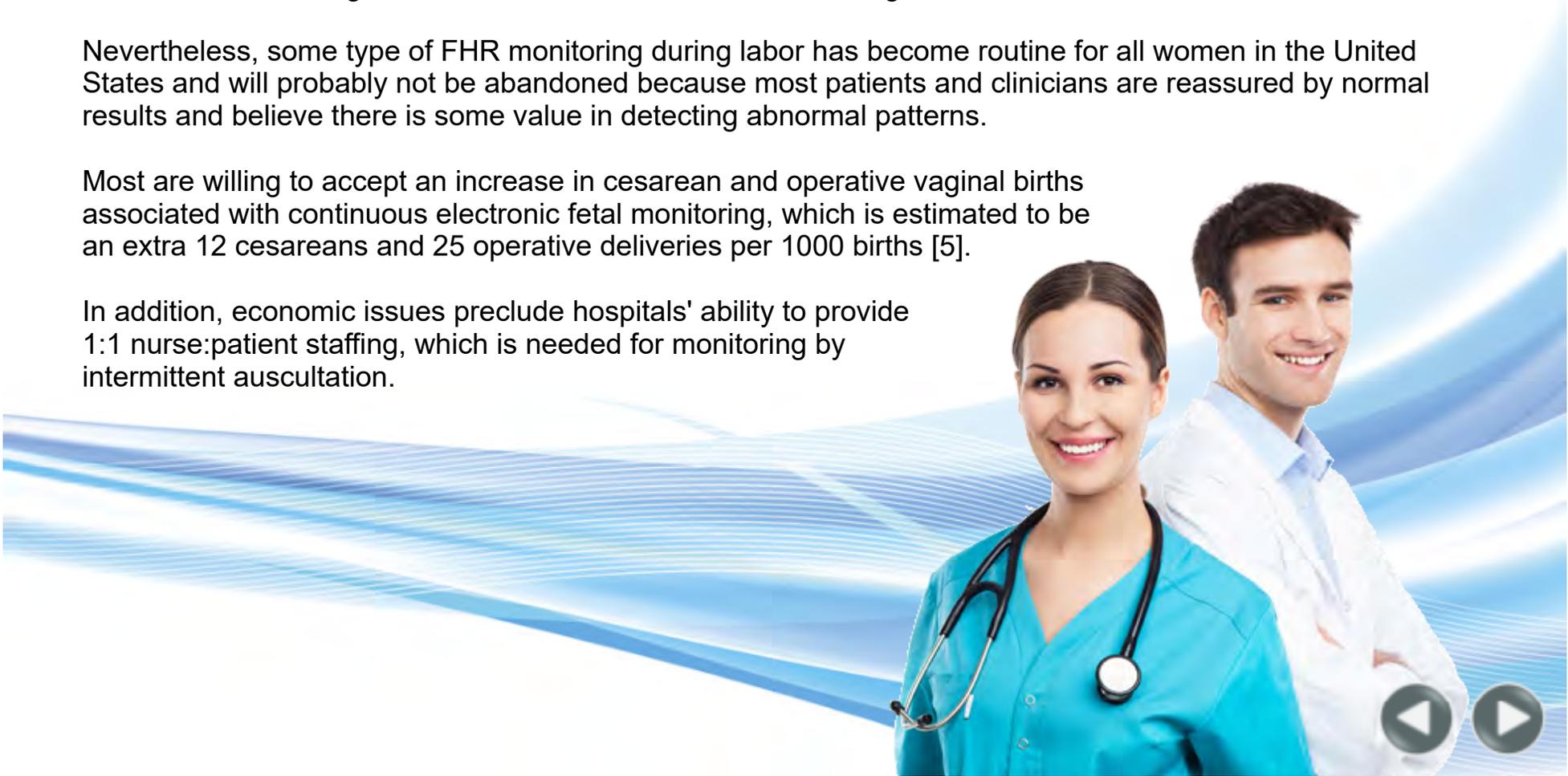
MATERNAL911®

Variability

10 Minute Window

Baseline Rate

Acceleration

Late Deceleration

Early Deceleration

Variable Deceleration

Prolonged Deceleration

National Institute of Child Health and Human Development (NICHD)
Definitions of FHR Characteristics

Variability

- Baseline fluctuations that are irregular in amplitude and frequency

- Absent = amplitude undetectable

- Minimal = amplitude 0 to 5 beats per minute (bpm)

- Moderate = amplitude 6 to 25 bpm

- Marked = amplitude over 25 bpm

Click each characteristic to see the definitions.   **Table 2**   **Table 3**   **ACOG Practice Bulletin no. 106 Table 1: Electronic Fetal Monitoring Definitions**

Category	Interpretation	Features
I - Normal	Strongly predictive of normal acid-base status at this time of observation	- Baseline FHR 110-160 bpm - Baseline FHR variability moderate 6 to 25 bpm - Late or variable FHR decelerations are absent - Early FHR decelerations are present or absent
II - Indeterminate	Not predictive of abnormal acid-base status, however there are insufficient data to classify as either Category I or III	All FHR tracings not categorized as Category I or III and may represent many tracings that are encountered in everyday clinical practice. Examples: - Minimal variability - Absent variability without recurrent decelerations - Marked variability - Absent of induced accelerations after fetal stimulation - Prolonged deceleration - Recurrent late decelerations with moderate variability - Variable decels with "slow return to baseline," "overshoots" or "shoulders"
III - Abnormal	Predictive of abnormal acid-base status at time of observation	Absent FHR variability AND any of the following: - Recurrent late FHR decelerations - Recurrent variable FHR decelerations - FHR bradycardia - Sinusoidal FHR pattern

Goal	FHR Abnormality	Intervention
Promote fetal oxygenation and improve blood flow to the uterus	• Recurrent late decelerations • Prolonged decelerations • Fetal bradycardia • Minimal or absent variability	• Reposition the woman in a lateral position. If in a lateral position, change her to the other side. • Oxygen (O_2) administration • Intravenous (IV) fluid bolus • Reduce frequency of uterine contractions
Reduce uterine activity	• Tachysystole with Category II or III tracing	• Discontinue oxytocin or cervical ripening agents • Administer tocolytic medication
Alleviate umbilical cord compression	• Recurrent variable decelerations • Prolonged deceleration • Fetal bradycardia	• Reposition the woman in a lateral or knee-chest position • Perform amnioinfusion • If cord prolapse, keep presenting fetal part elevated away from the cord
Normalize maternal hypotension	• Recurrent late decelerations • Prolonged decelerations • Fetal bradycardia • Catergory II or III tracings	• Lateral position • IV fluids • If FHR not improving with other interventions, consider Ephedrine 5 to 10mg intravenous push (IVP)

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.

**National Institute of Child Health
and Human Development (NICHD)**
Definitions of FHR Characteristics

Variability

10 Minute
Window

Baseline
Rate

Acceleration

Late
Deceleration

Early
Deceleration

Variable
Deceleration

Prolonged
Deceleration

Measured in a 10-minute Window

- The amplitude is measured peak to trough, defining baseline fetal heart rate variability in the following classification:
  - In any given 10-minute window, the minimum baseline duration must be at least 2 minutes or else the baseline is considered indeterminate. When this occurs, the previous 10-minute window should be reviewed and utilized to determine the baseline.

- Uterine contractions are quantified by the number of contractions present in a 10-minute window, averaged over a 30 minute period.

Amplitude Range	Classification
Undetectable	Absent
Undetectable to ≤5 beats/min	Minimal
6-25 beats/min	Moderate
>25 beats/min	Marked

- There is no distinction between short- and long-term variability.

*Click each characteristic to
see the definitions.*

Table 2   **Table 3**

ACOG Practice Bulletin
no. 106 Table 1: Electronic
Fetal Monitoring
Definitions

MATERNAL911®

Variability

10 Minute Window

Baseline Rate

Acceleration

National Institute of Child Health and Human Development (NICHD)
Definitions of FHR Characteristics

Baseline Rate

- Bradycardia = below 110 beats/minute

- Normal = 110 to 160 beats/minute

- Tachycardia = over 160 beats/minute

- The baseline rate is the mean beats/minute (rounded to 0 or 5) over a 10 minute interval, excluding periodic changes, periods of marked variability, and segments that differ by more than 25 beats/minute.

- The baseline must be identifiable for 2 minutes during the interval, but does not need to be a contiguous 2 minutes.

- If the baseline rate is not identifiable for 2 minutes, it is considered indeterminate.

Late Deceleration

Early Deceleration

Variable Deceleration

Prolonged Deceleration

Click each characteristic to see the definitions.   **Table 2**   **Table 3**   **ACOG Practice Bulletin no. 106 Table 1: Electronic Fetal Monitoring Definitions**

Variability

10 Minute
Window

Baseline
Rate

Acceleration

**National Institute of Child Health
and Human Development (NICHD)**
Definitions of FHR Characteristics

Acceleration

- An abrupt increase in the FHR.

- Before 32 weeks of gestation, accelerations should last >10 seconds and peak at >10 bpm above baseline.

- As of 32 weeks gestation, accelerations should last >15 seconds and peak at >15 bpm above baseline.

- A prolonged acceleration is ≥2 minutes but less than 10 minutes.

- When an acceleration lasts for 10 minutes or more, it is considered a change in FHR baseline.

Late
Deceleration

Early
Deceleration

Variable
Deceleration

Prolonged
Deceleration

Click each characteristic to see the definitions.   **Table 2   Table 3**   **ACOG Practice Bulletin no. 106 Table 1: Electronic Fetal Monitoring Definitions**

**National Institute of Child Health
and Human Development (NICHD)**
Definitions of FHR Characteristics

Late Deceleration

- A gradual decrease and return to baseline of the FHR associated with a uterine contraction.

- The deceleration is delayed in timing, with the nadir of the deceleration occurring after the peak of the contraction.

- The onset, nadir, and recovery usually occur after the onset, peak, and termination of a contraction.

Click each characteristic to see the definitions.

Table 2   **Table 3**

ACOG Practice Bulletin no. 106 Table 1: Electronic Fetal Monitoring Definitions

Variability

10 Minute Window

Baseline Rate

Acceleration

National Institute of Child Health and Human Development (NICHD)
Definitions of FHR Characteristics

Early Deceleration

- A gradual decrease and return to baseline of the FHR associated with a uterine contraction.

- The nadir of the FHR and the peak of the contraction occur at the same time.

- The deceleration's onset, nadir, and termination are usually coincident with the onset, peak, and termination of the contraction.

Late Deceleration

Early Deceleration

Variable Deceleration

Prolonged Deceleration

Click each characteristic to see the definitions.

Table 2   **Table 3**

[ACOG Practice Bulletin no. 106 Table 1: Electronic Fetal Monitoring Definitions](#)

MATERNAL911®

National Institute of Child Health and Human Development (NICHD)
Definitions of FHR Characteristics

Variable Deceleration

- An abrupt decrease in FHR below the baseline. The decrease is ≥15 bpm, lasting ≥15 secs and <2 minutes from onset to return to baseline.

- The onset, depth, and duration of variable decelerations commonly vary with successive uterine contractions.

Click each characteristic to see the definitions.

Table 2   **Table 3**

ACOG Practice Bulletin no. 106 Table 1: Electronic Fetal Monitoring Definitions

**National Institute of Child Health
and Human Development (NICHD)**
Definitions of FHR Characteristics

Prolonged Deceleration

- A decrease in FHR below the baseline of 15 bpm or more, lasting at least 2 minutes but <10 minutes from onset to return to baseline.

- A prolonged deceleration of 10 minutes or more is considered a change in baseline.

Click to see more on deceleration

Table 2   Table 3   ACOG Practice Bulletin no. 106 Table 1: Electronic Fetal Monitoring Definitions

Absent or Minimal Variability with Recurrent Decelerations

- Minimal variability is thought to result from cerebral hypoxemia and acidosis, and signifies failure of fetal compensatory mechanisms to maintain adequate oxygenation of the brain [12].

- It may be accompanied by recurrent or prolonged decelerations [12].

- The likelihood of fetal acidemia increases in tandem with increases in the frequency, depth, and duration of the decelerations [13].

- If decelerations occur with at least 50% of uterine contractions in a 20 minute window they are considered recurrent [12,15].

Recurrent Late Decelerations

- Late decelerations are caused by the reflex CNS response to transient hypoxia and acidemia caused by uterine contractions, as well as direct myocardial depression and humoral factors [14].

- If late decelerations occur with at least 50% of uterine contractions in a 20 minute window they are considered recurrent [12,15].
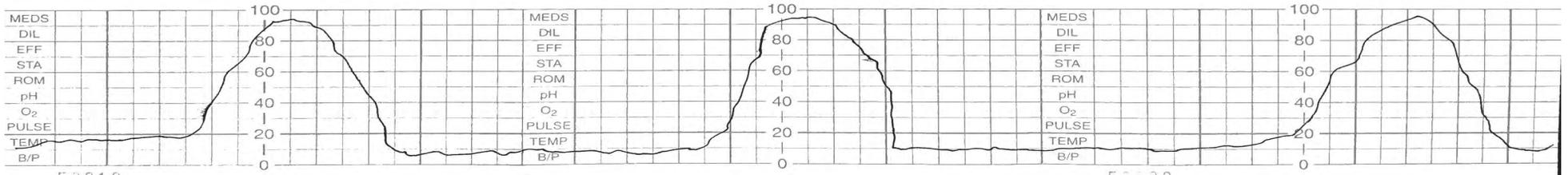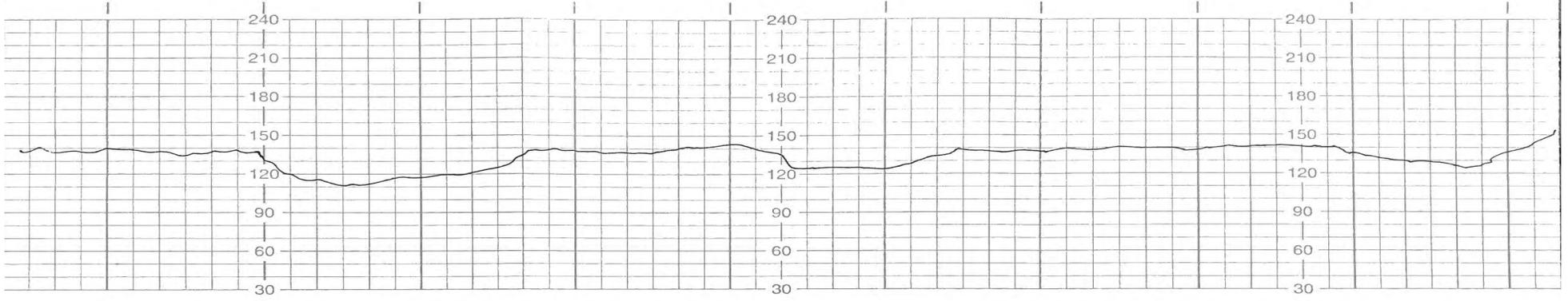
Click each link to see the waveforms.

Waveform 1

Waveform 2

Waveform 3
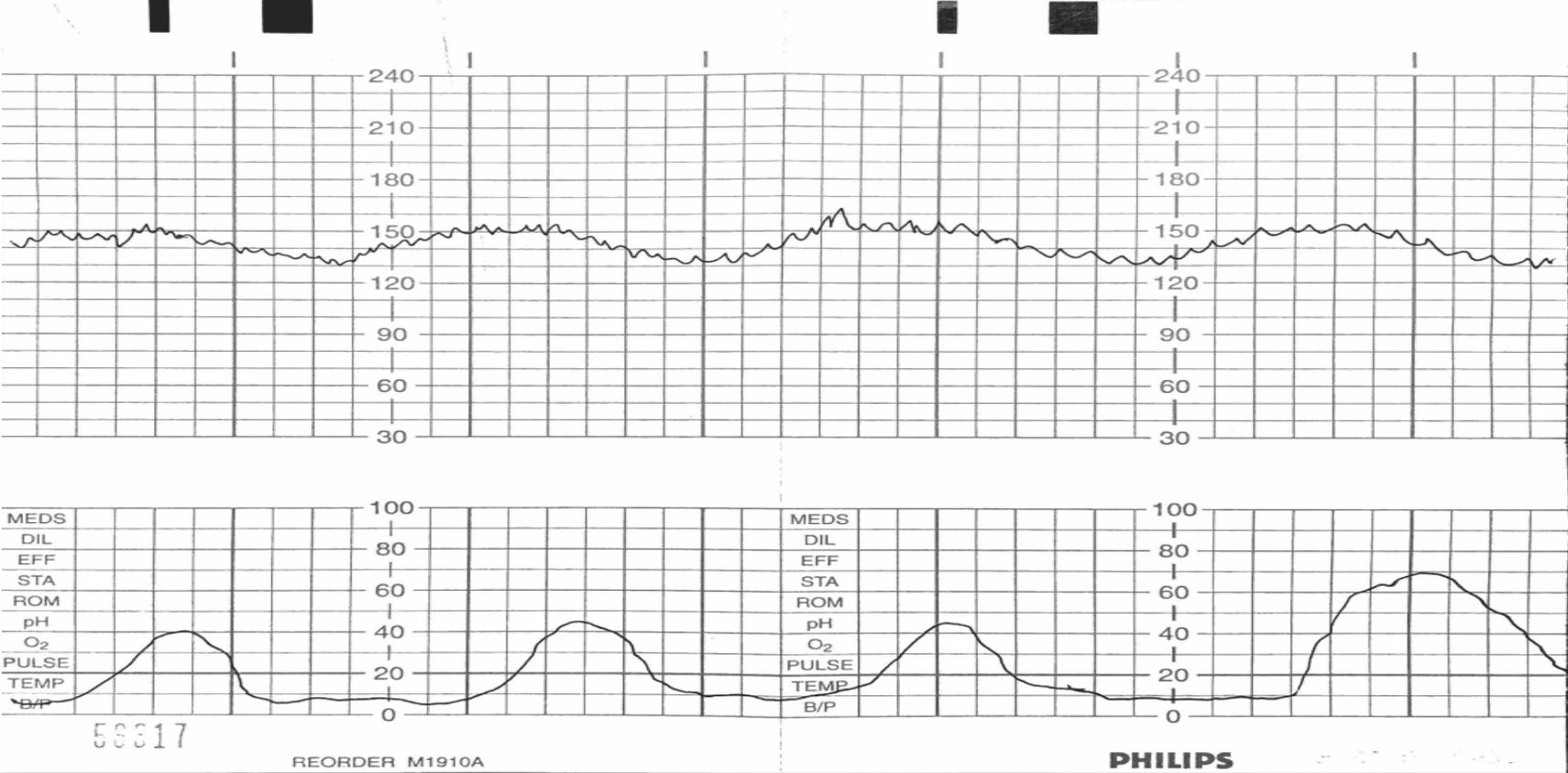
Waveform 4

Waveform 1 - Late Decelerations
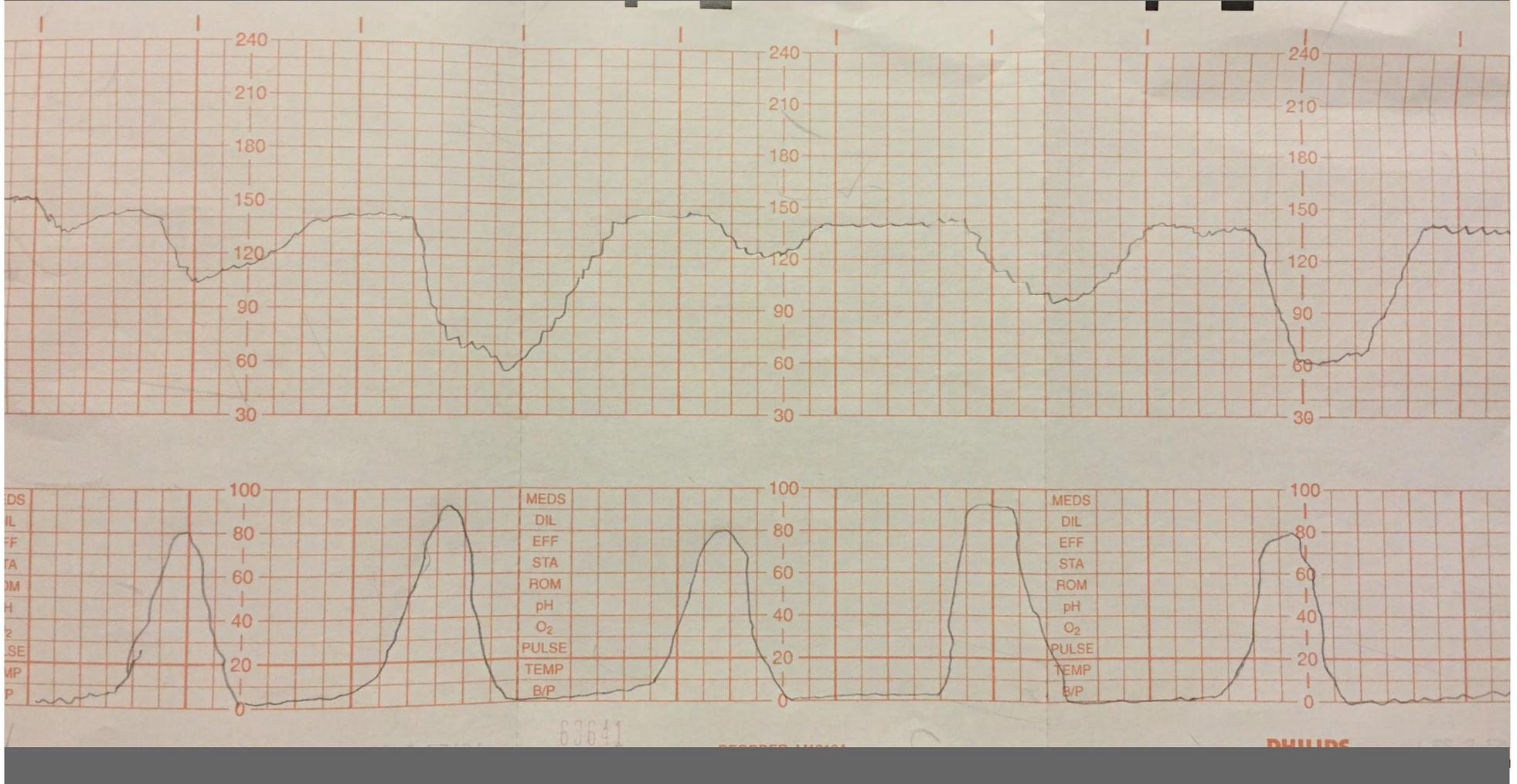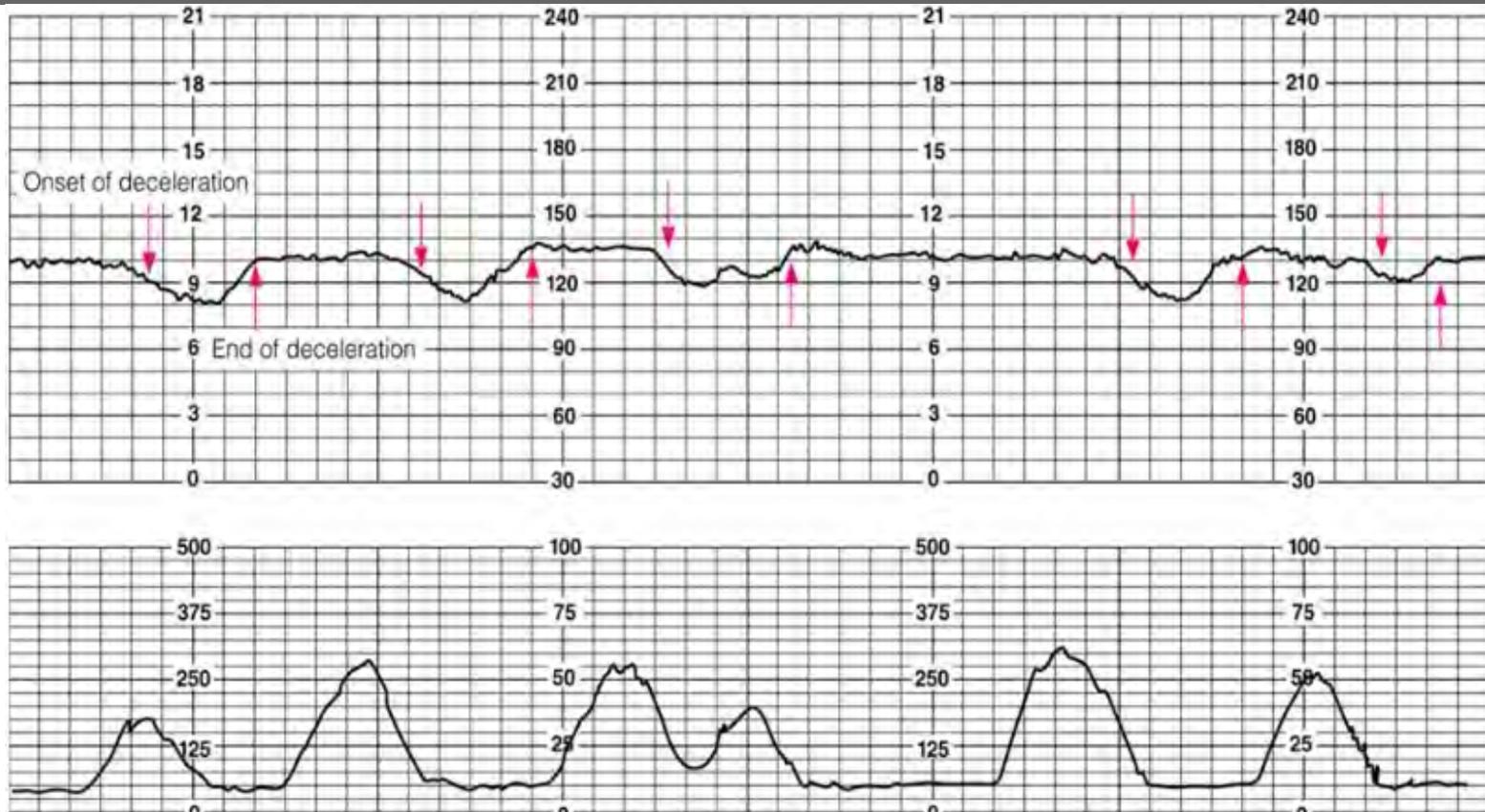
Waveform 3 - Deep Late Decelerations

Waveform 4 - Recurrent Late Decelerations

Recurrent Variable Decelerations

- Variable decelerations occur when the umbilical cord is compressed, which may happen during a contraction in the setting of oligohydramnios or a nuchal cord [11].
- The thin walled umbilical vein is more sensitive to compression than the umbilical arteries.
  - Compression results in variable effects on fetal preload and afterload, which lead to changes in FHR mediated by baroreceptors, and by chemoreceptors when there is sufficient hypoxemia.
- Intermittent variable decelerations are frequently observed in labor tracings and are not usually associated with adverse consequences, presumably because transient cord compression is well tolerated by the fetus.
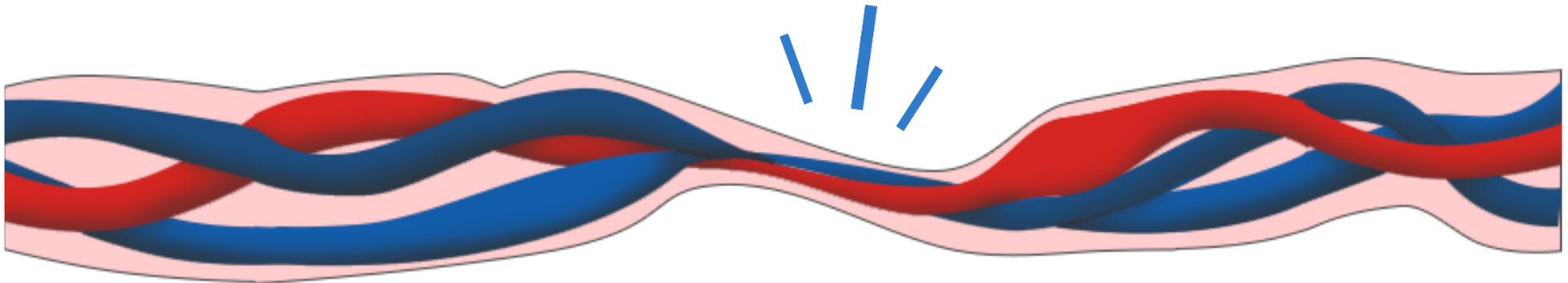
Recurrent Variable Decelerations Continued

- Fetal recovery may be aided with maternal pushing every other contraction [17].

- In a human study, pH fell when the decelerations had delayed recovery and when they were deeper than 60 bpm, but only 18% of newborns with these findings had a low Apgar score at 1 minute and none had a low score at 5 minutes [18].

Mouse over Waveform 5 to enlarge the image.

Waveform 5 - Recurrent Variable Decelerations

Variable Decelerations

- Variable decelerations are inherently variable with many atypical variations (**Waveform 6** and **Waveform 7**) [17].

- Evidence has not demonstrated clinical significance related to atypical features:

  - Variable decelerations with lambda or W pattern (biphasic deceleration)

  - Loss of primary or secondary acceleration (shoulders)

  - Persistent secondary acceleration (overshoot)

  - Reduction in post-deceleration baseline [12]

- The NICHD classification does not include atypical variable decelerations as a category of FHR pattern [12].

  - Variable decelerations with absent baseline variability are predictive of acidosis.

Click the links above to see the Waveforms.
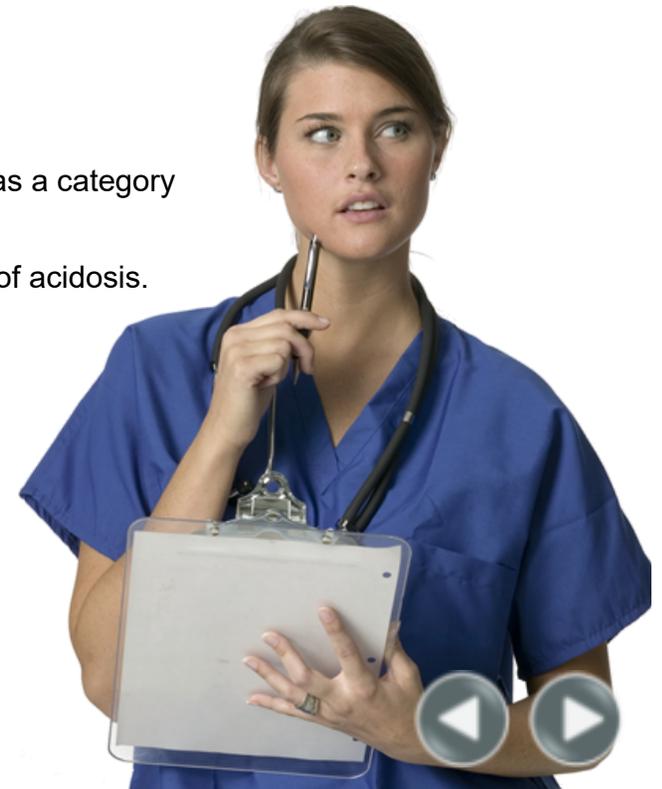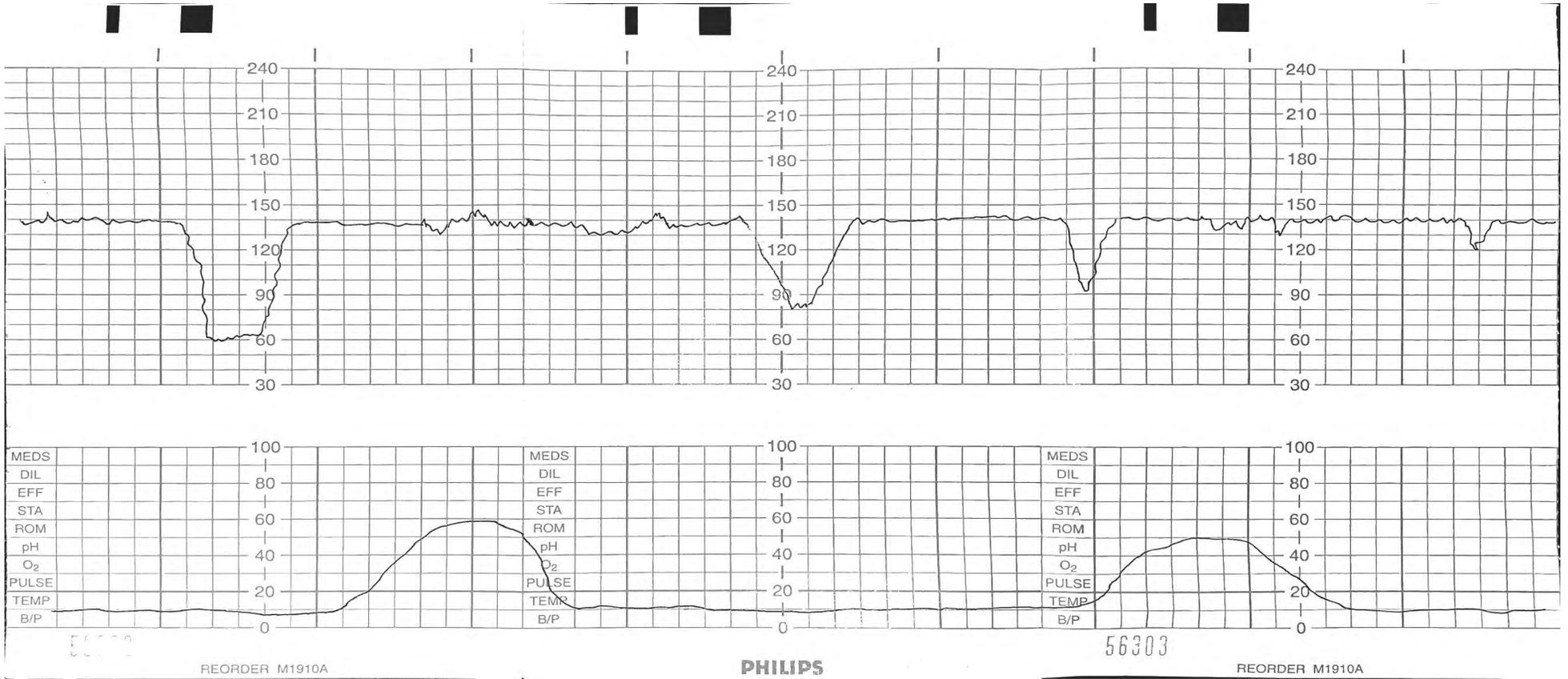
Waveform 7 - Variable Decelerations
with Minimal to Absent Variability
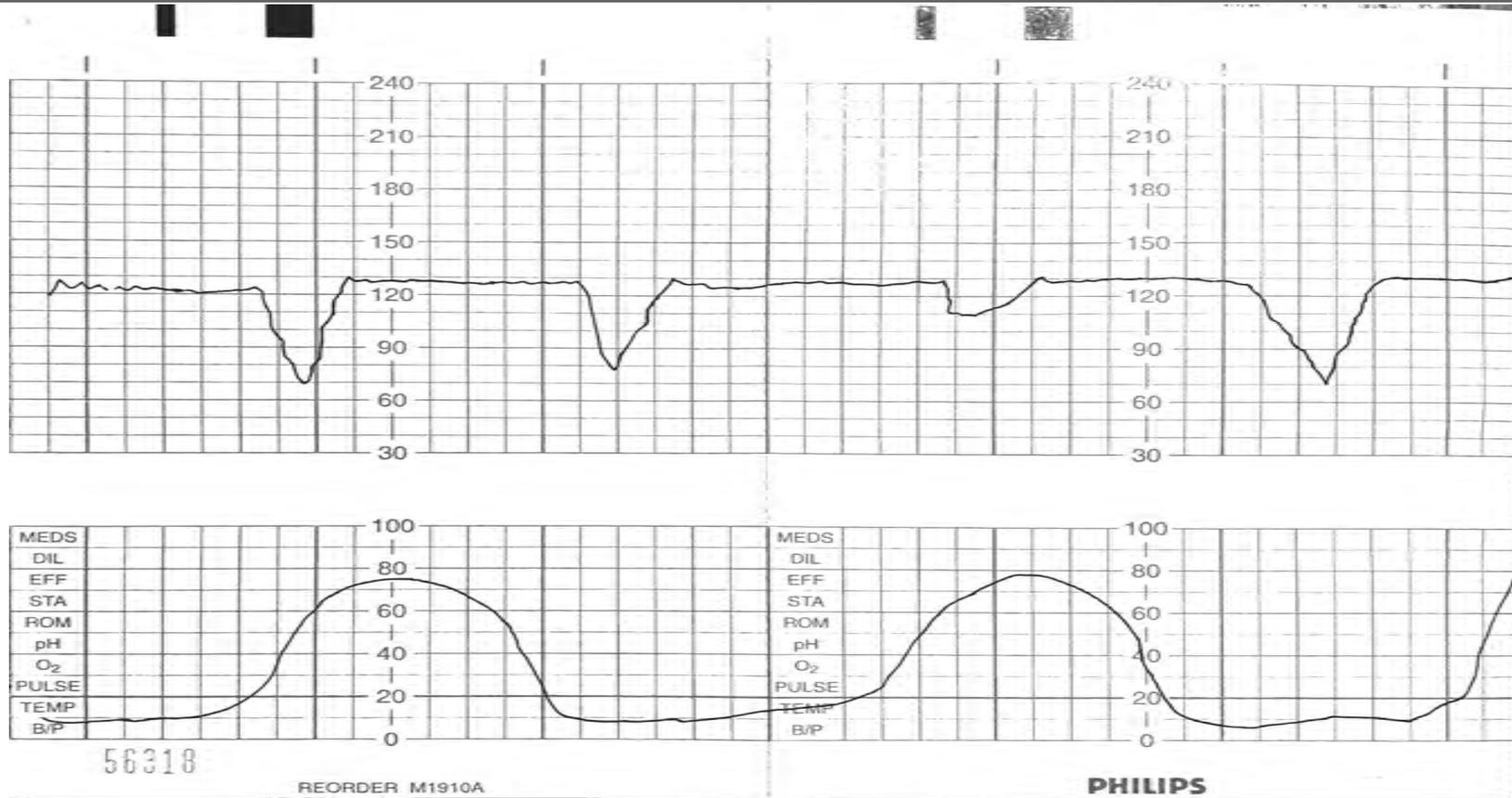
Prolonged Decelerations
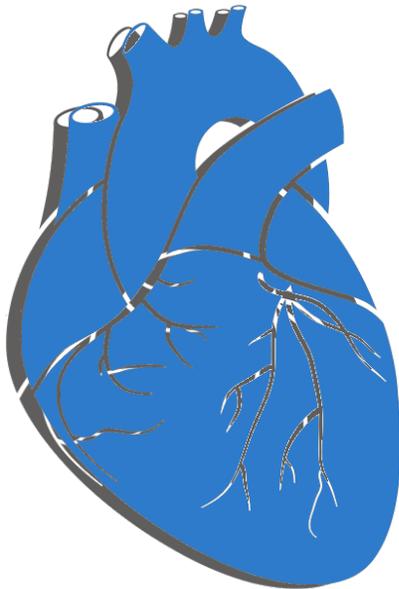
- A prolonged deceleration is defined as a decrease in FHR below the baseline of 15 bpm or more, lasting at least 2 minutes but <10 minutes from onset to return to baseline.

- When the FHR falls below 100, tissue perfusion may not be adequate.

- Bradycardia in a prolonged deceleration is abnormal even when variability is present since it may be due to an acute adverse event.

Click the heart to see more information.

Sinusoidal Heart Rate Pattern — A sinusoidal FHR pattern resembles a smooth sine wave, with periodicity of 3 to 5 cycles per minute and lasting for at least 20 minutes (**Waveform 8**) [12].
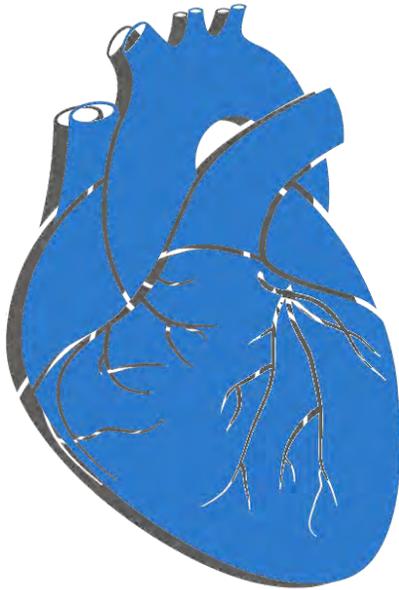
- Beat to beat changes are often small, but in the same direction, creating the wave pattern.

- Decelerations and accelerations in response to movement are absent.

- The mechanism for the sinusoidal pattern is believed to be a response to moderate fetal hypoxemia, often secondary to fetal anemia.

- A sinusoidal-like pattern has also been associated with physiological changes in fetal peripheral arterial resistance, fetal sucking movements, and maternal opioid administration [18-22].

Click the link above to see the waveform.

Waveform 8 - Sinusoidal Pattern
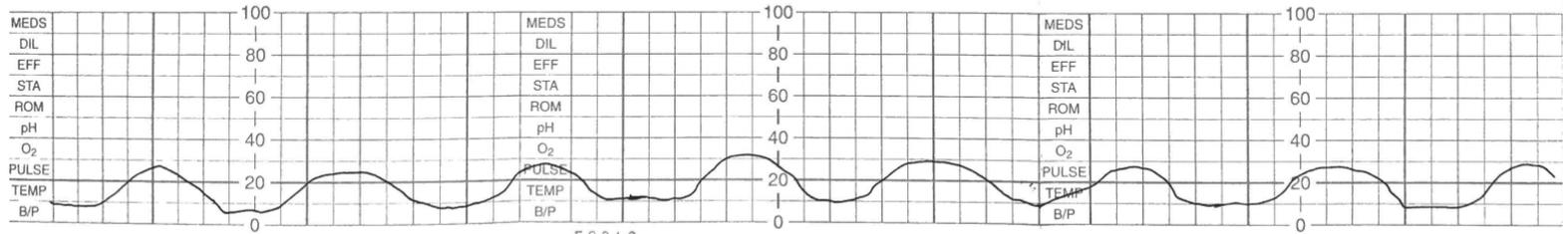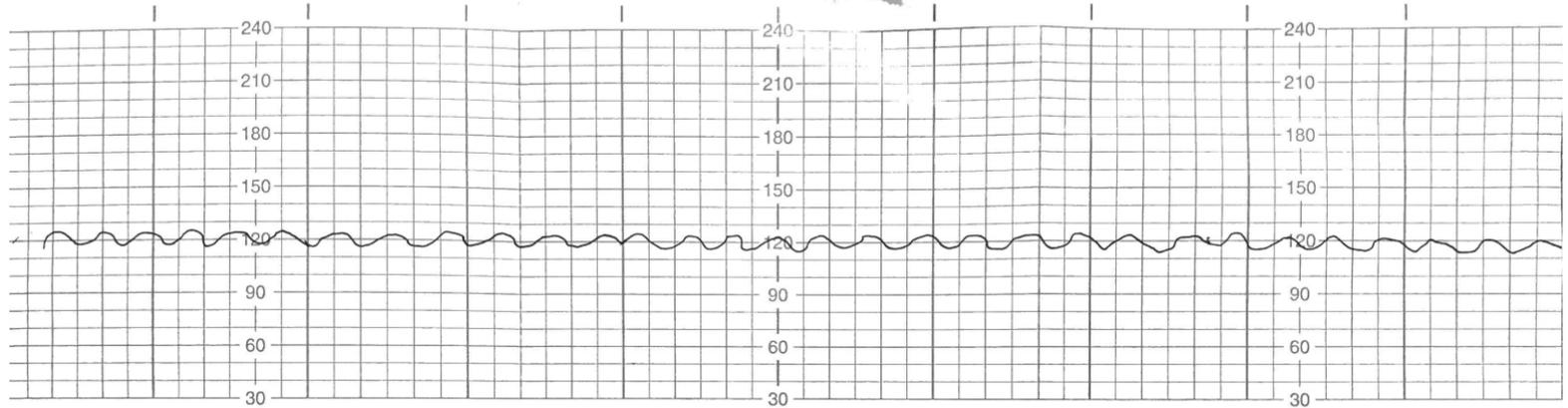
NICHD classification — Interpretation of FHR tracings is subjective and not very reproducible.

- Studies have consistently shown that there is large inter- and intra-observer variability in interpretation of electronic FHR monitoring tracings [23-29].

- For this reason, ACOG, the Society for Maternal-Fetal Medicine (SMFM), and the United States NICHD assembled a workshop to create standardized definitions and interpretation for EFM [30].

- The definitions tabulated in the prior slides have been endorsed by the ACOG and are used clinically [30].

- These definitions do not apply to computer generated FHR interpretations, and European standards differ from those in the United States.

- Observer agreement remains controversial because of disagreement between absent versus minimal variability and characterization of decelerations [24,31].

- Following NICHD standardization, the International Federation of Gynecology and Obstetrics (FIGO) and others have created similar guidelines [32].

The NICHD subsequently created a three-tier FHR interpretation system **(Table 2)**:

> **Category I** represents a normal tracing predictive of normal fetal acid-base balance at the time of observation

> **Category II** represents an indeterminate tracing that is neither Category I nor Category II.

> **Category III** represents an abnormal tracing predictive of a significant incidence of abnormal fetal acid-base status at the time of observation [12].

Evidence suggests improved neonatal outcomes with standardized approach to pattern recognition with standardized therapeutic interventions **(Table 3)** [33].

Click the links to see each table.

Category	Interpretation	Features
I - Normal	Strongly predictive of normal acid-base status at this time of observation	- Baseline FHR 110-160 bpm - Baseline FHR variability moderate 6 to 25 bpm - Late or variable FHR decelerations are absent - Early FHR decelerations are present or absent
II - Indeterminate	Not predictive of abnormal acid-base status, however there are insufficient data to classify as either Category I or III	All FHR tracings not categorized as Category I or III may represent many tracings that are encountered in everyday clinical practice. Examples: - Minimal variability - Absent variability without recurrent decelerations - Marked variability - Absent of induced accelerations after fetal stimulation - Prolonged deceleration - Recurrent late decelerations with moderate variability - Variable decels with "slow return to baseline," "overshoots" or "shoulders"
III - Abnormal	Predictive of abnormal acid-base status at time of observation	Absent FHR variability AND any of the following: - Recurrent late FHR decelerations - Recurrent variable FHR decelerations - FHR bradycardia - Sinusoidal FHR pattern

Goal	FHR Abnormality	Intervention
Promote fetal oxygenation and improve blood flow to the uterus	- Recurrent late decelerations - Prolonged decelerations - Fetal bradycardia - Minimal or absent variability	- Reposition the woman in a lateral position. If in a lateral position, change her to the other side. - Oxygen (O_2) administration - Intravenous (IV) fluid bolus - Reduce frequency of uterine contractions
Reduce uterine activity	Tachysystole with Category II or III tracing	- Discontinue oxytocin or cervical ripening agents - Administer tocolytic medication
Alleviate umbilical cord compression	- Recurrent variable decelerations - Prolonged deceleration - Fetal bradycardia	- Reposition the woman in a lateral or knee-chest position - Perform amnioinfusion - If cord prolapse, keep presenting fetal part elevated away from the cord
Normalize maternal hypotension	- Recurrent late decelerations - Prolonged decelerations - Fetal bradycardia - Catergory II or III tracings	- Lateral position - IV fluids - If FHR not improving with other interventions, consider Ephedrine 5 to 10mg intravenous push (IVP)

It is practical to consider evaluation and treatment of minimal variability without spontaneous accelerations. In this situation an effort should be made to elicit accelerations options may include:

- Digital scalp stimulation
- Vibroacoustic stimulation
- Fetal scalp sampling
- Alis clamp scalp stimulation

When accelerations follow stimulation, then acidosis is unlikely and labor may continue [30, 34].

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CATEGORY I

CATEGORY II

CATEGORY III

Category I tracings — A Category I tracing is reassuring as it indicates there is minimal likelihood of acidemia **at that point in time (Waveform 9).**

- It is not predictive of future status, as tracing patterns can change.
- A Category I tracing has all of the following components:
  - A baseline FHR of 110 to 160 bpm
  - No late or variable FHR decelerations
  - Moderate FHR variability (6 to 25 bpm)
  - Early decelerations may be present or absent (**Waveform 10**)
  - See **Table 2** [10]

Click for more on Category 1

You must click each link above to learn more before you can select a different category.

Click each dark blue category button as they appear to learn more.

Category	Interpretation	Features
I - Normal	Strongly predictive of normal acid-base status at this time of observation	• Baseline FHR 110-160 bpm • Baseline FHR variability moderate 6 to 25 bpm • Late or variable FHR decelerations are absent • Early FHR decelerations are present or absent
II - Indeterminate	Not predictive of abnormal acid-base status, however there are insufficient data to classify as either Category I or III	All FHR tracings not categorized as Category I or III may represent many tracings that are encountered in everyday clinical practice. Examples: • Minimal variability • Absent variability without recurrent decelerations • Marked variability • Absent of induced accelerations after fetal stimulation • Prolonged deceleration • Recurrent late decelerations with moderate variability • Variable decels with "slow return to baseline," "overshoots" or "shoulders"
III - Abnormal	Predictive of abnormal acid-base status at time of observation	Absent FHR variability AND any of the following: • Recurrent late FHR decelerations • Recurrent variable FHR decelerations • FHR bradycardia • Sinusoidal FHR pattern

Waveform 9 - Category I
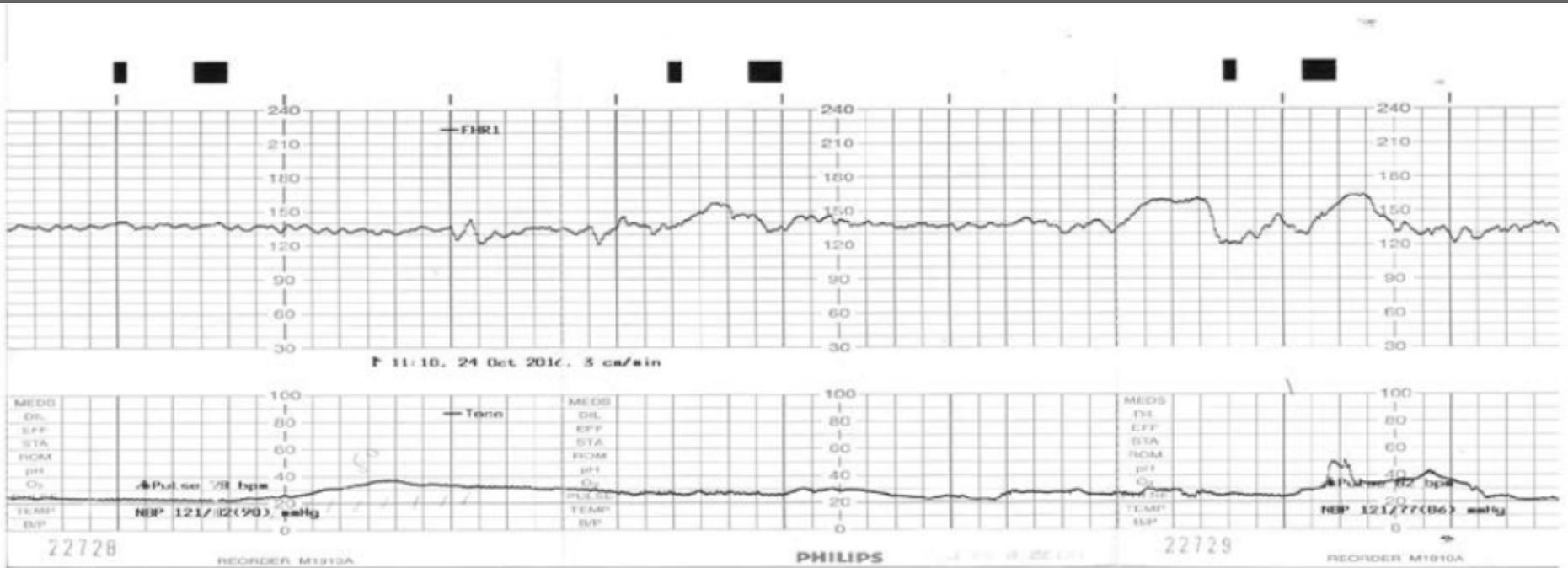
Waveform 10 - Early Deceleration

* 19:55:40 1/18/2015 3 cm/min   * 19:59:00

MATERNAL911®
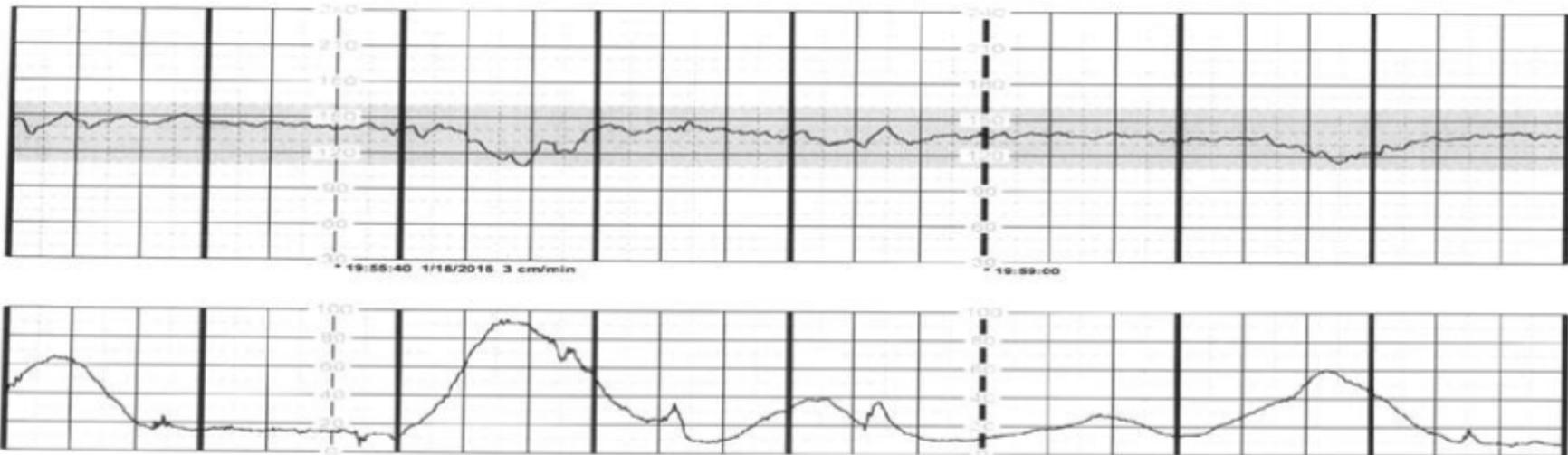
Category I Tracings

- Accelerations may be present or absent.

- FHR accelerations are an important finding when present because their presence, especially with moderate variability, almost always indicates that the fetus is not acidotic [12,35-37].

- Deviation from a normal baseline and periodic changes associated with contractions are not abnormal in the continuum of the FHR tracing.

- Early decelerations (Table 1 and Waveform 10) are felt to be a vagal response due to fetal head compressions and may be present or absent.

- Early decelerations are not associated with fetal acidosis or poor neonatal outcome.

- The baseline FHR can be as low as 100 and be associated with the vagally mediated head compression.

- In a study of 48,000 women with a singleton normal fetus in term labor, 99% of the tracings demonstrated a Category I pattern at some point during labor [38].

CATEGORY I

CATEGORY II

CATEGORY III

*You must click each link above to learn more before you can select a different category.*

*Click each dark blue category button as they appear to learn more.*

CATEGORY I

CATEGORY II

CATEGORY III

- Category II FHR tracings include all patterns that are not classified as category I or Category III. This pattern is neither normal or abnormal (**Table 2**).

- Fetal acidosis can vary with the different types of Category II tracings.

- Category II tracings are observed at some time in 84% of tracings and can remain stable for a prolonged period, making evaluation and management difficult [38].

Click each dark blue category button as they appear to learn more.

Category	Interpretation	Features
I - Normal	Strongly predictive of normal acid-base status at this time of observation	- Baseline FHR 110-160 bpm - Baseline FHR variability moderate 6 to 25 bpm - Late or variable FHR decelerations are absent - Early FHR decelerations are present or absent
II - Indeterminate	Not predictive of abnormal acid-base status, however there are insufficient data to classify as either Category I or III	All FHR tracings not categorized as Category I or III may represent many tracings that are encountered in everyday clinical practice. Examples: - Minimal variability - Absent variability without recurrent decelerations - Marked variability - Absent of induced accelerations after fetal stimulation - Prolonged deceleration - Recurrent late decelerations with moderate variability - Variable decels with "slow return to baseline," "overshoots" or "shoulders"
III - Abnormal	Predictive of abnormal acid-base status at time of observation	Absent FHR variability AND any of the following: - Recurrent late FHR decelerations - Recurrent variable FHR decelerations - FHR bradycardia - Sinusoidal FHR pattern

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CATEGORY I

CATEGORY II

CATEGORY III

A Category III tracing is considered abnormal and has increased occurrence of fetal hypoxia and metabolic acidemia.

- Absent FHR variability with [12]:
  - Recurrent late decelerations (**Waveform 4**)
  - Recurrent variable decelerations (**Waveform 5**)
  - Bradycardia
  - A sinusoidal pattern (**Waveform 8**)
- To reduce the occurrence of fetal/neonatal morbidity or mortality, rapid recognition and evaluation with in utero resuscitation and/or delivery is necessary if the pattern persists [38].
- In a study of 48,000 women with a singleton normal fetus in term labor, 0.1% of the tracings demonstrated a Category III pattern at some point during labor [38].
- Tachycardia may be an ominous finding in the absence of variability.
- Category III tracings may be caused by health conditions unrelated to hypoxemia. A complete health history is necessary.

Waveform 4 - Recurrent Late Decelerations
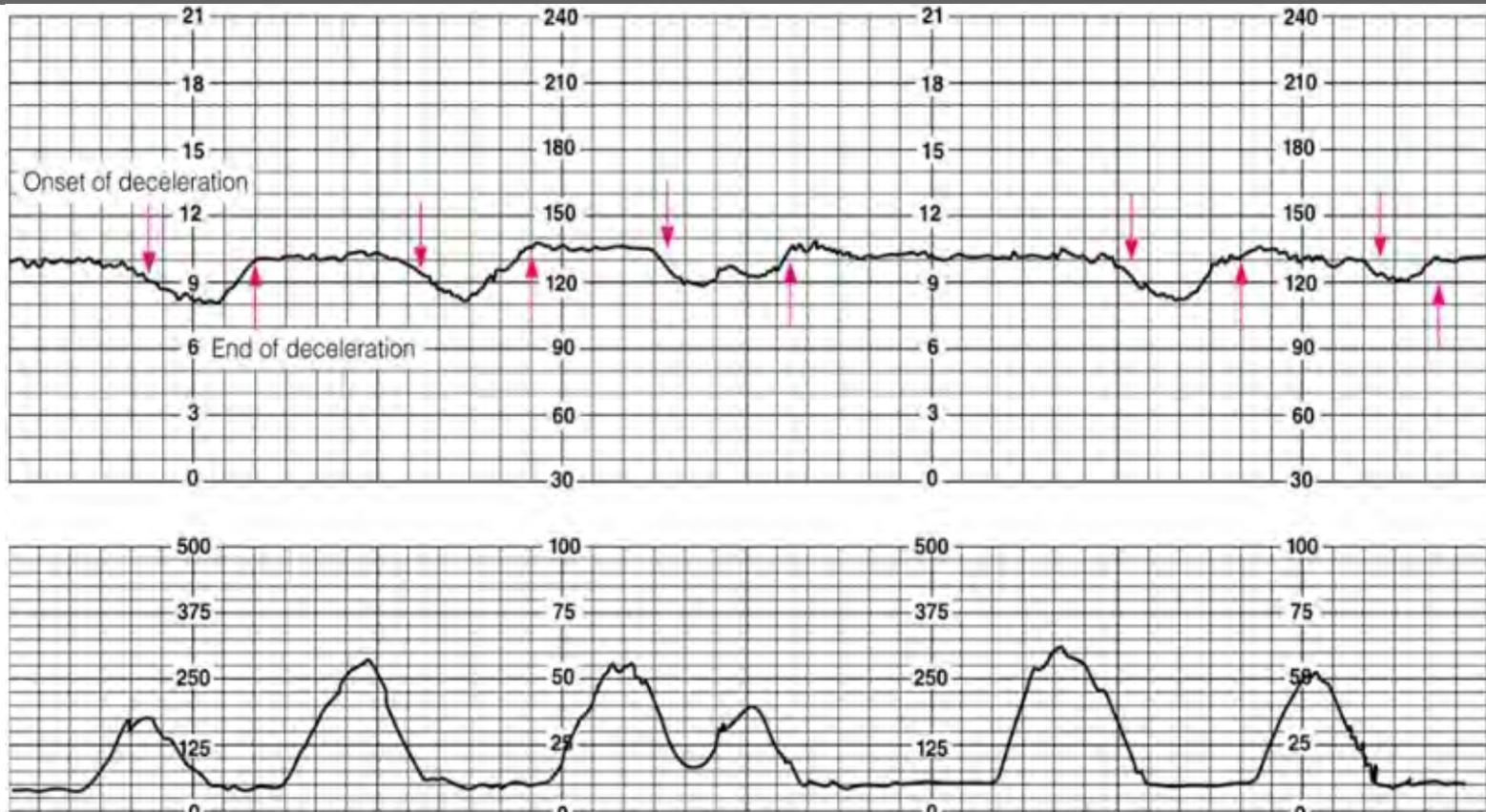
Waveform 5 - Recurrent Variable Decelerations
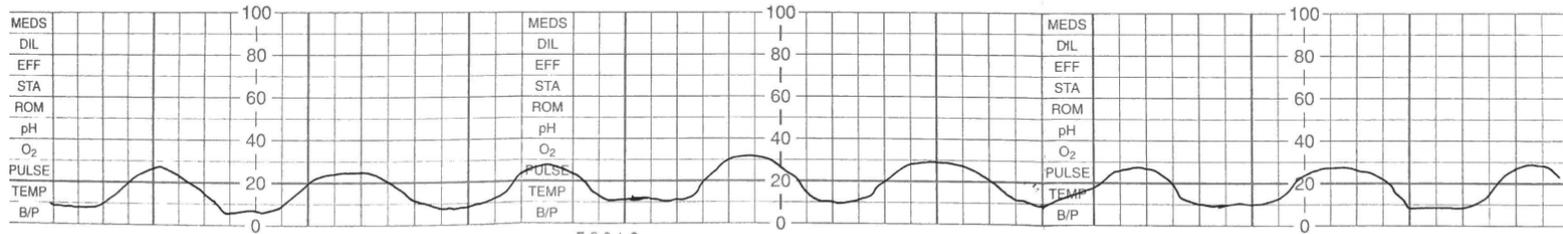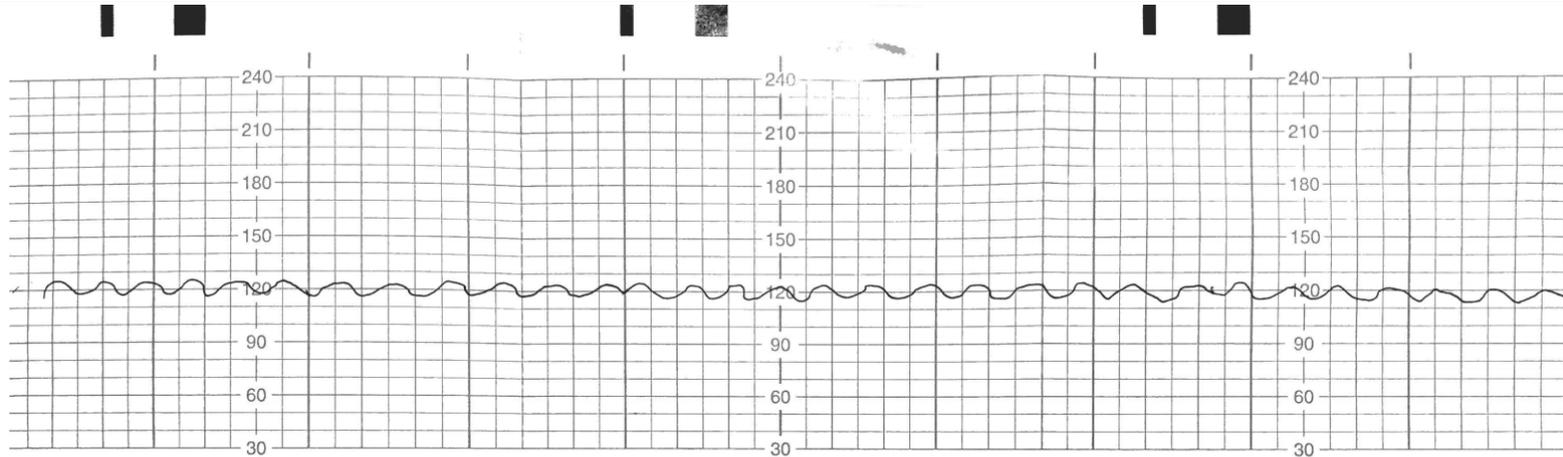
Fetal Heart Rate Tracings Unrelated to Hypoxemia

Fetal Arrhythmias

The credence correlation circuitry of the EFM represents signals interpreted as artifact with a pen lift, depicted as non-recording areas with internal and external FHR monitoring.

- There is generally no immediate threat to the fetus when intrapartum cardiac arrhythmias are present (Waveform 11).
- Fetal tachyarrhythmia can be benign or may cause heart failure or hydrops if prolonged.

Waveform 11 - Cardiac Arrhythmia
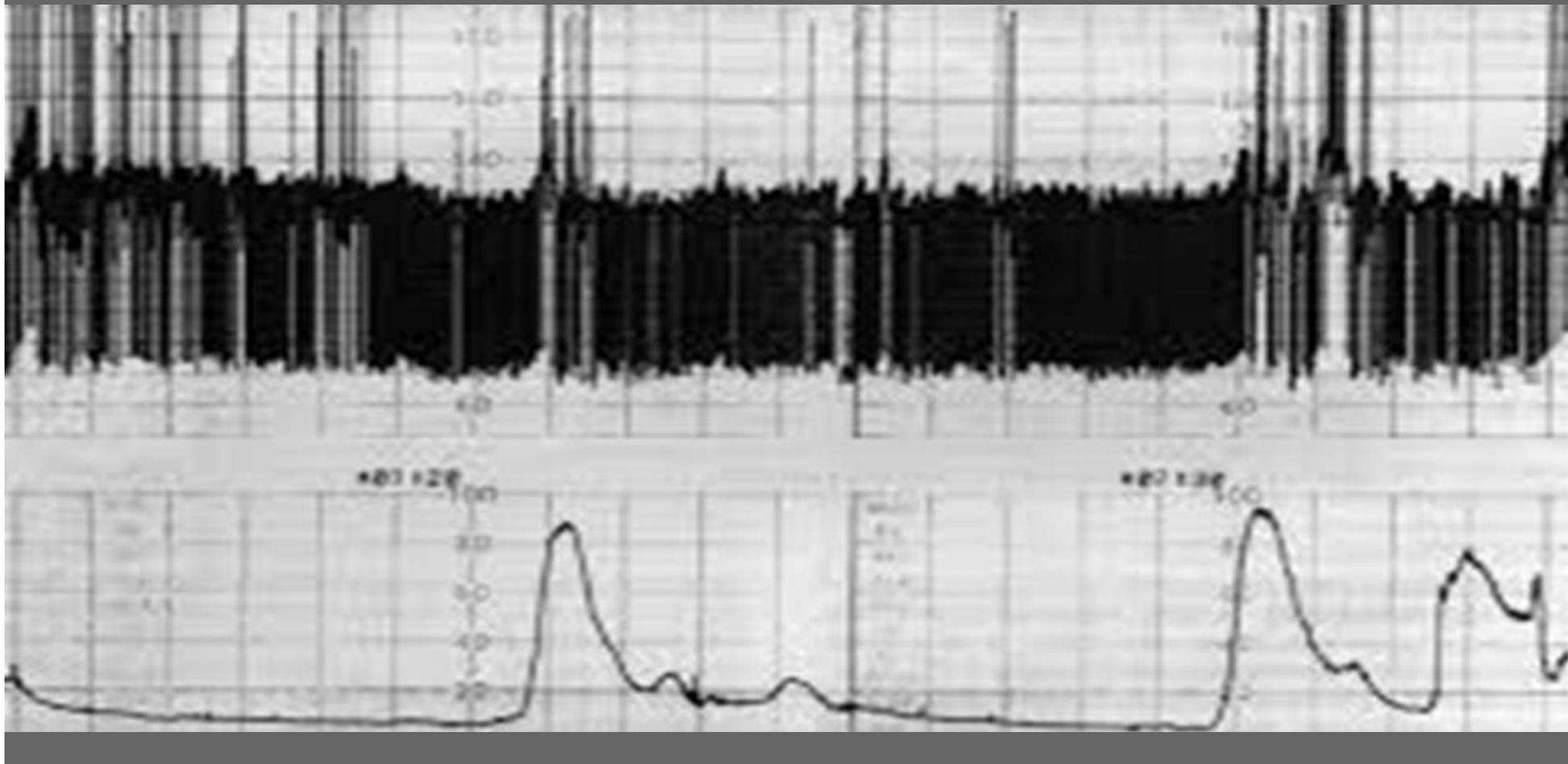
Fetal Heart Rate Tracings Unrelated to Hypoxemia

Fetal Sleep Cycle
- Fetal sleep may last for 40 minutes and be noted with decreased FHR variability and fewer accelerations.

Technical Factors
- Technical factors may include a malfunctioning leg plate, monitor cable, spiral electrode, or EFM. The EFM recording rate may be set to record at 1 cm/min instead of the standard 3cm/min. A very slow FHR may be doubled when recorded and a very fast rate >240 bpm may be halved by the equipment as a result of the computer algorithm.

Fetal Heart Rate Tracings Unrelated to Hypoxemia

Maternal Heart Rate Artifact

- Maternal artifact can interfere with accurate tracing of the FHR. The FHR is generally distinguished from the maternal rate because the FHR is faster [40].

- If FHR bradycardia is present, the rate may be similar to maternal rate as well, as fetal tachycardia may mimic maternal tachycardia due to elevated temperature, stress, or during uterine contractions [41-43].

- When the maternal heart rate is similar to FHR, as displayed on the EFM, further evaluation to distinguish maternal and fetal patterns should be performed.

CONTINUED on next slide

Fetal Heart Rate Tracings Unrelated to Hypoxemia

Maternal Heart Rate Artifact - Continued

- It is important to confirm that the external fetal monitor is actually recording the FHR and not the maternal heart rate transmitted from a maternal vessel, such as the aorta or uterine artery.

- An internal fetal electrode is not definitive, as a fetus that is recently dead can conduct the maternal cardiac signals through its body to the electrode [44].

- The simplest way to confirm that the FHR is being recorded is to confirm that the sound is not synchronous with the maternal pulse.

- Consider applying a pulse oximeter on the woman and comparing the rate to the FHR monitor tracing.

- Ultrasound examination of the fetal heart can be performed if there is continued uncertainty regarding fetal status.

Fetal Heart Rate Tracings Unrelated to Hypoxemia

Drug Effects
- Medication administered to the mother can pass through the placenta to the fetus and affect FHR.
- Decreased variability can be observed in the FHR tracing following maternal administration of opioids and magnesium sulfate.
- An increased FHR can be observed following maternal administration of atropine and a sinusoidal pattern following maternal administration of butorphanol [30].

Congenital Anomalies
- Brady-arrhythmia can be observed on the FHR tracing when the fetus has a structural cardiac abnormality such as complete heart block.

Maternal Fever
- FHR tracing may demonstrate changes when the woman has an increased temperature. Increased FHR baseline, tachycardia, and decreased variability may be noted.

Fetal Heart Rate Tracings Unrelated to Hypoxemia

Pre-Existing Fetal Neurologic Injury

- An antepartum neurologic injury can be suspected when an abnormal FHR pattern is present as soon as EFM is initiated.

- The most commonly observed FHR tracing present with neurologic injury is a non-reactive FHR and minimal or absent FHR variability with a persistent fixed FHR baseline [10,45].

- Be aware that antepartum neurologic injury can be present with a normal intrapartum FHR tracing [46].

- In studies of infants, an injury to the medulla oblongata or midbrain may be the cause of decreased or loss of FHR variability [47].

For improved neonatal outcome, FHR monitoring requires the health care provider to correctly recognize a Category I, II, and III tracing, communicate their interpretation with the health care team, and initiate appropriate and timely interventions [19,48].

General Principles of Evaluation and Management Include:

Management of Category II and III Tracings are aimed at improving uteroplacental perfusion and maternal/fetal oxygenation (Table 3).

- When possible, determine the likely cause of the abnormality:
  - Abruptio placenta
  - Cord prolapse
  - Tachysystole
  - Maternal medication
  - Malposition
  - Rapid descent of fetal head
- Reposition the patient onto her left or right side.
- Further management strategies are continued on the following slides.
  - Changing the maternal position may also beneficial by releasing the weight of the fetus on the maternal vena cava.
  - Changing the maternal position may reduce cord compression and improve maternal blood flow to the placenta.
  - The result is usually improved fetal gas exchange.

Click the arrows to see more principles.

Goal	FHR Abnormality	Intervention
Promote fetal oxygenation and improve blood flow to the uterus	- Recurrent late decelerations - Prolonged decelerations - Fetal bradycardia - Minimal or absent variability	- Reposition the woman in a lateral position. If in a lateral position, change her to the other side. - Oxygen (O_2) administration - Intravenous (IV) fluid bolus - Reduce frequency of uterine contractions
Reduce uterine activity	Tachysystole with Category II or III tracing	- Discontinue oxytocin or cervical ripening agents - Administer tocolytic medication
Alleviate umbilical cord compression	- Recurrent variable decelerations - Prolonged deceleration - Fetal bradycardia	- Reposition the woman in a lateral or knee-chest position - Perform amnioinfusion - If cord prolapse, keep presenting fetal part elevated away from the cord
Normalize maternal hypotension	- Recurrent late decelerations - Prolonged decelerations - Fetal bradycardia - Catergory II or III tracings	- Lateral position - IV fluids - If FHR not improving with other interventions, consider Ephedrine 5 to 10mg intravenous push (IVP)

General Principles of Evaluation and Management Include:

Administration of oxygen is controversial and not utilized routinely.

- There is controversy over the benefits and potential harms of oxygen therapy due to generation of free radicals [49,50].

- Observational studies have noted maternal oxygen administration can improve fetal oxygenation and decrease the frequency of late fetal decelerations [51-53]. There are no randomized trials evaluating oxygen therapy alone for treatment of category II and III tracings [54].

- Within 8 to 10 minutes of maternal oxygen administration, the fetal pO_2 and oxygen saturation reaches a higher level. These levels both decrease after supplemental maternal oxygen is removed [55-60].

- The effect of fetal pH related to maternal oxygen supplementation is **weak** and **inconsistent** [57-59,61-63].

- Fetal acidemia cannot be corrected by administering oxygen to the woman alone, the **underlying cause** of fetal hypoxemia needs to be corrected [64].

Click the arrows to see more principles.

General Principles of Evaluation and Management Include:

Administer a bolus of 500 to 1000mL of lactated Ringer's or normal saline solution:

- Improved fetal oxygenation is noted on the FHR tracing as a result of increased placental blood flow when the hypovolemic woman receives an intravenous (IV) fluid bolus of non-glucose crystalloid [55, 57].

- Women with preeclampsia, cardiovascular disease, or those receiving beta-adrenergic drugs for tocolysis should receive IV fluids with caution. These women are at increased risk of volume overload.

Click the arrows to see more principles.

General Principles of Evaluation and Management Include:

Discontinue Uterotonic Drugs

- If tachysystole occurs uterotonic drugs can be decreased or stopped [30].

- When uterine contractions, occur there is an interruption of blood flow to the intervillous space. When tachysystole occurs the fetus may develop fetal hypoxemia [65].

- If discontinuing the uterotonic drug does not result in decreased uterine contractions, it is recommended to administer a tocolytic drug. Terbutaline 250mcg subcutaneously, as a uterine relaxation medication, may improve placental blood flow and improve fetal oxygenation [65].

Click the arrows to see more principles.

General Principles of Evaluation and Management Include:

Women Who Have Recently Received Epidural Analgesia for Labor Pain Management:

- If maternal hypotension occurs an alpha adrenergic agonist, such as phenylephrine or ephedrine, could be considered. This medication, along with an IV fluid bolus, may be corrective and improve uteroplacental blood flow.

- If mild or marked maternal hypotension occurs, the FHR may decelerate due to reduced placental perfusion.

- Alpha-adrenergic agonists phenylephrine or ephedrine, should be administered by a health care provider with expertise in the dosing and side effects of these medications.

Click the arrows to see more principles.

General Principles of Evaluation and Management Include:

- The key observation is to determine if FHR accelerations are present and 15 bpm or more above the baseline and last for 15 seconds or more. This assures the absence of fetal acidosis [36,37].

- If accelerations are not observed, elicit by manual or vibro-acoustic stimulation.

- When FHR accelerations are stimulated, the fetal pH is >7.20 in over 90% of the cases, and when no FHR accelerations occur, the pH is <7.20 in approximately 50% of the cases [35,66-69].

Click the arrows to see more principles.

General Principles of Evaluation and Management Include:

- If accelerations cannot be elicited, further evaluation is necessary.

- Close observation and surveillance are recommended until a Category II tracing improves to a Category I or progresses to a Category III tracing. To date, there is no data to outline how long to monitor a fetus with a persistent Category II tracing with the use of standard interventions.

Click the arrows to see more principles.

General Principles of Evaluation and Management Include:

Fetal Pulse Oximetry

There are theoretical evaluations which can be done, but are not routinely performed nor validated:

- fetal pulse oximetry
- fetal scalp blood sampling
- ST analysis of fetal heart rate (STAN)

Click the arrows to see more principles.

General Principles of Evaluation and Management Include:

FHR Response to Stimulation

- The fetal scalp stimulation maneuver is easy to perform, inexpensive, readily available, and not uncomfortable.

- Fetal scalp stimulation can be elicited with digital scalp stimulation, vibroacoustic stimulation, fetal scalp puncture, or Allis clamp scalp stimulation [67].

- Scalp stimulation should be performed when the FHR is at its baseline rate.

- Fetal scalp stimulation performed during a FHR deceleration is not predictive of fetal acid-vase status, will not terminate the deceleration, and may further compromise the fetus.
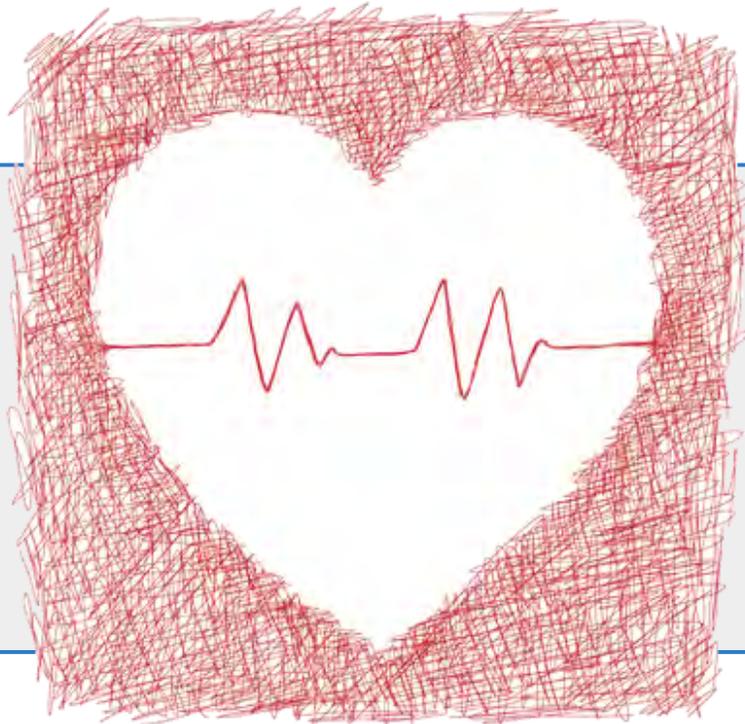
External monitoring is as reliable as internal monitoring in most cases [71].

Internal monitoring may be needed when the external tracing is difficult to interpret because of poor quality.

Poor quality external tracing may be a result of prematurity, multiple gestation, maternal obesity, frequent maternal or fetal movement, uterine myomata, or polyhydramnios.

Noninvasive or external FHR monitoring can be performed with a Doppler ultrasound device on the maternal abdomen [72].

- The EFM detects FHR atrial and ventricular contractions and opening and closing of the valves to create a complex wave form tracing.

- The computer then detects the peak of the wave to calculate a mechanical R wave-to-R wave (RR) interval.

- Because of the inherent variation in the Doppler ultrasound signal, a computer calculates the FHR by averaging several consecutive RR intervals to minimize artifact. This is known as auto correlation.

- This results in a highly processed record that smooths out signal variation and produces a processed sound, which is not the actual fetal heart beat.

Click the picture for more information.

Noninvasive or external FHR monitoring can be performed with a Doppler ultrasound device on the maternal abdomen (continued) [72]:

- The FHR tracing closely resembles that derived from a fetal electrocardiogram, but there is more baseline variability inherent with the Doppler technique.

- The Monica AN24 is an alternative technology that requires several electrodes to be placed on the maternal abdomen. The electrodes detect the fetal RR interval.

- Wireless monitors enable FHR monitoring while the women is ambulating.

- Auscultation of the FHR using a fetal stethoscope is also possible, but is rarely used because it is impractical due to requiring one-to-one nursing, and provides no information about variability, presence or frequency of accelerations, or shape of decelerations.
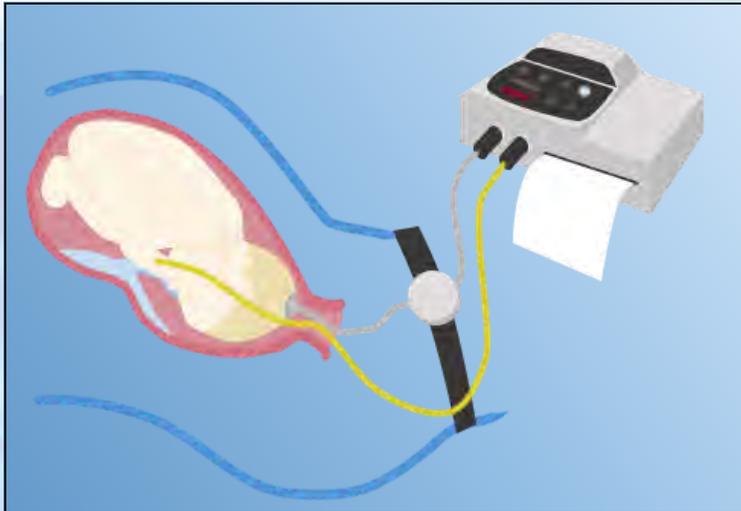
A fetal electrocardiogram (ECG) can be obtained by placing a bipolar spiral electrode into the fetal scalp transcervically.

- A second reference electrode is placed on the maternal thigh to eliminate electrical interference from maternal cardiac activity.

- A computer calculates the FHR based on the RR interval based on QRS complex of an electrocardiogram.

- Artifact is minimal so the signal is very clear and provides accurate measurement of beat-to-beat variability without autocorrelation [73-74].

Click here for more information.

The American College of Obstetricians and Gynecologists (ACOG) [30]:
- Continuous electronic FHR monitoring or intermittent auscultation (or intermittent monitoring) is acceptable in uncomplicated patients.
- High risk pregnancies (e.g., preeclampsia, suspected growth restriction, type 1 diabetes mellitus) should be monitored continuously during labor.

National Institute for Health Care Excellence:
- In all birth settings, offer intermittent auscultation to low-risk women in the first stage of labor. Do not perform cardiotocography in low-risk women.
- Advise continuous cardiotocography if any of the following risk factors occur during labor:
  - Suspected chorioamnionitis, sepsis, or temperature ≥38°C
  - Severe hypertension (≥160/110mmHg)
  - Oxytocin use
  - Significant meconium
  - Fresh vaginal bleeding

If continuous cardiotocography was used because of concerns arising from intermittent auscultation, but the tracing is normal after 20 minutes of observation, remove the cardiotocograph and return to intermittent auscultation.
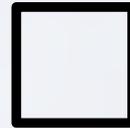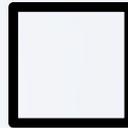
- Two commonly used modalities for intrapartum FHR monitoring are continuous electronic FHR monitoring and intermittent auscultation/monitoring. The body of evidence indicates that neither test performs better than the other.

- Medical and legal views in the United States make some form of intrapartum FHR monitoring mandatory. Continuous electronic FHR monitoring is recommended for high-risk pregnant women.

- For the low-risk pregnant woman, intermittent or continuous electronic FHR monitoring is reasonable.

- Intrapartum FHR monitoring is usually not performed when a pregnancy is at a gestation age below the limit of viability or the fetus has an untreatable anomaly lethal in the newborn.

Click each box for more information.
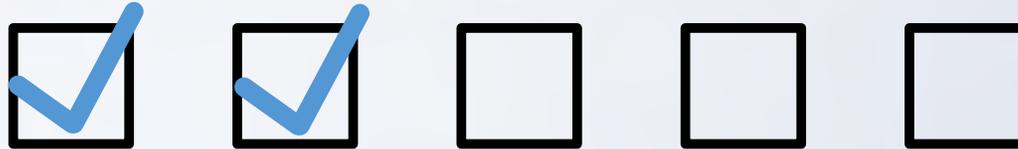
The National Institutes of Child Health and Human Development (NICHDA) definitions of FHR characteristics and their three-tier approach for interpreting fetal heart rate patterns (**Table 2**) and managing pregnancies with these patterns (**Table 3**) is generally agreeable.

However, it seems prudent to manage pregnancies with minimal variability similar to those with absent variability.

Use of this standardized approach to pattern recognition coupled with a standardized package of therapeutic interventions may improve neonatal outcomes.

Click each box for more information.

Category	Interpretation	Features
I - Normal	Strongly predictive of normal acid-base status at this time of observation	• Baseline FHR 110-160 bpm • Baseline FHR variability moderate 6 to 25 bpm • Late or variable FHR decelerations are absent • Early FHR decelerations are present or absent
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III - Abnormal	Predictive of abnormal acid-base status at time of observation	Absent FHR variability AND any of the following: • Recurrent late FHR decelerations • Recurrent variable FHR decelerations • FHR bradycardia • Sinusoidal FHR pattern

Goal	FHR Abnormality	Intervention
Promote fetal oxygenation and improve blood flow to the uterus	• Recurrent late decelerations • Prolonged decelerations • Fetal bradycardia • Minimal or absent variability	• Reposition the woman in a lateral position. If in a lateral position, change her to the other side. • Oxygen (O_2) administration • Intravenous (IV) fluid bolus • Reduce frequency of uterine contractions
Reduce uterine activity	• Tachysystole with Category II or III tracing	• Discontinue oxytocin or cervical ripening agents • Administer tocolytic medication
Alleviate umbilical cord compression	• Recurrent variable decelerations • Prolonged deceleration • Fetal bradycardia	• Reposition the woman in a lateral or knee-chest position • Perform amnioinfusion • If cord prolapse, keep presenting fetal part elevated away from the cord
Normalize maternal hypotension	• Recurrent late decelerations • Prolonged decelerations • Fetal bradycardia • Catergory II or III tracings	• Lateral position • IV fluids • If FHR not improving with other interventions, consider Ephedrine 5 to 10mg intravenous push (IVP)

FHR abnormalities can be related to multiple factors other than hypoxemia.

A major goal of intrapartum fetal monitoring is to distinguish the large number of fetuses with Category II tracings who are hypoxemic, but well compensated, from the small number who are at risk of acidosis or death. This is also true for Category III tracings, except the likelihood of fetal acidosis is much higher with this pattern than with category II tracings. Further evaluation using ancillary tests may be useful.

Click each box for more information.

A key step in evaluation of a Category II or III FHR tracing is to determine if accelerations are present as a rise of ≥15 beats per minute above baseline lasting for ≥15 seconds almost always assures the absence of fetal acidosis. If accelerations are not observed, they should be elicited with manual or vibroacoustic stimulation.

When accelerations are induced in this setting, the fetal pH is >7.20 in over 90% of cases, and when no accelerations occur, pH is <7.20 in approximately 50% of cases.

Determine the cause of the abnormal FHR tracing and initiate corrective interventions such as discontinuing uterotonic drugs, changing the maternal position, administering an IV fluid bolus, and providing maternal oxygen supplementation.

Click each box for more information.

Transient episodes of hypoxemia, such as during a contraction or temporary cord compression, are generally well-tolerated by the fetus.

Repeated or prolonged episodes of hypoxemia, especially if severe, may lead to fetal acidosis. Further evaluation of a Category II and III FHR tracings is indicated to distinguish the fetus who is not hypoxemic, or hypoxemic but well compensated, from one who is acidotic.

Assessing the FHR response to stimulation is a readily available method of fetal assessment that is easy to perform, inexpensive, and comfortable for the patient.
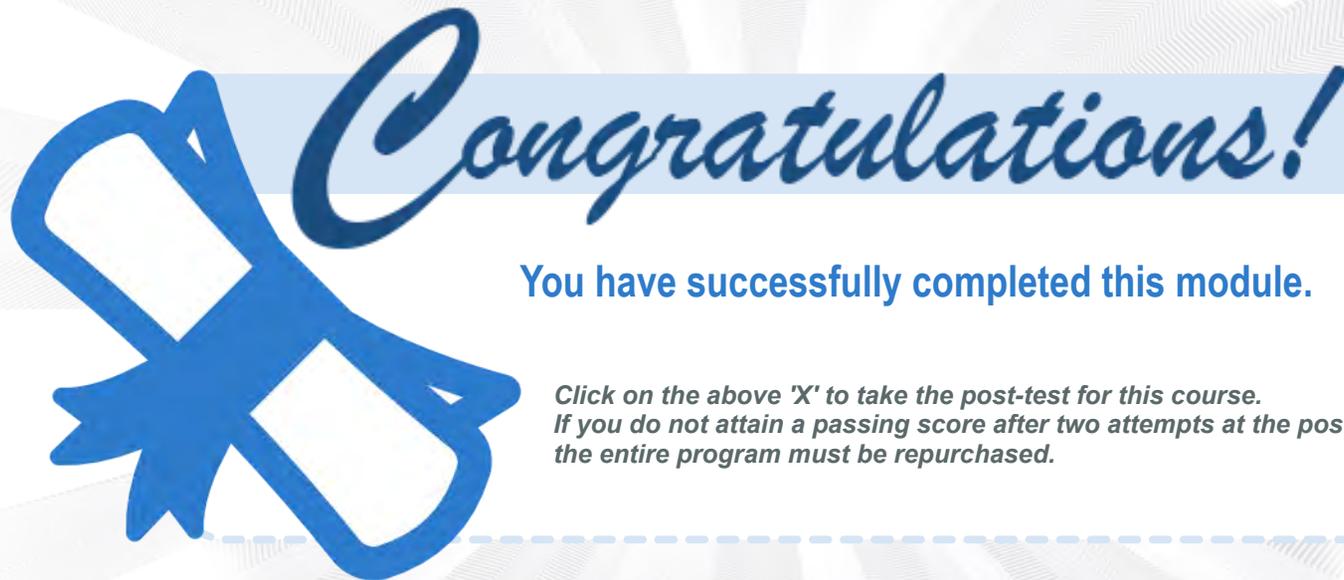
Congratulations!

You have successfully completed this module.

Click on the above 'X' to take the post-test for this course.
If you do not attain a passing score after two attempts at the post-test
the entire program must be repurchased.

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