How to differentiate maternal from fetal heart rate patterns on electronic fetal monitoring

Three cases illustrate how maternal heart rate may masquerade as a fetal heart rate pattern and obscure the interpretation of EFM recordings

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IN THIS ARTICLE

Continuous electronic fetal heart rate monitoring (EFM) is used in the vast majority of all labors in the United States. With the use of EFM categories and definitions from the American College of Obstetricians and Gynecologists, the National Institutes of Health, and the Society for Maternal-Fetal Medicine, clinicians can now better define and communicate tracing assessments. Except for reducing neonatal seizure activity, however, EFM use during labor has not been demonstrated to significantly improve fetal and neonatal outcomes, yet EFM is associated with an increase in cesarean deliveries and instrument-assisted vaginal births.[1]

The negative predictive value of EFM for fetal hypoxia/acidosis is high, but its positive predictive value is only 30%, and the false-positive rate is as high as 60%.[2] Although a false-positive assessment may result in a potentially unnecessary operative vaginal or cesarean delivery, a falsely reassuring strip may produce devastating consequences in the newborn and, not infrequently, medical malpractice liability. One etiology associated with falsely reassuring assessments is that of EFM monitoring of the maternal heart rate and the failure to recognize the tracing as maternal.

In this article, I discuss the mechanisms and periods of labor that often are associated with the maternal heart rate masquerading as the fetal heart rate. I review common EFM patterns associated with the maternal heart rate so as to aid in recognizing the maternal heart rate. In addition, I provide 3 case scenarios that illustrate the simple yet critical steps that clinicians can take to remedy the situation. Being aware of the potential for a maternal heart rate recording, investigating the EFM signals, and correcting the monitoring can help prevent significant morbidity.

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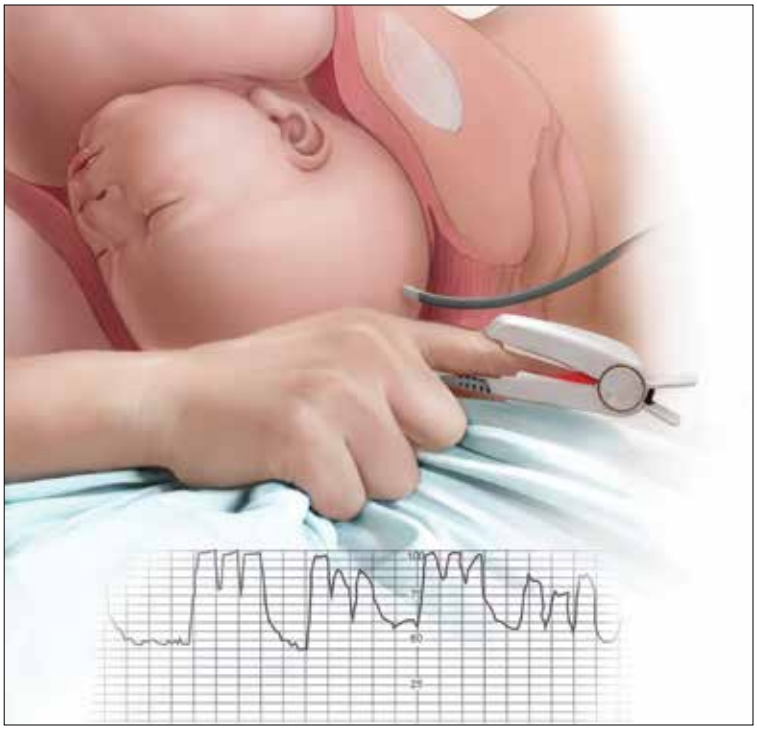
CASE 1 EFM shows seesaw decelerations and returns to baseline rate

A 29-year-old woman (G3P2) at 39 weeks' gestation was admitted to the hospital with spontaneous labor. Continuous EFM external monitoring was initiated. After membranes spontaneously ruptured at 4 cm dilation, an epidural was placed. Throughout the active phase of labor, the fetus demonstrated intermittent mild variable decelerations, and the fetal heart rate baseline increased to 180 beats per minute (BPM). With complete dilation, the patient

initiated pushing. During the first several pushes, the EFM demonstrated an initial heart rate deceleration, and a loss of signal, but the heart rate returned to a baseline rate of 150 BPM. With the patient's continued pushing efforts, the EFM baseline increased to 180 BPM, with evidence of variable decelerations to a nadir of 120 BPM, although with some signal gaps (**FIGURE 1,** red arrow). The tracing then appeared to have a baseline of 120 BPM with variability or accelerations (**FIGURE 1**, green arrow) before shifting again to 170 to 180 BPM.

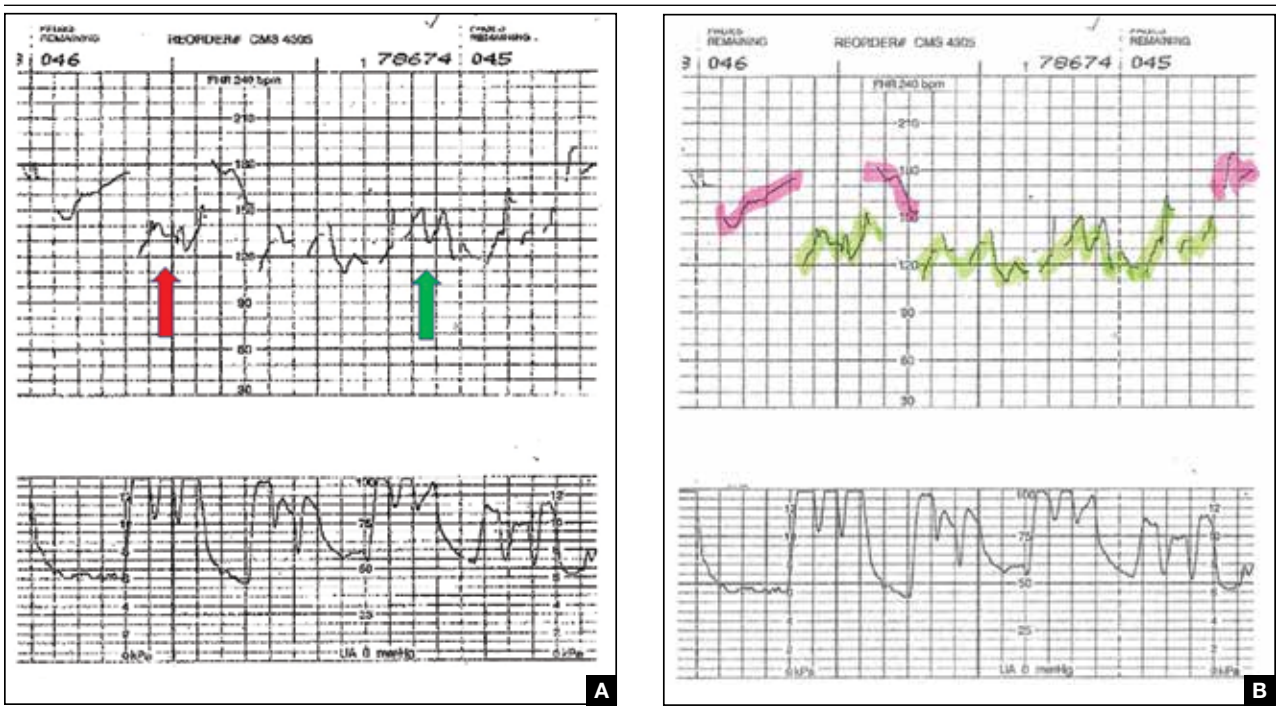
What was happening?



Why does the EFM record the maternal heart rate?

Most commonly, EFM recording of the maternal heart rate occurs during the second stage of labor. Early in labor, the normal fetal heart rate (110–160 BPM) typically exceeds the basal maternal heart rate. However, in

FIGURE 1 Variable decelerations



This EFM recording during the second stage of labor demonstrates pushing efforts every 1 minute (**panel A**). The red arrow indicates signal gaps; the green arrow shows variability or accelerations. In **panel B**, with the maternal heart rate highlighted in green and the fetal heart rate in pink, the patterns are now visible.

Abbreviation: EFM, electronic fetal heart rate monitoring.

ILLUSTRATION: KIMBERLY MARTENS FOR OBG MANAGEMENT

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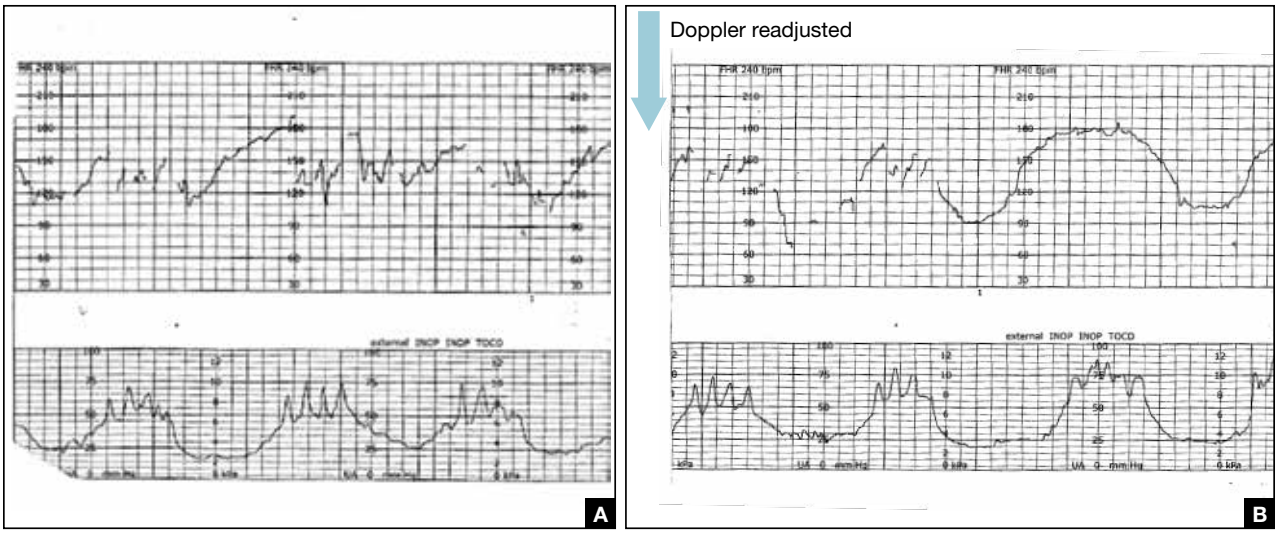
FIGURE 2 Breaks in the tracing



This EFM recording during the second stage of labor shows pushing efforts every 2 minutes (**panel A**). With adjustment of the Doppler monitor, the pattern of late decelerations is visible (**panel B**).

Abbreviation: EFM, electronic fetal heart rate monitoring.

FAST TRACK

The external Doppler fetal monitor may lose focus on the fetal heart as a result of descent of the baby, the abdominal shape-altering effect of uterine contractions, and the patient's pushing

the presence of chorioamnionitis and maternal fever or with the stress of maternal pushing, the maternal heart rate frequently approaches or exceeds that of the fetal heart rate. The maximum maternal heart rate can be estimated as 220 BPM minus the maternal age. Thus, the heart rate in a 20-year-old gravida may reach rates of 160 to 180 BPM, equivalent to 80% to 90% of her maximum heart rate during second-stage pushing.

The external Doppler fetal monitor, having a somewhat narrow acoustic window, may lose the focus on the fetal heart as a result of descent of the baby, the abdominal shape-altering effect of uterine contractions, and the patient's pushing. During the second stage, the EFM may record the maternal heart rate from the uterine arteries. Although some clinicians claim to differentiate the maternal from the fetal heart rate by the "whooshing" maternal uterine artery signal as compared with the "thumping" fetal heart rate signal, this auditory assessment is unproven and likely unreliable.

CASE 1 Problem recognized and addressed

In this case, the obstetrician recognized that "slipping" from the fetal to the maternal heart rate recording occurred with the onset of maternal pushing. After the pushing ceased, the maternal heart rate slipped back to the fetal heart rate. With the next several contractions, only the maternal heart rate was recorded. A fetal scalp electrode was then placed, and fetal variable decelerations were recognized. In view of the category II EFM recording, a vacuum procedure was performed from +3 station and a female infant was delivered. She had Apgar scores of 6 and 8 at 1 and 5 minutes, respectively, and she did well in the nursery.

CASE 2 EFM tracings belie the clinical situation

A 20-year-old woman (G1P0) presented for induction of labor at 41 weeks' gestation. Continuous EFM recording was initiated, and the patient was given dinoprostone and, subsequently, oxytocin. Rupture of membranes at 3 cm demonstrated a small amount of fluid with thick meconium. The patient progressed to complete dilation and developed a temperature of 38.5°C; the EFM baseline increased to 180 BPM. Throughout the first hour of the second stage of labor, the EFM demonstrated breaks in the tracing and a heart rate of 130 to 150 BPM with each pushing effort (**FIGURE 2A**). The Doppler monitor was subsequently adjusted to focus on the fetal heart and repetitive late decelerations were

observed (**FIGURE 2B**). An emergent cesarean delivery was performed. A depressed newborn male was delivered, with Apgar scores of 2 and 4 at 1 and 5 minutes, respectively, and significant metabolic acidosis.

What happened?

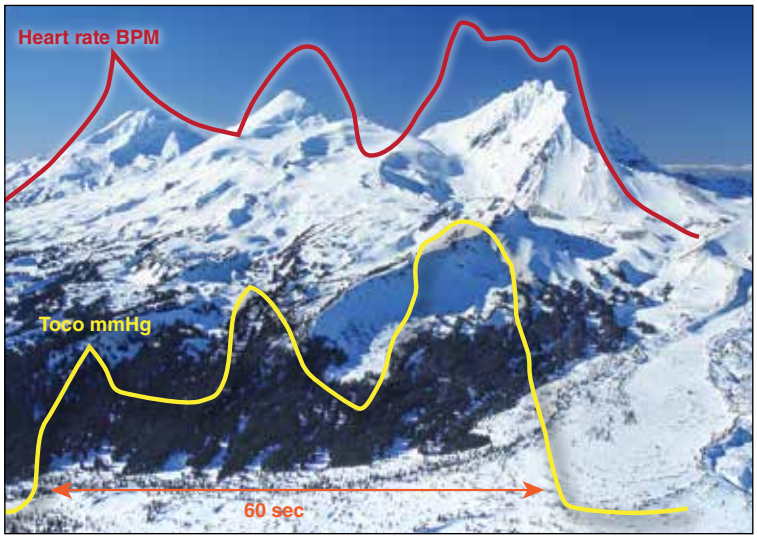
Fetal versus maternal responses to pushing

The fetal variable deceleration pattern is well recognized by clinicians. As a result of umbilical cord occlusion (due to compression, stretching, or twisting of the cord), fetal variable decelerations have a typical pattern. An initial acceleration shoulder resulting from umbilical vein occlusion (due to reduced venous return) is followed by an umbilical artery occlusion–induced sharp deceleration. The relief of the occlusion allows the sharp return toward baseline with the secondary shoulder overshoot.

In some cases, partial umbilical cord occlusion that affects only the fetal umbilical vein may result in an acceleration, although these usually resolve or evolve into variable decelerations within 30 minutes. By contrast, the maternal heart rate typically increases with contractions and with maternal pushing efforts. Thus, a repetitive pattern of *heart rate accelerations with each contraction* should warn of a possible maternal heart rate recording.

How maternal heart rate responds to pushing. Maternal pushing is a Valsalva maneuver. Although there are 4 classic cardiovascular phases of Valsalva responses, the typical maternal pushing effort results in an increase in the maternal heart rate. With the common sequence of three 10-second pushes during each contraction, the maternal heart rate often exhibits 3 acceleration and deceleration responses. The maternal heart rate tracing looks similar to the shape of the Three Sisters mountain peaks in Oregon (**FIGURE 3**). Due to Valsalva physiology, the 3 peaks of the Sisters mirror the 3 uterine wave form peaks, although with a 5- to 10-second delay in the heart rate responses (mountain peaks) from the pushing efforts.

FIGURE 3 Pattern of maternal heart rate



The shape of the Three Sisters mountain peaks is similar to the pattern of maternal heart rate (red line) in response to 3 maternal pushing efforts during a single uterine contraction (yellow line).

Pre- and postcontraction changes offer clues. Several classic findings aid in differentiating the maternal from the fetal heart rate. If the tracing is maternal, typically the heart rate gradually *decreases* following the end of the contraction/pushing and continues to decrease until the start of the next contraction/pushing, at which time it increases. During the push, the Three Sisters wave form, with the 5- to 10-second offset, should alert the clinician to possible maternal heart rate recordings. By contrast, the fetal heart rate variable deceleration typically *increases* following the end of the maternal contraction/pushing and is either stable or increases further (variable with slow recovery) prior to the next uterine contraction/pushing effort. These differences in the patterns of precontraction and postcontraction changes can be very valuable in differentiating periods of maternal versus fetal heart rate recordings.

With "slipping" between fetal and maternal recording, it is not uncommon to record fetal heart rate between contractions, slip to the maternal heart rate during the pushing effort, and return again to the fetal heart rate with the end of the contraction. When confounded with the potential for other EFM

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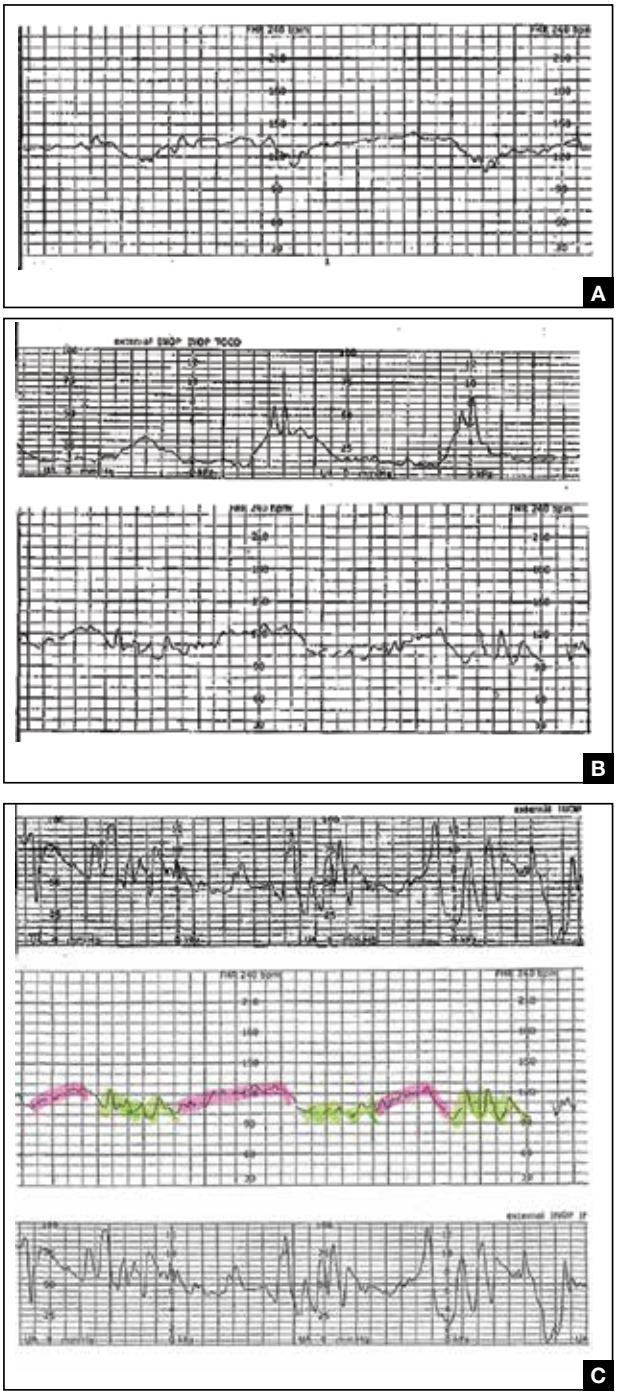
A repetitive pattern of heart rate accelerations with each contraction should warn of a possible maternal heart rate recording

PHOTO: SHUTTERSTOCK

FIGURE 4 Fetal to maternal heart rate recording



EFM recording during the active phase of labor (**panel A**). Note the small decelerations with each contraction. Maternal pulse was recorded as 71 BPM during this period, confirming this is the fetal heart rate. In the second stage, the tracing appears similar (**panel B**). However, as shown in **panel C**, the EFM is now recording the maternal heart rate (highlighted in green) during each contraction and the fetal heart rate (highlighted in pink) between contractions.

Abbreviations: BPM, beats per minute; EFM, electronic fetal heart rate monitoring.

artifacts, including doubling of a low maternal or fetal heart rate, or halving of a tachycardic signal, it is not surprising that it is challenging to recognize an EFM maternal heart rate recording.

CASE 2 Check the monitor for accurate focus

A retrospective analysis of this case revealed that the maternal heart rate was recorded with each contraction throughout the second stage. The actual fetal heart rate pattern of decelerations was revealed with the refocusing of the Doppler monitor.

CASE 3 Low fetal heart rate and variability during contractions

A 22-year-old woman (G2P1) in spontaneous labor at term progressed to complete dilation. Fetal heart rate accelerations occurred for approximately 30 minutes. With the advent of pushing, the fetal heart rate showed a rate of 130 to 140 BPM and mild decelerations with each contraction (**FIGURE 4A**). As the second stage progressed, the tracing demonstrated an undulating baseline heart rate between 100 and 130 BPM with possible variability during contractions (**FIGURE 4B**). This pattern continued for an additional 60 minutes. At vaginal delivery, the ObGyn was surprised to deliver a depressed newborn with Apgar scores of 1 and 3 at 1 and 5 minutes, respectively.

Slipping from the fetal to the maternal heart rate may be imperceptible

In contrast to the breaks in the tracings seen in Case 1 and Case 2, the EFM tracing in Case 3 appears continuous. Yet, slipping from the fetal to the maternal recording was occurring.

As seen in **FIGURE 4C,** the maternal heart rate with variability was recorded during pushing efforts, and the fetal heart rate was seen rising back toward a baseline between contractions. Note that the fetal heart rate did not reach a level baseline, but rather decelerated with the next contraction. The slipping to the maternal heart rate occurred without

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a perceptible break in the recording, making this tracing extremely difficult to interpret.

CASE 3 Be ever vigilant

The lack of recognition that the EFM recording had slipped to the maternal heart rate resulted in fetal and newborn hypoxia and acidosis, accounting for the infant's low Apgar scores.

Follow 3 steps to discern fetal vs maternal heart rate

These cases illustrate the difficulties in recognizing maternal heart rate patterns on the fetal monitor tracing. The 3 simple steps described below can aid in differentiating maternal from fetal heart rate patterns.

1 Be aware and alert

Recognize that EFM monitoring of the maternal heart rate may occur during periods of monitoring, particularly in second-stage labor. Often, the recorded tracing is a mix of fetal and maternal patterns. Remember that the maternal heart rate may increase markedly during the second stage and rise even higher during pushing efforts. When presented with a tracing that ostensibly represents the fetus, it may be challenging for the clinician to question that assumption. Thus, be aware that tracings may not represent what they seem to be.

Often, clinicians view only the 10-minute portion of the tracing displayed on the monitor screen. I recommend, however, that clinicians review the tracing over the past 30 to 60 minutes, or since their last EFM assessment, for an understanding of the recent fetal baseline heart rate and decelerations.

2 Investigate

Although it is sometimes challenging to recognize EFM maternal heart rate recordings, this is relatively easy to investigate. Even without a pulse oximeter in place, carefully examine the EFM recording for maternal signs to determine if the maternal heart rate is within the range of the recording. You can confirm that the recording is *maternal* through 1 of 3 easy measures:

- First, check the maternal radial pulse and correlate it with the heart rate baseline.
- Second, place a maternal electrocardiographic (EKG) heart rate monitor.
- Last, and often the simplest approach for continuous tracings, place a finger pulse oximeter to provide a continuous maternal pulse reading. Should the maternal heart rate superimpose on the EFM recording, maternal patterns are likely being detected. However, since the pulse oximeter and EFM Doppler devices use different technologies, they will provide similar—but not precisely identical—heart rate numerical readings if both are assessing the maternal heart rate. In that case, take steps to assure that the EFM truly is recording the fetal heart rate.

3 Treat and correct

If the EFM is recording a maternal signal or if a significant question remains, place a fetal scalp electrode (unless contraindicated), as this may likely occur during the second stage. Alternatively, place a maternal surface fetal EKG monitor, or use ultrasonography to visually assess the fetal heart rate in real time.

Key point summary

The use of a maternal finger pulse oximeter, combined with a careful assessment of the EFM tracing, and/or a fetal scalp electrode are appropriate measures for confirming a fetal heart rate recording.

The 3 steps described (be aware and alert, investigate, treat and correct) can help you effectively monitor the fetal heart rate and avoid the potentially dangerous outcomes that might occur when the maternal heart rate masquerades as the fetal heart rate. ●

FAST TRACK

To confirm that a recording is maternal, check the maternal radial pulse and correlate it with baseline heart rate, place a maternal EKG, or place a finger pulse oximeter to provide a continuous maternal pulse reading

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