Reviewed By
RAAOUM M. JABOR

Video Case

Intrapartum Fetal Surveillance

Objectives:

- → Describe the techniques of fetal surveillance.
- → Interpret electronic fetal heart rate monitoring.
- → Discuss the complications of abnormal fetal heart rate patterns including asphyxia and meconium aspiration.

- → Slides
- → Important
- → Golden notes
- → Extra
- → 439 Doctor's notes
- → 441 Doctor's notes
- → 441 Female Presentation
- → Reference

Female presentation

Video Case | Editing File

Intrapartum Fetal surveillance

The goals of Intrapartum Fetal surveillance

- Fetal surveillance during labor is an essential element of good obstetric care. On the basis of **intrapartum maternal history**, **physical examination, and laboratory data.**
- 20-30% of pregnancies are designated high risk.
- 50% of perinatal morbidity and mortality occurs in high risk group.
- Improves the management of labor and **reduces perinatal morbidity and mortality.**
- The goal of intrapartum fetal surveillance it's a detective event that occur during labor that could compromise fetal oxygenation

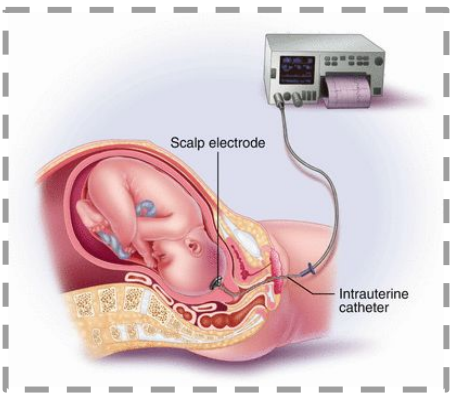
Fetal Heart Rate Monitoring

- fetal heart rate monitoring is a modality intended to determine if the fetus is well oxygenated
- **Normal** fetal heart rate (FHR) findings are highly **reassuring** of fetal well-being.
- **Abnormal** FHR findings are **poor predictors** of fetal compromise. It probably related to a combination of hypoxia, acidosis, and inflammation

- **Both of the following modalities are equivalent in predicting fetal outcome:**
  - **Intermittent auscultation** of FHR is performed with a fetoscope using auditory FHR counting averaged for 10–15 s (low risk patients). It performed by listening from the beginning of one contraction to the beginning of the next contraction.
    - For Low risk Pt : every **30** minutes after a uterine contraction during the **first** stage, and at least every **15** minutes in the **second** stage of labor.
    - If high risk (In hospitals that lack the facilities to perform continuous monitoring **:** Auscultate the FHR every **15** minutes in the **first** stage of labor, and continuously or every **5** minutes in **second** stage.)
  - **Electronic fetal monitoring (EFM)** measures the milliseconds between consecutive cardiac cycles giving an instantaneous FHR continuously (High risk patients).

    The term EFM is sometimes used synonymously with CTG monitoring, but is considered to be a less precise term because CTG monitoring also includes monitoring the mother's contractions.
    - in the United States 85% of labors involve electronic fetal heart rate monitoring electronic fetal monitoring may be performed externally with a Doppler device or internally with a fetal scalp electrode .

Fetoscope



Fetal scalp electrode

Intrapartum Fetal surveillance

Continuous Electronic Monitoring

Continues electronic monitoring	
External Devices : by doppler device	**Internal Devices** : by fetal scalp electrode
• External devices (1st line and most common) are placed on the uterine fundus.	• Internal devices are placed through the dilated cervix (a bit invasive).
• **Advantages**: utilization before significant cervical dilation and membrane rupture.	• **Advantages**: optimum signal quality, which is unaffected by maternal obesity.
• **Disadvantages**: poor quality tracing with maternal obesity and maternal discomfort from the device belts. Also it can affected by maternal movement.	• **Disadvantages**: limitation to labor when cervical dilation and membrane rupture have occurred.
• **Fetal**: A continuous ultrasound transducer picks up fetal cardiac motion but also can register maternal great vessel pulsations.	• **Fetal**: A direct scalp electrode precisely senses each QRS complex of the fetal cardiac cycle. Complications can include fetal scalp trauma/Laceration and infection.
• **Contractions**. A tocographic transducer device senses the change in uterine wall muscle tone. It can measure the beginning and ending of contractions but cannot assess contraction intensity.	• **Contractions**: An intrauterine pressure catheter (IUPC) placed into the uterine cavity precisely registers intrauterine hydrostatic changes with each contraction.

In the clinical setting, internal and external techniques are often combined by using a scalp electrode for precise heart rate recording and the external tocodynamometer for contractions. This approach minimizes possible side effects from invasive internal monitoring.

The pathophysiology of FHR change

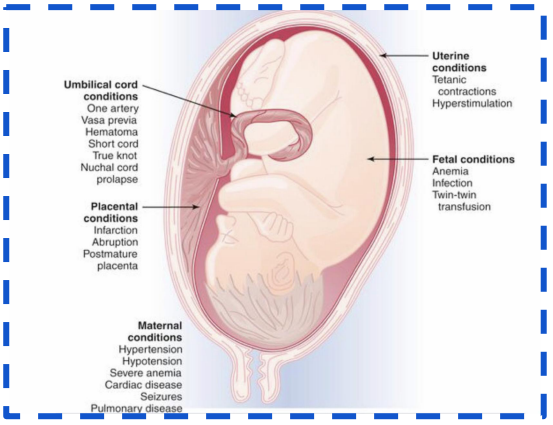
- The fetal arterial blood oxygen tension in only 25± 5 mm HG, adults 100 mmHG.
- Normal fetus can withstand the **temporary reduction** in blood flow to the placenta **without** suffering from hypoxia because sufficient oxygen exchange occurs during the interval between contractions.
- **Hypoxia when sufficiently severe**, will result in anaerobic metabolism, resulting in the accumulation of pyruvic and lactic acid and causing **fetal acidosis.**
- Fetal acidosis is measured by sampling blood from the presenting part. Normally the pH varies between 7.25-7.30.
- Fetal death occurs when **50% or more** of the transplacental oxygen is **interrupted**.

Intrapartum Fetal surveillance

The pathophysiology of FHR change cont.

The fetal oxygenation pathway can be interrupted at different locations within the uteroplacental-fetal circulatory loop. For example :

- **Maternal conditions:** Such as in **hypertensive** or **anemic** mothers
- **Fetal conditions:** Such as in **hemolytic anemia** in Rh-isoimmunization
- **Umbilical cord conditions:** Such as in **hematoma of the cord, short or true knot of the cord**.
- **Placenta conditions:** Such as in **infarction or abruption**
- **Uterine conditions:** Such as in **hyperstimulation**

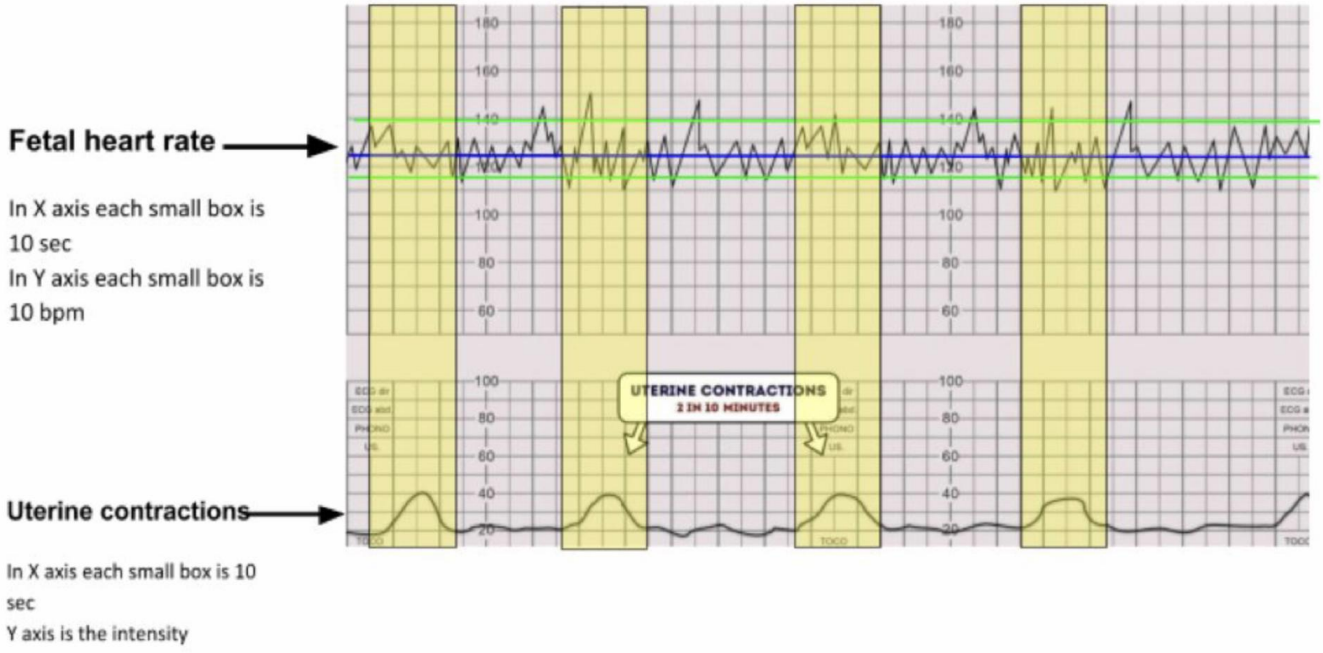


Follow these steps To Read the FHR

1. Draw a straight line between the fluctuations **(the blue line)** and see the number it cross, **this is the heart rate.** (if there is accelerations or decelerations in this step just ignore them)

2. Look at the fluctuation **(green lines)** and count the boxes between them, (each small step box in this figure is 10 bpm) **this is the variability.** (again if there is accelerations or decelerations in this step just ignore them)
   eg. here there is two and half small boxes, you can say the variability is 25 bpm.

3. Now search for accelerations or decelerations (Periodic fetal heart rate changes),
   + compare the time of deceleration with the uterine contractions **(the yellow area)**.

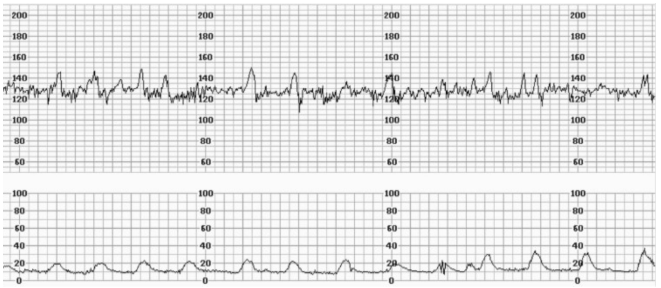


How to interpret EFM ?

How to interpret CTG?

The most popular structure can be remembered using the acronym "DR C BRAVADO":

- **DR:** Define risk.
- **C:** Contractions.
- **BRa:** Baseline rate.
- **V:** Variability.
- **A:** Accelerations.
- **D:** Decelerations.
- **O:** Overall impression.



Baseline Fetal Heart Rate (FHR) Most of the lines عليه ماشي

- **Baseline Fetal Heart Rate (FHR):** The mean **FHR** rounded to increments of 5 beats/min during a 10-minute segment. Normal FHR baseline is **110–160 beats/minute.**

Tachycardia: FHR baseline is >160 beats/min.	Bradycardia: FHR baseline is <110 beats/min.
Non-hypoxic explanations include: • **Maternal: most commonly medications**:(β adrenergic agonists[terbutaline], atropine, scopolamine), fever, thyrotoxicosis. **Infection and dehydration** • **Fetal**: repetitive accelerations (from fetal movements), fetal tachyarrhythmias, prematurity	Non-hypoxic explanations include: • **Maternal medications**: β-adrenergic blockers, local anesthetics • **Fetal arrhythmia**: congenital heart block (associated with maternal lupus)

Take a deep breath

How to interpret EFM ?

Baseline variability

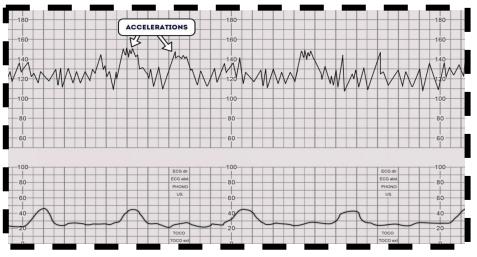
- **Variability** is the beat to beat change / variation in the fetal heart rate, it describes **fluctuations in the baseline FHR** that are **irregular** in amplitude and frequency. It is a reflection of the autonomic interplay between the **sympathetic and parasympathetic** nervous system.
- most important finding in the CTG for the wellbeing of the fetus

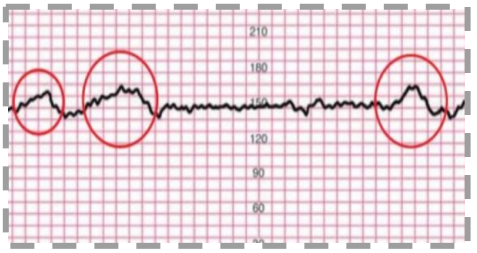
Types of variability	Variability
Absent Amplitude	no variation in the fetal heart rate / Undetectable amplitude
Minimal / reduce Amplitude	≤ 5 Beats/min
Moderate (Normal)	6-25 beats/min
Marked	>25 beats/ min

- Marked variability is associated with increased sympathetic response in the neonate due to a stressful intrapartum event (e.g. cord compression, meconium)
- Moderate variability is a reassuring sign that reflects adequate fetal oxygenation and normal brain
- Decreased variability is associated with :
  - Prolonged uterine contraction
  - Fetal : hypoxia, acidemia, tachycardia, CNS or cardiac anomalies, or sleeping.
  - Taking a drug that depress CNS fetal system, such as : morphine or magnesium

Acceleration

- Acceleration is a transit increases in the fetal heart rate they do not have any specific relationship to uterine contractions.
- It is reassuring sign of fetal well-being.
- A visually apparent **abrupt increase** (onset to peak in <30 seconds) in the FHR.
- These are mediated by the SNS in response to fetal movements or scalp stimulation.
- At <32 weeks gestation, an acceleration has a peak of ≥10 beats/min above baseline, with a duration of ≥10 sec but <2 min from onset to return and the same thing can be applied to deceleration
- At ≥32 weeks gestation, an acceleration has a peak of >15 beats/min above baseline, with a duration of >15 seconds but < 2 min from onset to return and the same thing can be applied to deceleration





How to interpret EFM ?

Decelerations

Early Decelerations
has to be mirror image of the uterine contraction

- It has a slow onset and slow recovery that corresponds to the start and the end of the contraction
- A 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.
- 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.**
- These are mediated by parasympathetic stimulation and occur in response to **head compression**.
- These are favorable and reassuring when see in fetal heart rate.

Late Deceleration
after uterine contraction

- It is symmetric fall and rise in the fetal heart rate tracing that begins at or after the peak of the uterine contraction has ended.The descent and return are gradual and smooth .
- A 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.
- 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.**
- These are mediated by either vagal stimulation or myocardial depression and occur in response to **placental insufficiency.** (abrupt placenta, IUGR, pre-eclampsia)

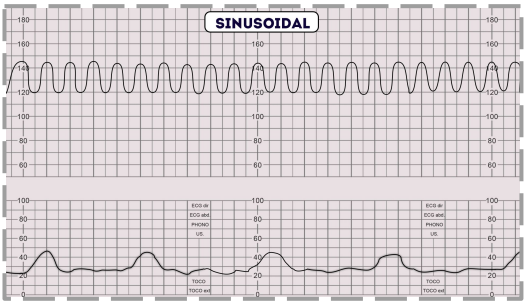
Variable Decelerations
may not have any specific relationship to uterine contractions

- This is when there is an acute fall / **abrupt** in fetal heart rate with a rapid downsel and rapid recovery back to baseline.
- An abrupt FHR decrease is defined as from the onset of the deceleration to the beginning of the FHR nadir of <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, lasting ≥15 seconds, and <2 minutes in duration.
- They are characteristically variable in duration and intensity and timing .
- They Resemble letter v.
- It caused by **cord compression.** (oligohydramnios, IUGR and premature rupture of membranes)

How to differentiate between early and late deceleration ?
-Early : start with a contraction and end with the contraction mirroring it (almost with it) And contraction's peak goes with the deceleration's peak + Gradual increase and gradual decrease to the beasline.
-Late : the peak comes after the contraction (after the contraction end the peak of the deceleration comes after)

How to interpret EFM ?

Sinusoidal pattern / wave

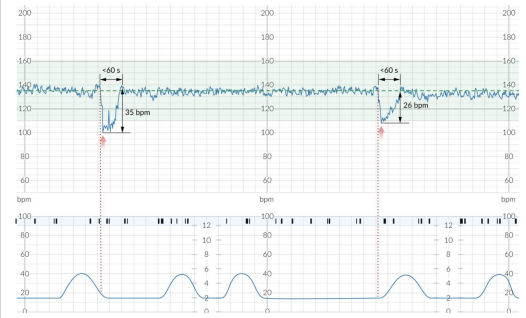
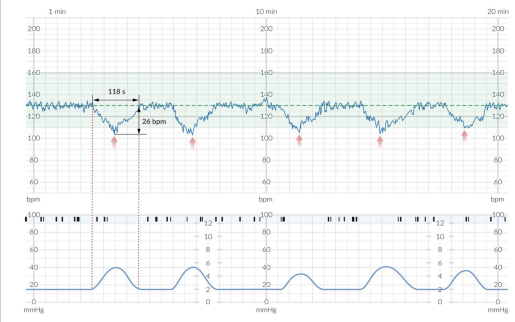
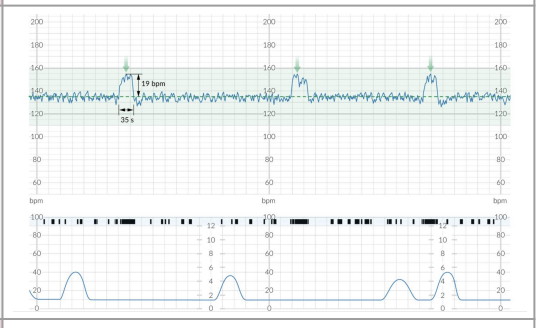
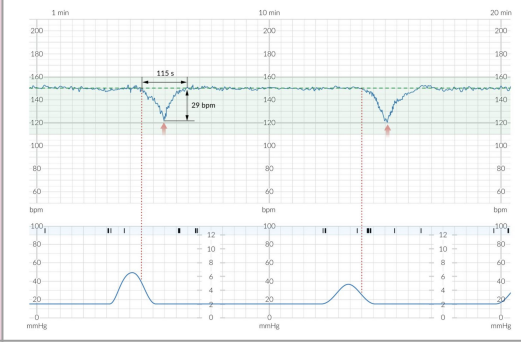


Sinusoidal pattern: A visually apparent ,fixed, smooth, sine wave-like undulating pattern in FHR baseline with a cycle frequency of 3–5/min which persists for ≥20 min.

It is very unusual and is ominous and requires immediate delivery

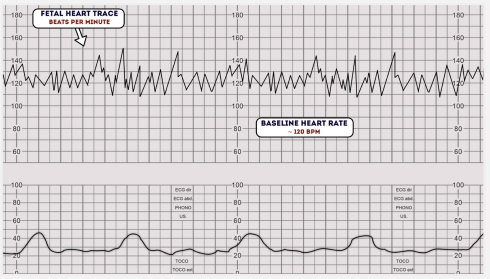
Acceleration & Decelerations

To remember this use the mnemonic **VEAL CHOP**

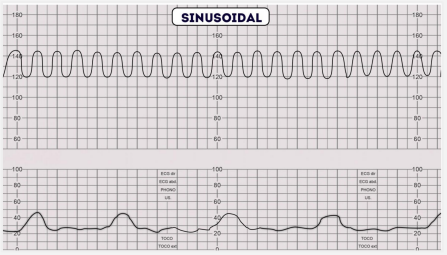
V	**VARIABLE**	**C**	**CORD COMPRESSION**	
E	**EARLY**	**H**	**HEAD COMPRESSION**	
A	ACCELERATION	**O**	OK!	
L	LATE	**P**	PLACENTAL INSUFFICIENCY	

Fetal Heart Rate categories

- **A three-tiered system** for the categorization of FHR patterns is recommended.
- Categorization evaluates the fetus at that point in time; tracing patterns can and will change
- FHR tracing may move back and forth between the categories depending on the clinical situation and management strategies used.

Category I: FHR tracings are normal	Criteria include all of the following: • **Baseline rate:** 110–160 beats/min • **Baseline FHR variability:** moderate • **Late or variable decelerations:** absent • **Early decelerations**: present or absent • **Accelerations**: present or absent	

Category II: FHR tracings are indeterminate	These include all FHR tracings **not** categorized as **category I or III a**nd may represent an appreciable fraction of those encountered in clinical care.
	• **Baseline rate:**
	  ○ Bradycardia not accompanied by absent baseline variability
	  ○ Tachycardia
	• **Baseline FHR variability:**
	  ○ Minimal baseline variability
	  ○ Absent baseline variability not accompanied by recurrent decelerations
	  ○ Marked baseline variability
	• **Accelerations:**
	  ○ Absence of induced accelerations after fetal stimulation Periodic or episodic decelerations
	  ○ Recurrent variable decelerations accompanied by minimal or moderate baseline variability
	  ○ Prolonged deceleration ≥2 minutes but ≤10 minutes
	  ○ Recurrent late decelerations with moderate baseline variability
	  ○ Variable decelerations with other characteristics, such as slow return to baseline, “overshoots,” or “shoulders”	

Category III: FHR tracings are abnormal	Criteria include **absent baseline FHR variability and any of the following:** • Recurrent late decelerations • Recurrent variable decelerations • Bradycardia • Sinusoidal patternاسنان المشط	

The intervention depend on the category:

- **Category I :** No specific action
- **Category II :** evaluation and continued surveillance and reevaluation, taking into account the entire associated clinical circumstances, consider In utero resuscitation (see the box), can change to category I or III.
- **Category III :** In utero resuscitation, prepare for delivery.

Resuscitation and PH assessment

Intrauterine resuscitation

- **Decrease uterine contractions**: Turn off or decrease IV oxytocin infusion or administer terbutaline 0.25 mg subcutaneously to **enhance intervillous placental blood flow.**
- **Augment IV fluid volume**: Infuse the parturient with a 500 mL bolus of intravenous normal saline to **enhance uteroplacental infusion.**
- **Administer high-flow oxygen:** Give the parturient 8–10 L of oxygen by facemask to **increase delivery of maternal oxygen to the placenta.**
- **Change position:** Removing the parturient from the supine position **decreases inferior vena cava compression and enhances cardiac return, thus cardiac output to the placenta**. Turning the parturient from one lateral position to the other may relieve any umbilical cord compression that may be present.
- **Vaginal examination:** Perform a digital vaginal examination to **rule out** possible **prolapsed umbilical cord.**
- **Amnioinfusion** is useful for eliminating or **reducing the severity and frequency of variable decelerations.**
- **Scalp stimulation:** Perform a digital scalp stimulation **observing for accelerations,** which would be reassuring of fetal condition.

Fetal PH assessment :

Intrapartum

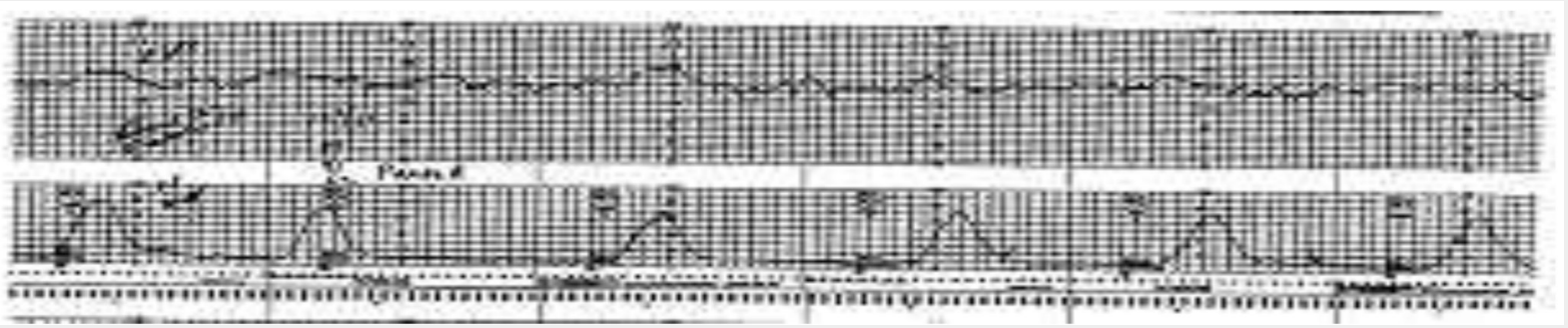
- **Fetal scalp blood pH** may be used in labor if the EFM strip is **equivocal**.
- **Prerequisites** include cervical dilation, ruptured membranes, and adequate descent of the fetal head.
- **Contraindications** are suspected fetal blood dyscrasia.
- A **small, shallow fetal scalp incision** is made resulting in capillary bleeding.
- The blood is collected in a heparinized capillary tube and sent to the laboratory for blood gas analysis.
- This procedure is seldom performed today.

Postpartum

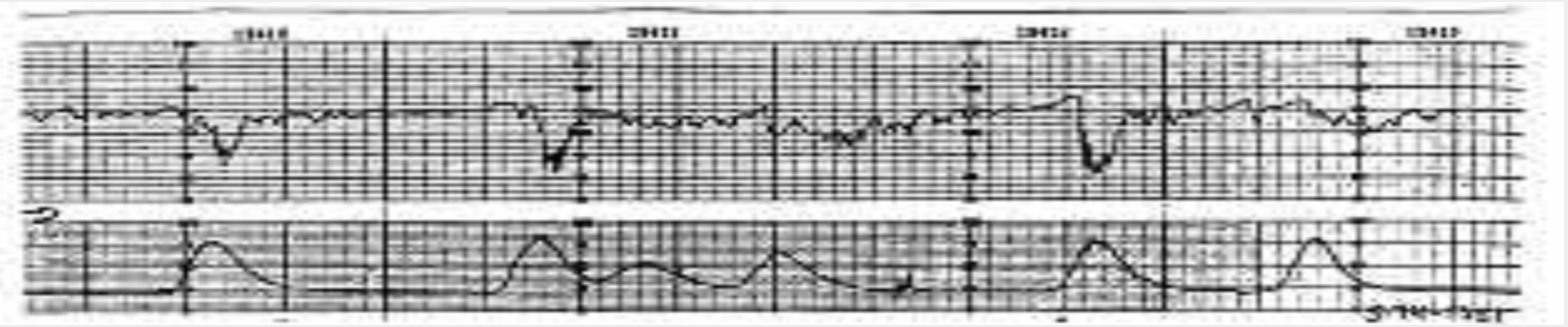
- **Umbilical artery blood pH** is used to confirm **fetal status at delivery.**
- It involves obtaining both **umbilical cord venous and arterial samples.**
- Arterial Pco2 and base deficit values are higher than venous, but pH and Po2 are lower.

Teaching case

A 27 year-old G3P2 woman at 39 weeks gestation(term) is admitted to the labor and delivery unit in early labor. She has had an uncomplicated pregnancy similar to her other two pregnancies, both of which delivered vaginally. Her last labor was 4 hours in length, and the infant's birth weight was 3900 grams after an uncomplicated delivery.
At the time of admission, her physical examination reveals a healthy appearing woman in moderate distress with contractions every 4-6 minutes, described as 7 on a pain scale of 1-10, with 10 being most severe. Her weight is 165 pounds, blood pressure is 135/82, and fundal height is 37 cm. The estimated fetal weight is around 4000 grams (macrosomia, this may indicate delay. But sense the prev fetal weight was 3.9 which means her pelvis is okay and she can deliver this fetus), the fetus is in the vertex presentation and her pelvic examination reveals a gynecoid pelvis with cervix dilated to 5 cm/80% effacement/-1 station(minus means above the ischial spine, head is still not engaged). Fetal heart rate is noted to be 120 beats per minute when the external monitor is applied.



This patient appears to be having a normal labor at term.
The fetal heart rate is normal and the fetus is having accelerations of the fetal heart rate, also a reassuring finding. You determine she has a "category 1" tracing. Her contraction pattern appears normal, and we should expect a vaginal delivery in the next few hours.
Two hours later, the nurse calls you to the labor suite to review the fetal heart tracing below. She expresses concern about the changed appearance of the fetal heart tracing and asks for your opinion.



Start interpreting systematically:

1- baseline.(normal 110-160 bpm) 2- variability. 3- accelerations. 4- decelerations.

Q1. What is the purpose of intrapartum fetal heart rate monitoring?

The goal of intrapartum fetal monitoring is to recognize changes in fetal oxygenation that could result in adverse outcomes. During intrapartum (labor)

Teaching case

Q2. What are the commonly used methods of intrapartum fetal monitoring?

Electronic fetal monitoring (have 2 types external and internal)

Q3. What is the most important aspect in the evaluation of any fetal heart tracing?

- **Baseline variability is the most important aspect and is defined as:** the fluctuation of the baseline FHR in amplitude and frequency. It is defined as:
  - Absent
  - Minimal (amplitude detectable to 5 beats per minute).
  - Moderate (amplitude 6-25 beats per minute).
  - Marked (amplitude greater than 25 beats per minute).

Moderate variability has been associated with an arterial umbilical cord pH higher than 7.00-7.15, and with reassuring fetal well-being and the absence of metabolic academia

- Start interpreting systematically:

  1- baseline.(normal 110-160 bpm) 2- variability. 3- accelerations. 4- decelerations.

Teaching case

Q4.What are the periodic changes that occur in the FHR? What is the physiology, and what interventions, if any, would be appropriate?

- Current fetal heart rate (FHR) definitions were described as a result of the 2008 National Institute of Child Health and Human Development workshop on electronic fetal monitoring
- **Accelerations**:
  - Abrupt increase in the FHR above the baseline
  - At ≥32 weeks gestation, an acceleration has a peak of >15 beats/min above baseline, with a duration of >15 seconds but < 2 min from onset to return.
  - At <32 weeks gestation, an acceleration has a peak of ≥10 beats/min above baseline, with a duration of ≥10 sec but <2 min from onset to return.
  - Presence of accelerations is usually associated with reassuring fetal well-being and the absence of hypoxia and acidemia. Acceleration is response to fetal movement. It is a reassuring sign.
- **Decelerations** - The FHR decreases in response to uterine contractions. May be:

Early	**symmetrical**, **gradual** decrease and return of the FHR with the nadir **occurring at the same time as the peak of the contraction.** It is a mirror to the contractions (ate the same time) In most cases the onset and the recovery occur coincident with the beginning and the end of the contraction. Early decelerations are usually the **result of pressure on the fetal head** resulting in a physiologic vagal reflex response with acetylcholine release at the fetal sinoatrial node, and therefore not concerning. Intervention is not required.
Late	Symmetrical decrease and return in FHR associated with a uterine contraction. The nadir of the FHR deceleration and recovery occur **after** the peak and resolution of the contraction, respectively. Particularly when late decelerations are repetitive and associated with **decreased baseline FHR variability**, they are considered **nonreassuring** and a result of **uteroplacental insufficiency**, decreased intervillous exchange of oxygen and carbon dioxide, and worsening hypoxia and acidemia. Interventions would include maternal repositioning, oxygen supplementation, intravenous fluid administration, and in some cases delivery of the fetus. Occurs **after** the contractions. It is dangerous
Variable	**Abrupt decrease** in FHR lasting less than 2 minutes, with onset to nadir less than 30 seconds; timing may or may not be associated with uterine contractions. Variable decelerations are also mediated by the vagus nerve's sudden release of acetylcholine at the fetal sinoatrial node; these are associated with umbilical cord compression. Interventions may include maternal position change or amnioinfusion. Not related to the contractions, doesn't have specific pattern, and **V shape.**

Teaching case

Q5. Define the three-tiered FHR interpretation system?

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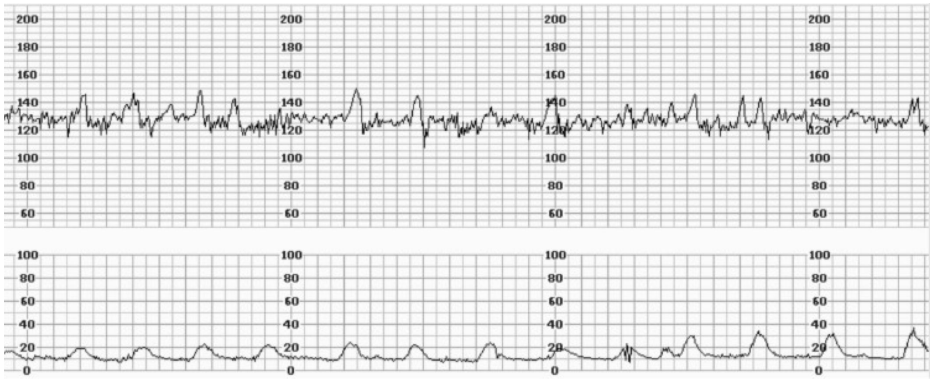
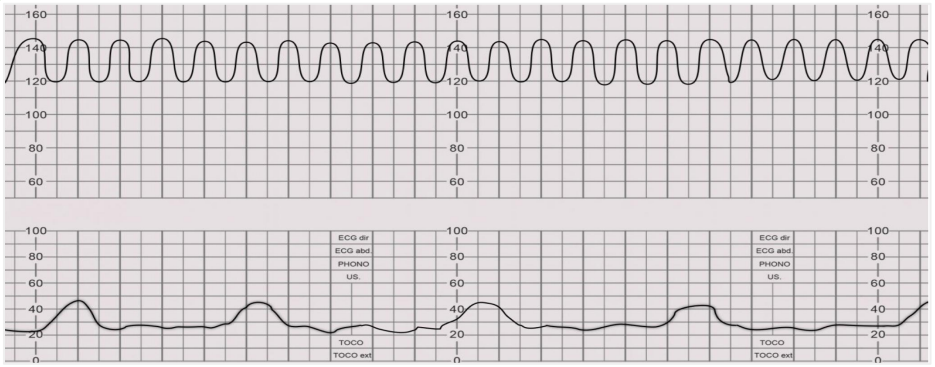
Category III: FHR tracings are abnormal	Criteria include **absent baseline FHR variability and any of the following:** • Recurrent late decelerations • Recurrent variable decelerations • Bradycardia • Sinusoidal pattern **A sinusoidal fetal FHR pattern** is defined as a pattern of fixed, uniform fluxuations of the FHR, cycle frequency: 3.5 \ minute for > 20 minutes. Require immediate delivery.

441 Dr's Cases

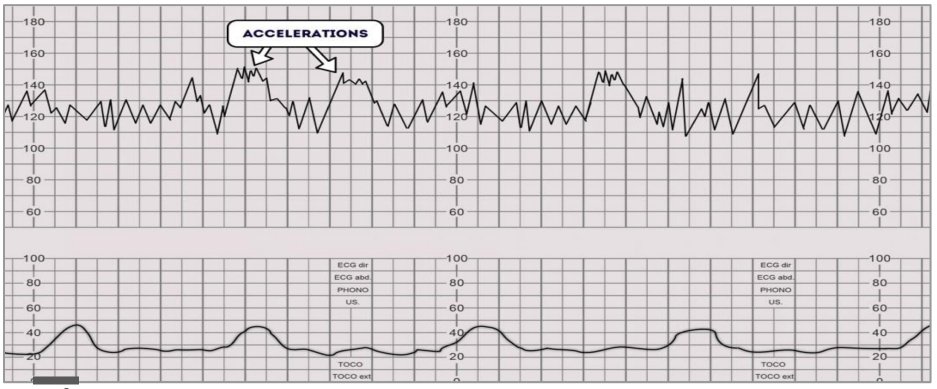
This is how it come in the exam



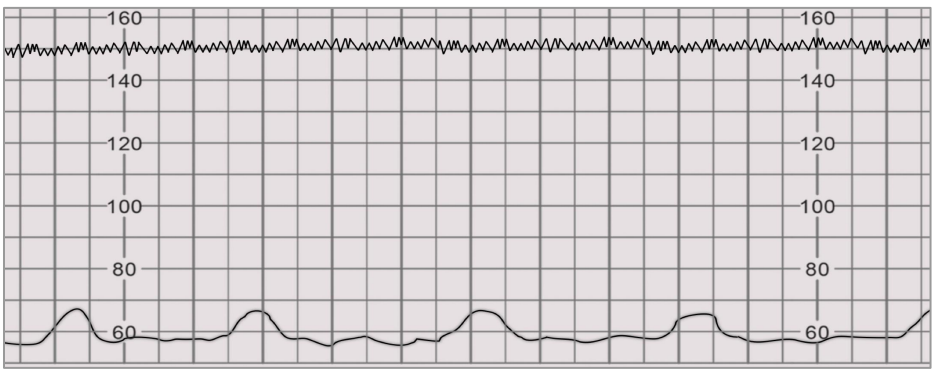
- **Variability ?** moderate
- **Acceleration ?** yes
- **Deceleration ?** no
- **Uterine contraction ?** yes
  - **How many ?** 3-4 in 10 min
- **Interpretation ?** this is normal CTG and reassuring category 1



- **Variability ?** sinusoidal



- **Acceleration ?** yes
- **Uterine contraction ?** yes
  - **Regular ?** yes
  - **How many ?** almost 2 per 10 min
- **Interpretation ?** normal CTG



- **Variability ?** reduced

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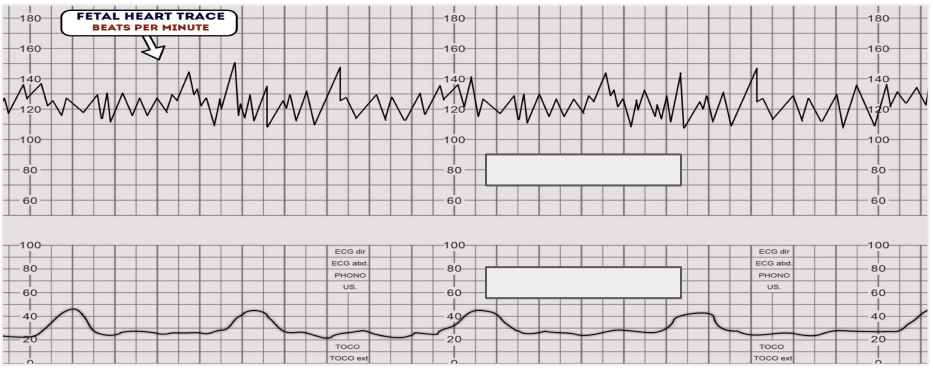
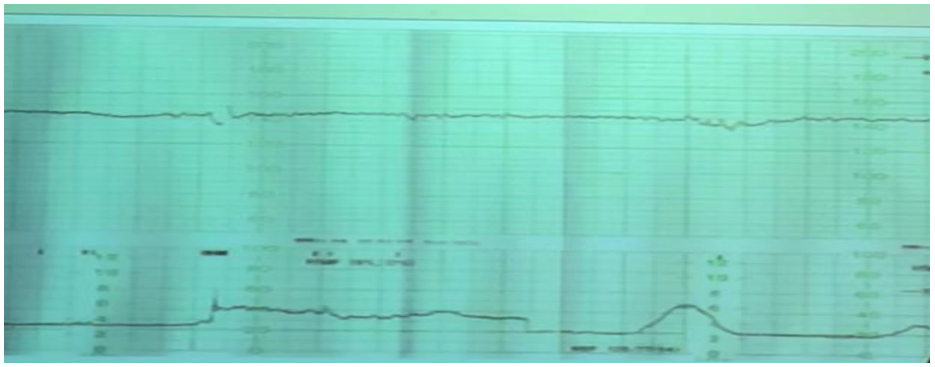
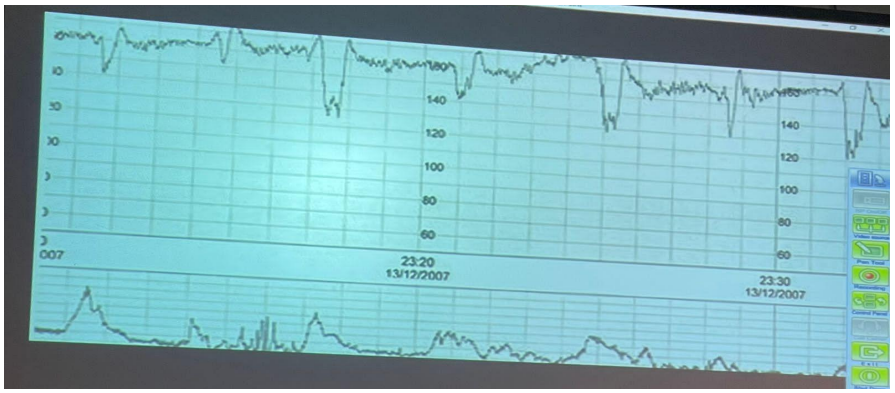


- **Variability ?** moderate
- **Acceleration ?** yes
- **Baseline fetal heart rate ?** around 120



- **Variability ?** reduced



- **Variability ?** moderate
- **Deceleration ?** repetitive variability declaration
  - **When we can say late ?** When we have gradual decrease of the deceleration after contraction But abrupt and not related to the contraction we call it variable

441 Dr's Notes

- **Why do we do intrapartum fetal surveillance?**
  Help to manage hypoxic fetus fast → the management depend on the stage of labor, and clinical mostly → 1st stage of labor → cesarean section 2nd stage of labor → instrumental delivery.

- **For whom do we do intrapartum fetal surveillance? The standard is :**
  - **High risk patient**: continuous fetal monitoring until delivery.
  - **Low risk patient**: intermittent auscultation, if you suspect anything → then put the patient on continuous fetal monitoring.

- **Examples of high risk patients:**
  - **Fetus with Intrauterine Growth Restriction (IUGR)**: the fetus is already in state of stress due to placental insufficiency and might not tolerate labor
  - **Pre-eclampsia**: placental insufficiency (vasoconstriction) and decreased blood supply
  - **Antepartum hemorrhage**: might be abruption of the placenta
  - **Multifetal gestation**: more than one fetus
  - **2nd stage of labor**: because it is stressful
  - **Maternal medical disease**: cardiac, diabetic, HTN and previous pregnancy complications

- **Can we use both internal and external monitoring in intrapartum and antepartum?**
  We can't use internal monitoring antepartum because the membranes had to be ruptured so you could insert it.

- **Deceleration VS Bradicardia**
  - **Deceleration :**
    It is a drop / decrease in the fetal heart rate from the baseline but with return to baseline and it has 3 types
  - **Bradycardia:**
    Drop in the fetal heart rate from the baseline but it lasts long, it continues up to 10 minutes worrisome, and might mandate taking the patient to the OR for C-section , Example: pregnancy complicated by abrupt placenta, then there will be decelerations, if recovered, it means that the abruption is partial because there still is blood supply to fetus, if bradycardia it means sever abruption and there is no supply and I have to get this baby out as soon as possible.

- **How to differentiate between early and late deceleration ?**
  - **Early :**
    - start with a contraction and end with the contraction mirroring it (almost with it)
    - Contraction's peak goes with the deceleration's peak
    - Gradual increase and gradual decrease to the beasline.
  - **Late :**
    - the peak comes after the contraction (after the contraction end the peak of the deceleration comes after)

441 Dr's Notes

- **Early deceleration is not a bad sign?**
  In fact it's reassuring as the patient progresses into the labor

- **If we have CTG with repetitive variable deceleration,How to manage?**
  a. Give fluids
  b. Give oxygen,
  c. Change the position to ensure that the fetus is getting oxygen to the left lateral or right lateral,decrease the IVC compression

  All of this to enhance the blood flow

  Now depending on the mother situation if she is progressing and fully dilated and the head station is downward,Then we can help her with assisted vaginal delivery or it can be spontaneous if she's pushing very well.But if still not assuring and the head station is high then we go with the emergency C.S.

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- Internal monitoring is used when external monitoring isn't providing enough information because the mother is moving.

- Internal monitoring by fetal scalp electrode is contraindicated in HIV positive and Hepatitis B because of the risk of transmission.

- If baby is breech we use external monitoring.

- Less than 28 weeks, baby is monitored by Doppler.

- **Cardiotocography (CTG) V.S Non Stress Test (NST):**
  - **CTG :**
    - Continuous fetal heart monitoring while in labor
    - There is decelerations and uterine contractions
  - **NST :**
    - Monitor fetal heart rate at the clinic while the patient not in labor, to check on the status of the baby
    - No uterine activity (contractions) , Since there is no uterine contractions we cannot classify decelerations to early, late or variable
    - If there is decelerations during this test then it is worrisome because there was no stress and the fetal heart rate decelerated (fetus is in a state of hypoxia)

- Fetal tachycardia is most likely caused by a maternal cause, so ruling out maternal infections is important.

- **What is variability?**
  It reflects hypoxia, if the oxygenation for the baby is enough or not. Because decrease supply of oxygen will stimulate the sympathetic and parasympathetic systems and the heart rate of the fetus will change in response, hence it will be reflected in the CTG. It is the most important aspect in evaluation of fetal heart tracing.

- Moderate variability is reassuring, it means the baby is okay and there's no acidemia or hypoxia.

- Early decelerations mirror contractions and are reassuring, and they happen when the baby's head descends to the pelvis and cause vasovagal stimulation > SA node inhibition.

- Variable decelerations are associated with cord compression which could be caused by the baby (holding the cord) or by uterine contractions.

- Intervention in late deceleration: first line is IV fluid and change position to left lateral to improve the perfusion.

Reference

Fetal Surveillance during Labor

CALVIN J. HOBEL • AMY R. LAMB

CLINICAL KEYS FOR THIS CHAPTER

- The most important principle of both fetal and maternal surveillance during labor is that childbirth is a normal process, and the majority of laboring women and their fetuses will have a safe journey. Obstetricians must be aware of each patient's past history and be prepared to monitor the journey based upon maternal and fetal needs during the labor process.
- Simple auscultation of the fetal heart rate in accordance with specific guidelines is acceptable to assess the health of the fetus. Continuous fetal heart rate and uterine activity monitoring have the advantage of providing continuous electronic records throughout the labor process but may not always be necessary.
- The pathophysiology of abnormal fetal heart rate patterns is complex, and both clinical and research findings suggest that hypoxia, acidosis, and inflammation form a triad of mixed metabolic dysregulation that may increase the risk of early (during delivery) and late (during childhood) physical and mental abnormalities.
- To improve our understanding of the assessment of abnormal and potentially pathologic heart rate patterns, the National Institutes of Health (NIH) has developed a three-tier fetal heart rate interpretation system (normal, intermediate, and abnormal). This is designed to improve the recognition of risk for poor fetal outcomes and to allow implementation of strategies for effective intervention.
- Abnormal fetal heart rate tracings associated with hypoxia, acidosis, and inflammation have five characteristics: (1) absent base line variability, (2) recurrent late decelerations, (3) recurrent variable decelerations, (4) bradycardia, and (5) sinusoidal patterns.

Effective fetal surveillance during labor is an essential element of good obstetric care. On the basis of the antepartum maternal history, physical examination, and laboratory data, 20-30% of pregnancies may be designated high risk, and 50% of perinatal morbidity and mortality occurs in this group. **The remaining 50% of morbidity and mortality occurs in pregnancies that are considered to be normal at the onset of labor.** Although fetal heart rate (FHR) monitoring by auscultation or continuous electronic fetal monitoring (EFM) provides useful information that improves the management of labor and reduces perinatal morbidity and mortality, evidence about its complete adequacy for fetal surveillance is conflicting.

The pathogenesis of abnormal FHR patterns is complex and remains poorly understood. In the past, it was felt that hypoxia was the main cause of abnormal FHR patterns and that continuous EFM and fetal scalp sampling would reliably identify those fetuses at greatest risk. However, a decrease in the incidence of cerebral palsy, one of the most serious complications associated with pregnancy and childbirth, has not occurred with increased monitoring.

This chapter provides the current concepts and recognized standards for appropriate fetal surveillance during labor.

Methods of Monitoring Fetal Heart Rate

AUSCULTATION OF THE FETAL HEART RATE

The time-honored technique for evaluating the fetus during labor has been auscultation of the FHR. The first step in deciding on the optimal method (auscultation or continuous EFM) is to determine whether a patient has any risk factors. **Auscultation of the fetal heart is performed by listening from the beginning of one contraction to the beginning of the next contraction.** For low-risk patients, a competent nurse should listen every 30 minutes during the first stage of labor and at least every 15 minutes in the second stage of labor. For high-risk patients, the FHR should be assessed every 15 minutes during the first stage of labor and every 5 minutes during the second stage. Some studies have suggested that intermittent auscultation of the fetal heart is comparable to continuous electronic monitoring, in terms of neonatal outcome, if performed at the intervals stated above with a 1:1 patient-to-nurse ratio.

CONTINUOUS ELECTRONIC FETAL HEART RATE MONITORING

EFM during labor was developed to detect FHR patterns frequently associated with delivery of infants in a depressed condition. It was reasoned that early recognition of changes in FHR patterns that are associated with hypoxia and umbilical cord compression would serve as a warning that would enable a physician to intervene and prevent fetal death or irreversible brain injury.

Pathophysiology of Abnormal Fetal Heart Rate Patterns

The focus of EFM has been on the recognition that hypoxia leads to a greater risk of acidosis, which can be identified by fetal scalp blood sampling during labor and cord blood gas analysis at delivery. **Today, the cause of abnormal FHR patterns is thought to be more complex and probably related to a combination of hypoxia, acidosis, and inflammation** that subjects all physiologic systems (brain, heart, placenta, blood vessels, and the fetal adrenal gland) to multisystem dysregulation and is associated with a complex array of FHR perturbations. These changes in heart rate are difficult to interpret without better ways to define the most optimal biomarkers that identify the fetus at highest risk. **Important maternal and fetal biomarkers of current research interest are inflammatory markers (such as C-reactive protein) and vitamin D deficiency.**

EFM allows continuous reporting of the FHR, uterine contractions, maternal heart rate, and blood pressure (FHR-UC-MHR-MBP) by means of a monitor that prints results on a two-channel strip chart recorder that can be stored as part of an electronic record. Uterine contractions result in a reduction in blood flow to the placenta, which can cause an interruption in fetal oxygenation and lead to corresponding alterations in the FHR. **The "FHR-UC-MHR-MBP" record can be obtained using external transducers that are placed on the maternal abdomen and arm.** It is important that external palpation of the uterus is carried out to determine the intensity of contractions with this method. **This technique is used in early labor.**

Internal monitoring is carried out by placing a spiral electrode onto the fetal scalp to monitor heart rate and inserting a plastic catheter transcervically into the amniotic cavity to monitor uterine contractions (Figure 9-1). To carry out this technique, the fetal membranes must be ruptured and the cervix must be dilated to at least 2 cm. Caution must be exercised when the decision to rupture the membranes is made,

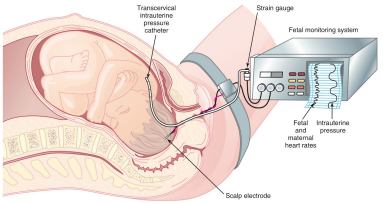

FIGURE 9-1 Technique for internal continuous electronic monitoring of both fetal and maternal heart rates, as well as the pressure and frequency of uterine contractions. External monitoring of uterine contractions provides information only about the frequency of contractions.

and it should be performed only when more exact information is needed to monitor a mother or fetus at risk.

Internal monitoring gives better FHR tracings because the rate is computed from the sharply defined R-wave peaks of the fetal electrocardiogram, whereas with the external technique, the rate is computed from the less precisely defined first heart sound obtained with an ultrasonic transducer. However, fetal scalp electrodes should be placed only when the benefit outweighs the risk, and fetal scalp electrodes should always be placed with care. For example, **patients with specific infections (HIV and hepatitis B) should not have a scalp electrode placed.** In addition, when placing a scalp electrode, the presenting part of the fetus must be ascertained to avoid placing the electrode on the face or external genitals if the fetus is presenting as a breech.

The internal uterine catheter allows precise measurement of the intensity of the contractions in millimeters of mercury, whereas the external tocodynamometer measures only frequency and duration, not intensity. The strength of uterine contractions, however, can easily be assessed by abdominal palpation by a trained observer (a nurse or physician).

In the clinical setting, internal and external techniques are often combined by using a scalp electrode for precise heart rate recording and the external tocodynamometer for contractions. This approach minimizes possible side effects from invasive internal monitoring.

Etiology of Hypoxia, Acidosis, and Fetal Heart Rate Changes

The developing fetus presents a paradox. Its arterial blood oxygen tension is only 25 ± 5 mm Hg, as compared with adult values of about 100 mm Hg. The rate of oxygen consumption, however, is twice that of the adult per unit weight, and its oxygen reserve is only enough to meet its metabolic needs for 1 to 2 minutes. Blood flow from the maternal circulation, which supplies the fetus with oxygen through placental exchange of respiratory gases, is momentarily interrupted during a contraction. **A normal fetus can withstand the temporary reduction in blood flow to the placenta without developing hypoxia because sufficient oxygen exchange occurs during the interval between contractions.**

Under normal circumstances, the FHR is determined by the atrial pacemaker. Modulation of the rate occurs physiologically through innervation of the heart by the vagus (decelerator) and sympathetic (accelerator) nerves. A fetus whose oxygen supply is marginal cannot tolerate the stress of contractions and will become hypoxic. **Under hypoxic conditions, chemoreceptors and baroreceptors in the peripheral arterial circulation of the fetus influence the FHR by giving rise to contraction-related or periodic FHR changes.** Hypoxia, when sufficiently severe, will also result in anaerobic metabolism, resulting in the accumulation of pyruvic and lactic acid and causing fetal acidosis. **The degree of fetal acidosis can be measured by sampling blood from the presenting part. The normal fetal scalp blood pH varies between 7.25 and 7.30. Values below 7.20 are considered to be abnormal (fetal acidosis) but not necessarily indicative of fetal compromise.**

The fetal oxygenation pathway can be interrupted at different locations within the uteroplacental-fetal circulatory loop. For example, impairment of oxygen transportation to the intervillous space may occur as a result of maternal hypertension or anemia; oxygen diffusion may be impaired in the placenta because of infarction or abruption; or the oxygen content in the fetal blood may be impaired because of hemolytic anemia in rhesus (Rh)-isoimmunization. Figure 9-2 summarizes the clinical conditions that may be associated with fetal distress during labor.

It is unrealistic to believe that hypoxia and acidosis are the only markers that determine the ultimate outcome of the fetus and neonate. Other markers of inflammation and the immune system must also play a role. **Current research is focused on vitamin D deficiency and inflammatory markers such as C-reactive protein and fibronectin.**

FETAL HEART RATE PATTERNS

The assessment of the FHR depends on an evaluation of the baseline pattern and the periodic changes related to uterine contractions. Table 9-1 gives a comprehensive list of FHR patterns and definitions based upon a workshop sponsored by the National Institute of Child Health and Human Development in 2008.

Baseline Assessment

Baseline assessment of FHR requires the determination of the rate (in beats/min) and the variability. Normal and abnormal rates are listed in Table 9-1. Normal FHR baseline is from 110 to 160 beats/min; tachycardia is a baseline greater than 160 beats/min, and bradycardia is less than 110 beats/min. Baseline variability can be divided into short- and long-term intervals. These are described in the subsections below.

1. **Short-term or beat-to-beat variability.** This reflects the interval between either successive fetal electrocardiographic signals or mechanical events of the cardiac cycle. **Normal short-term variability fluctuates between 6 and 25 beats/min.** Variability below 5 beats/min is considered to be potentially abnormal. When associated with decelerations, a variability of less than 5 beats/min usually indicates severe fetal distress.

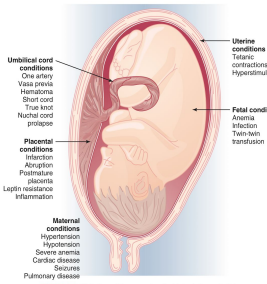

FIGURE 9-2 Clinical conditions associated with fetal distress in labor.

2. **Long-term variability.** These fluctuations may be described in terms of the frequency and amplitude of change in the baseline rate. The normal long-term variability is 3 to 10 cycles per minute. Variability is physiologically decreased during the state of quiet sleep of the fetus, which usually lasts for about 25 minutes until transition occurs to another state. Changes in the long-term variability in prolonged and difficult labors may be a sign of an accumulated risk of metabolic dysregulation.
3. **Decreased beat-to-beat variability.** A prolonged flat baseline is the result of fetal sedation.

Periodic Fetal Heart Rate Changes

Periodic FHR changes are changes in baseline FHR related to uterine contractions. The responses to uterine contractions may be categorized as follows:

1. **No change.** The FHR maintains the same characteristics it had in the preceding baseline FHR.
2. **Acceleration.** The FHR increases in response to uterine contractions. This is a normal response and is reassuring that the fetal status is normal.
3. **Deceleration.** The FHR decreases in response to uterine contractions. Decelerations may be ***early, late, variable,*** **or** ***mixed.*** All except early decelerations are abnormal and are categorized according to a three-tier FHR interpretation system (Box 9-1).

Types of Patterns

EARLY DECELERATION (HEAD COMPRESSION). This pattern usually has an onset, maximum fall, and recovery that is coincident with the onset, peak, and end of the uterine contraction (Figure 9-3). The nadir of the FHR coincides with the peak of the contraction. This pattern is seen when engagement of the fetal head has occurred. Early decelerations are not thought to be associated with fetal distress. The pressure on the fetal head leads to increased intracranial pressure that elicits a vagal response similar to the Valsalva maneuver in the adult. The vagal reflex can be abolished by the administration of atropine, but this approach is not used clinically.

LATE DECELERATION (UTEROPLACENTAL INSUFFICIENCY). This pattern has an onset, maximal decrease, and recovery that are shifted to the right in relation to the contraction (Figure 9-4). Fetal hypoxia and acidosis are usually more pronounced with severe decelerations. Severe, repetitive late decelerations usually indicate fetal metabolic acidosis, low arterial pH, and increased base deficit values. The partial pressure of carbon dioxide in the fetal blood is usually in the normal range, and the fetal blood oxygen partial pressure is only slightly below normal because of the Bohr effect—the shift to the left of the oxygen dissociation curve caused by the acidosis.

VARIABLE DECELERATION (CORD COMPRESSION). This pattern has a variable time of onset and a variable form and may be nonrepetitive (Figure 9-5). Variable decelerations are caused by umbilical cord compression. Note that the decelerations have a more rapid drop and more rapid return to normal. This is characteristic of a reflex change, or rapid change, compared with the slower change in both early and late decelerations. Partial or complete compression of the cord causes a sudden increase in blood pressure in the central circulation of the fetus. The bradycardia is mediated via baroreceptors. This reflex can be abolished or ameliorated by atropine (e.g., chemical vagotomy), although this approach is not used clinically. Fetal blood gases indicate respiratory acidosis with a low pH and high carbon dioxide. When cord compression has been prolonged, hypoxia is also present, showing a picture of combined respiratory and metabolic acidosis in fetal blood gases.

The severity of variable decelerations is graded by their duration. When the FHR falls below 80 beats/min during the nadir of the deceleration, there is usually a loss of the P-wave in the fetal electrocardiogram, indicating a nodal rhythm or a second-degree heart block.

NONPATTERN SIGNS OF FETAL DISTRESS

Fetal Tachycardia

As a baseline change, tachycardia is not a very reliable sign of fetal distress. **In general, fetal tachycardia occurs to improve placental circulation when the fetus is stressed.** Brief periods of tachycardia (15 to 30 minutes) are usually associated with excessive oxytocic augmentation of labor, after which the heart rate returns to baseline when the augmentation is discontinued. **Prolonged periods of tachycardia are usually associated with elevated maternal temperature or an intrauterine infection,** which should be ruled out. The acid-base status is usually normal.

Meconium

Early passage of meconium occurs any time before rupture of the membranes and is classified as trace (+1, +2, +3) and particulate based on its color and viscosity. Trace meconium is lightly stained yellow or greenish amniotic fluid. Meconium of +2 to +3 is dark green or black and is usually thick and tenacious with a pea soup appearance. It is associated with lower 1- and 5-minute Apgar scores and with the risk of meconium aspiration.

TABLE 9-1
ELECTRONIC FETAL MONITORING DEFINITIONS

Pattern	Definition
Baseline	The mean FHR rounded to increments of 5 excluding: Periodic or episodic changes Periods of marked FHR variability Segments of baseline that differ by more than 25 beats/min The baseline must be for a minimum of 2 min in any 10-min segment, or the baseline for that time period is indeterminate; in this case, one may refer to the prior 10-min window for determination of baseline Normal FHR baseline: 110-160 beats/min Tachycardia: FHR baseline is >160 beats/min Bradycardia: FHR baseline is <110 beats/min
Baseline variability	Fluctuations in the baseline FHR that are irregular in amplitude and frequency Variability is visually quantitated as the amplitude or peak-to-trough in beats per minute Absent: amplitude range undetectable Minimal: amplitude range detectable, but ≤5 beats/min Moderate (normal): amplitude range 6-25 beats/min Marked: amplitude range >25 beats/min
Acceleration	A visually apparent abrupt increase (onset to peak in <30 sec) in the FHR At 32 weeks' gestation and beyond, an acceleration has a peak ≥15 beats/min above baseline, with a duration of 15 sec to 2 min from onset to return Before 32 weeks' gestation, an acceleration has a peak ≥10 beats/min above baseline, with a duration of ≥10 sec but <2 min from onset to return Prolonged acceleration lasts ≥2 min but <10 min in duration If an acceleration lasts ≥10 min, 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 or ≥30 sec 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 contraction In most cases, the onset, nadir, and recovery of the deceleration occur after the beginning, peak, and ending of the contraction, respectively
Late deceleration	Visually apparent, usually symmetrical, gradual decrease and return of the FHR associated with uterine contraction A gradual FHR decrease is defined as one of ≥30 sec from the onset to the FHR nadir The decrease in FHR is calculated from the onset to the nadir of the deceleration The decrease 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 contraction, respectively
Variable deceleration	Visually apparent abrupt decrease in FHR An abrupt FHR decrease is defined as one of <30 sec from the onset of the deceleration to the beginning of the FHR nadir The decrease in FHR is calculated from the onset to the nadir of the deceleration The decrease in FHR is ≥15 beats/min, lasting ≥15 sec and <2 min 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 the FHR from baseline that is ≥15 beats/min, lasting ≥2 min but <10 min in duration If a deceleration lasts ≥10 min, 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 min that persists for ≥20 min

From Macones A, Hankins GDV, Spong CY, et al: 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* 112:661-666, 2008.
FHR, Fetal heart rate.

BOX 9-1
THREE-TIER FETAL HEART RATE INTERPRETATION SYSTEM

Category I (Normal)

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

Category II (Intermediate/Possible Early Dysregulation)

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

1. Baseline rate
   - Bradycardia not accompanied by absent baseline variability
   - Tachycardia
2. Baseline FHR variability
   - Minimal baseline variability
   - Absent baseline variability not accompanied by recurrent decelerations
   - Marked baseline variability
3. Accelerations
   - Absence of induced accelerations after fetal stimulation
4. Periodic or episodic decelerations
   - Recurrent variable decelerations accompanied by minimal or moderate baseline variability
   - Prolonged deceleration ≥2 min but <10 min
   - Recurrent late decelerations with moderate baseline variability
   - Variable decelerations with other characteristics, such as slow return to baseline, "overshoots," or "shoulders"

Category III (Abnormal)

Category III FHR tracings include either of the following:
- Absent baseline FHR variability and any of the following
  - Recurrent late decelerations
  - Recurrent variable decelerations
  - Bradycardia
- Sinusoidal pattern

From Macones A, Hankins GDV, Spong CY, et al: 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* 112:661-666, 2008.
FHR, Fetal heart rate.
Interpretation system: Category I (Normal) = Green, Category II (Intermediate) = Orange, and Category III (Abnormal) = Red.

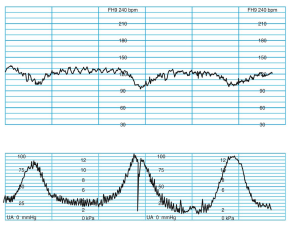

FIGURE 9-3 Early deceleration. Note that the deceleration starts and ends with the uterine contraction. Good beat-to-beat variability is demonstrated.

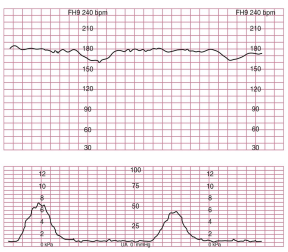

FIGURE 9-4 Late decelerations on electronic fetal monitoring tracing as would be recorded with a severely distressed fetus. Note the fetal tachycardia, lack of beat-to-beat heart rate variability, and the late decelerations (*upper trace*). Uterine contractions are recorded in the *lower trace.*

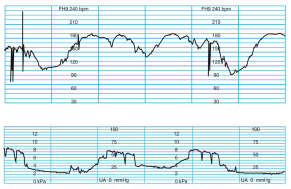

FIGURE 9-5 Umbilical cord compression pattern. Variable decelerations (cord compression) on electronic fetal monitoring traces (six panels [each panel = 60 seconds] beginning on the left side of each tracing) associated with maternal pushing in the second stage of labor. Note in both *upper* and *lower traces* the rapid drop in fetal heart rate with a nadir of 25 seconds, followed by a rapid return toward baseline. In the rightmost panels, the traces also show a decreased beat-to-beat variability with fetal tachycardia, which suggests some fetal distress (Category II-b tracing).

Late passage usually occurs during the second stage of labor, after clear amniotic fluid has been noted earlier. Late passage, which is most often heavy, is usually associated with some event (e.g., umbilical cord compression or uterine hypertonus) late in labor that causes fetal distress.

Strategies for Intervention

In 2008, the National Institute of Child Health and Human Development reported on a series of workshops on EFM with the goal of defining FHR characteristics more clearly to improve the predictive value of monitoring and to allow evidence-based clinical management of intrapartum fetal compromise. Table 9-1 lists the definitions for FHR characteristics, and Box 9-1 displays the three-tier FHR interpretation system.

CATEGORY I FHR (NORMAL)

A normal FHR pattern is strongly predictive of normal fetal acid-base status at the time of observation. The characteristics of Category I tracings are a normal baseline rate, moderate FHR variability, and absence of late or variable decelerations; early decelerations (head compression) may be present or absent. The presence of Category I FHR patterns requires no specific action.

CATEGORY II FHR (INTERMEDIATE/POSSIBLE EARLY DYSREGULATION)

Category II FHR tracings are intermediate and are not predictive of abnormal fetal acid-base status. This category includes changes in (1) baseline rate, (2) baseline FHR variability, (3) accelerations, and (4) periodic or episodic decelerations. There has been an attempt to further subdivide Category II FHR abnormalities to improve the recognition of changes that are most ominous. These subtypes are summarized in Box 9-2.

BOX 9-2
SUBTYPES OF CATEGORY II FHR TRACINGS

Category II-a: Reduced fetal heart rate variability but without decelerations; risk of fetal acidosis is low
Category II-b: Reduced fetal heart rate variability with mild decelerations; risk of fetal acidosis is moderate
Category II-c: Absence of fetal heart rate variability and deep decelerations; risk of fetal acidosis is high

From Parer JT, Ikeda T: A framework for standardized management of intrapartum fetal heart rate patterns. *Am J Obstet Gynecol* 197:26.e1-e6, 2007.

Strategies for Resuscitation

Because Category II patterns are intermediate, resuscitative measures always depend on the clinical circumstances. **When abnormal patterns are seen, the first step should be a search for the underlying cause.** When the cause is identified, such as maternal hypotension, steps should be taken to correct the problem. In general, a term-sized fetus tolerates Category II FHR patterns better than a preterm fetus. A fetus with additional maternal or fetal risk factors, such as preterm labor, intrauterine growth restriction, preeclampsia, diabetes, or intrauterine infection from chorioamnionitis, may experience metabolic dysregulation sooner than a fetus in a normal parturient with Category I FHR tracings. **The three simple interventions are to (1) change the woman's position to the left lateral recumbent,** or if she is already on her side, switch positions to the other side; **(2) reduce the infusion rate of oxytocin** if this is running; and **(3) increase intravenous fluids** by infusing 1 L of normal saline with either 5% or 10% dextrose to ensure adequate vascular volume and substrate for the fetus and placenta. Studies have shown that this intervention shortens labor in nulliparous women.

Amnioinfusion

A more complex intervention for repetitive variable decelerations (cord pattern) is **amnioinfusion. This is the replacement of amniotic fluid with normal saline infused through a transcervical intrauterine pressure catheter, and it has been reported to decrease both the frequency and severity of variable decelerations.** The use of a double-lumen uterine catheter is recommended because it allows a continuous infusion while measuring uterine tone to guard against overdistention from excessive fluid accumulation. A common technique is to infuse a bolus of up to 800 mL of normal saline at a rate of 10 to 15 mL/min over a period of 50 to 80 minutes. This is followed by a maintenance dose of 3 mL/min until delivery. Overdistention of the uterine cavity can be avoided by maintaining the baseline uterine tone in the normal range and at less than 20 mm Hg. **Amnioinfusion results in reduced cesarean deliveries for fetal distress and fewer low Apgar scores at birth without apparent maternal or fetal distress.**

CATEGORY III FHR (ABNORMAL)

Category III FHR tracings are abnormal and require prompt evaluation because each of the five characteristics listed in Box 9-1 under Category III FHR patterns) is predictive of abnormal fetal acid-base status. The major issue is to determine the optimal time for intervention, either by vaginal or cesarean delivery, to avoid serious perinatal morbidity and mortality. There are published data to suggest that, in the presence of Category III FHR patterns, the optimal time for delivery is within 30 minutes; thus, the delivery team must act quickly to decide whether there is sufficient time for a vaginal delivery, keeping in mind that it takes at least 30 minutes to prepare for an emergency cesarean delivery. The optimal answer is somewhere between the observations of Category II and the early onset of Category III, so it is sometimes prudent to notify the surgical team that a cesarean delivery may be called when Category II patterns are seen. The degree of fetal acidosis, as determined by fetal scalp blood sampling, to identify the fetus at greatest risk is no longer used by most obstetrical services. Until new biomarkers, such as inflammatory markers, become available, reliance must be placed on FHR categories to determine management.

A review of the five components of the classification of Category III tracings is as follows:

1. **Absent baseline variability** suggests a serious state of metabolic dysregulation.
2. **Recurrent late decelerations** of the FHR have been associated primarily with severely reduced uteroplacental blood flow.
3. **Recurrent variable decelerations** are characteristic of umbilical cord compression and are associated with reduced amniotic fluid volume. They may be related to the loss of the protective effect of intact membranes.
4. **Prolonged bradycardia** is secondary to the failure of the fetus to use its baroreceptive signaling to its cardiovascular centers to control heart rate because of severe metabolic dysregulation.
5. **Sinusoidal patterns** observed on admission suggest the possibility of severe fetal anemia (of unknown cause), and the occurrence of a sinusoidal pattern during labor lasting longer than 20 minutes is suggestive of a severe, acute fetal bleed.

Strategies for Intervention

The simple interventions discussed above for the observations of Category II tracings should have already been implemented, except maybe amnioinfusion. There are four additional procedures that can be used to assess the status of the fetus when Category III FHR patterns are present:

1. **Fetal scalp blood sampling** for pH determination has been used when clinical parameters such as Category III FHR patterns and heavy meconium are present, but it is no longer the standard of practice in many centers. Fetal scalp pH correctly predicts neonatal outcome in 82% of cases as determined by the Apgar score. The false-positive rate is approximately 8%, and the false-negative rate is approximately 10%. Blood is obtained from the fetus by placing an amnioscope transvaginally against the fetal skull (Figure 9-6). Cervical mucus is removed with cotton swabs. Silicone grease is applied to the skull for blood bead formation. A 2 × 2-mm lancet is used for a stab incision, and a drop of blood is aspirated into a long, heparinized capillary tube and sent to the laboratory for pH and base deficit determinations. Table 9-2 lists the normal values for fetal scalp blood samples.
2. **Ultrasonic Doppler velocimetry** for blood flow measurements in umbilical and fetal blood vessels and **percutaneous umbilical blood sampling** have been used antepartum in some centers, but they are generally not feasible methods for labor assessment.

Reference

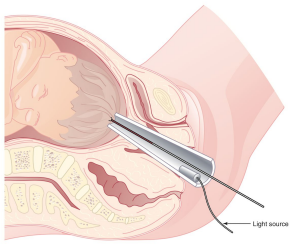

FIGURE 9-6 This technique of fetal scalp blood sampling via an amnioscope is still used in many centers. After making a small stab incision in the fetal scalp, the blood is drawn off through a long, heparinized capillary tube.

TABLE 9-2
NORMAL RANGES FOR FETAL SCALP AND CORD BLOOD INDICES

Blood	pH	PCO_2 (mm Hg)	PO_2 (mm Hg)	Base Deficit (mEq/L)
Scalp Blood				
Early labor	7.34-7.38	43-57	20-24	(-0.2)-(0.4)
Active phase	7.34-7.40	36-54	20-24	(-2.0)-(0.0)
Complete cervical dilation	7.26-7.42	36-60	20-24	(-3.3)-(-0.3)
Cord Blood				
Artery	7.22-7.34	32-64	14-22	(-7.8)-(-2.2)
Vein	7.29-7.41	25-53	23-35	(-6.2)-(-1.8)

Data from Hobel CJ: Intrapartum clinical assessment of fetal distress. *Am J Obstet Gynecol* 110:336-342, 1971.
PCO_2, Partial pressure of carbon dioxide in fetal arterial blood; PO_2, partial pressure of oxygen in fetal arterial blood.

3. If cervical dilation and station permit, the safest intervention for compression of the umbilical cord is **assisted vaginal delivery.**
4. **Cesarean delivery** is indicated for severe, repetitive decelerations and a FHR tracing indicative of developing acidosis. Another circumstance that may require intervention is a prolonged deceleration. This condition occurs when the FHR falls to 60 to 90 beats/min for more than 2 minutes.

Fetal Assessment at Birth to Document the Status of the Fetus at Risk for Birth Asphyxia

APGAR SCORE

The Apgar scoring system has classically been used to assess the newborn's condition. Over time, however, the Apgar score has come to be used inappropriately to define asphyxia. This is a misapplication because many other conditions (e.g., prematurity, maternal drug administration) can result in low scores that are not reflective of asphyxia. Asphyxia implies hypoxia of sufficient degree to cause metabolic acidosis. Thus, the Apgar score alone cannot be used to define asphyxia. A low Apgar score of less than 5 helps the obstetric team to focus on both cardiovascular and respiratory adaptation (see Table 8-9).

UMBILICAL CORD BLOOD SAMPLING

A more appropriate tool for defining asphyxia is assessment of the fetal and neonatal acid-base status. Normal ranges for these indices are given in Table 9-2. One reasonable protocol for umbilical cord blood pH and blood gas analysis is as follows:

1. Doubly clamp a segment of umbilical cord immediately after birth in all preterm deliveries and in term deliveries where fetal distress is suspected, as well as in cases where the 1- and/or 5-minute Apgar score is low (<7).
2. If a specimen cannot be obtained from the umbilical artery of the cord, obtain a specimen from an artery on the chorionic surface of the placenta.

Controversies about Fetal Monitoring for the Diagnosis and Treatment of Fetal Distress

After more than 40 years of routine use of electronic monitoring for assessment of the FHR during labor, there is significant but incomplete evidence of its effectiveness for improving long-term fetal outcome, particularly in preterm infants. Over the past 40 years, more careful attention to monitoring of the fetus during labor has led to a reduction in the incidence of postterm fetal complications and to an improvement in perinatal mortality rates. The incidence of hypoxic-ischemic encephalopathy in term infants has also decreased. **Preterm births (spontaneous and induced) continue to add to the pool of infants who develop cerebral palsy.**

The improvements in outcome for term infants have not been mirrored by improved prevention of cerebral palsy in preterm infants. There is a pressing need to inform the public, as well as the medical profession, that **cerebral palsy is probably not caused by events during labor such as asphyxia and acidosis.** These intrapartum events appear to play only a small part in the overall incidence of this disorder. Events earlier in pregnancy probably play the major role. **Newer methods must be used to determine the actual prenatal events or unrecognized intrapartum events that increase the risk of preterm birth.** These events could include the subclinical inflammation associated with obesity.

Med 441 Team:

Leaders:

Leen Alrajhi - Yara Almufleh

Members:

Maram Aldeej

Good Luck!

Med 438 Team:

Leaders:

Ateen Almutairi - Lama ALzamil - Lina Alosaimi

Members:

Renad AlKanaan - Taif alotaibi - Ghaliah Salem

Med 439 Team:

Leader:

Bushra Alotaibi - Renad Alhomaidi

Members:

Ghada Aljedaie - Noura alsheikh