Fetal Assessment and Safe Labor Management

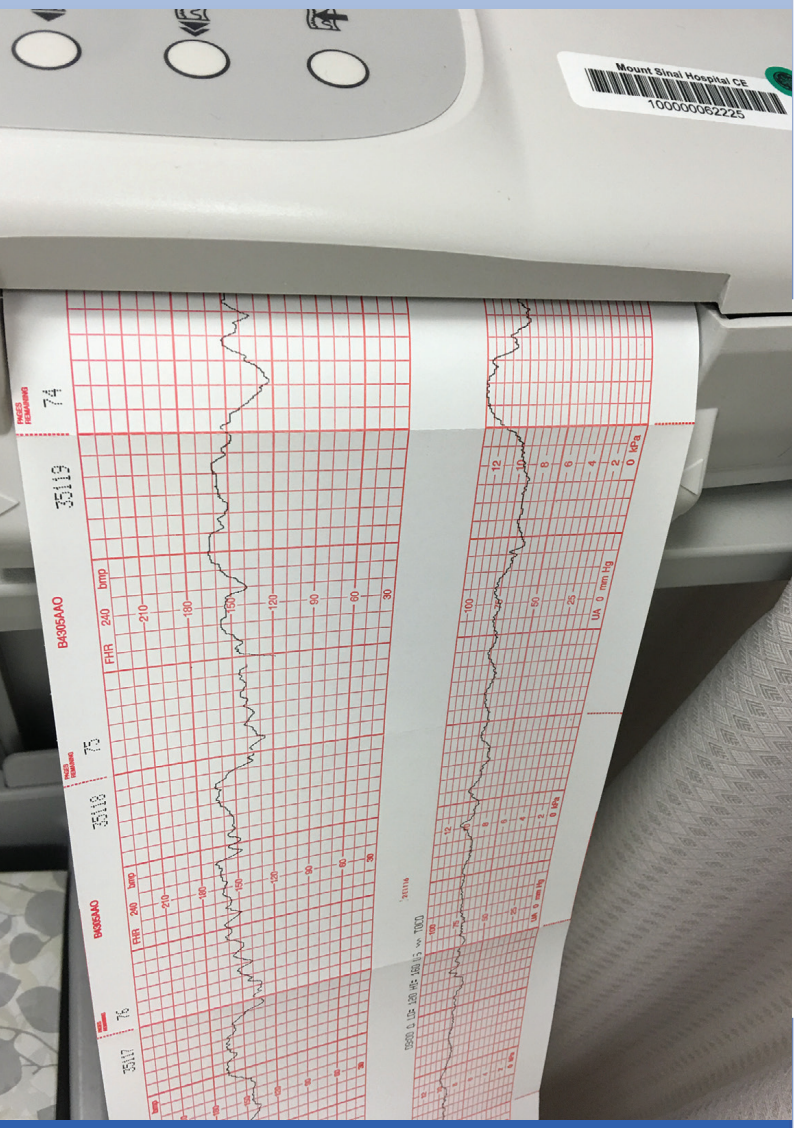
MONOGRAPH

National Certification Corporation

Purpose of this Monograph

Safe care for mothers and babies during labor and birth is the goal of all health care professionals and is an expectation of childbearing women and their families. Fetal assessment is a key aspect of perinatal patient safety. More evidence has been published over the last several years about what constitutes normal labor progress and associated maternal-newborn outcomes. These data have been used to redefine routine labor management practices.[1] One of the main objectives of the heightened focus on labor management is prevention of the first cesarean birth, which would then avoid maternal morbidity and mortality related to primary and repeat cesareans.[1,2] While vaginal birth after cesarean (VBAC) has increased from 12.4% of births to women with a prior cesarean in 2016 to 13.3% in 2018, the rate remains low for eligible candidates.[3] Labor management guidelines based on current evidence and characteristics of contemporary child-bearing women,[1, 2] along with efforts to minimize unnecessary interventions [4,5,6] may result in longer labors for selected women progressing at the upper limits of normal. Renewed interest in elective induction of labor at 39 weeks gestation for low risk nulliparous women based on results of the ARRIVE trial[7] may likewise contribute to a longer intrapartum length of stay. Although longer labors require extended fetal surveillance, many women may be able to have a vaginal birth applying updated labor guidelines[2] whereas in the past, a cesarean for "failure to progress" would likely have occurred. The use of patience supported by evidence and clinical guidelines may influence labor outcomes. In some cases, despite the best efforts of all involved, a cesarean birth may be necessary to have a healthy outcome.

The purpose of this monograph is to incorporate evidence-based labor management guidelines into fetal assessment during the intrapartum period. A brief review of the definitions for fetal heart rate (FHR) patterns developed by the National Institute of Child Health and Human Development (NICHD)[8,9] is offered followed by an overview of FHR interpretation principles, physiologic implications, and intrauterine resuscitation measures. A summary of the 2014 recommendations for labor management from the American College of Obstetricians and Gynecologists (ACOG) and the Society for Maternal-Fetal Medicine (SMFM)[1,2] is then presented with discussion of the implications of the ARRIVE trial.[7] Operational and clinical considerations for induction of labor with a focus on facilitating and maintaining fetal well-being are included. The monograph concludes with a discussion of aspects of a safe maternity unit culture that support and promote high quality care during labor and birth including adequate nurse staffing for maternal-fetal assessment based on patient acuity.



Overview of NICHD Terminology and Interpretation of Electronic Fetal Monitoring Tracings

The NICHD definitions and classifications in the "The 2008 National Institute of Child Health and Human Development Workshop Report on Electronic Fetal Monitoring" were published in *Obstetrics and Gynecology* and in the *Journal of Obstetric, Gynecologic and Neonatal Nursing*.[8,9] NCC encourages the reader to obtain the original documents for further review and study.

Operational Principles for Using NICHD Terminology

Operational principles as the basis for defining terms and their interpretive value in assessing fetal heart rate tracings, were standardized in 1997 and reaffirmed in 2008. The most pertinent are listed below:

- Definitions are to be used for visual interpretation.
- Definitions apply to patterns obtained from a direct fetal electrode or an external Doppler device.
- Focus is on intrapartum patterns, but the definitions may also apply to antepartum observations as well.
- FHR patterns and uterine activity are determined through interpretation of tracings of good quality.
- The components of FHR tracings do not occur in isolation; therefore, evaluation of FHR patterns should take into account all components of the FHR pattern, including baseline rate, variability, and presence of accelerations and/or decelerations. EFM tracings should be assessed over time to identify changes and trends.
- No differentiation between short- and long-term variability is made because in practice, they are visually determined as a unit.
- FHR patterns are dependent on gestational age; thus this is an essential interpretative factor for evaluating a FHR pattern. Maternal medical status, prior fetal assessment results, use of medications and other factors also may need to be considered.
- A complete description of the EFM tracing includes uterine contractions, baseline fetal heart rate, baseline variability, presence of accelerations, periodic (associated with contractions) or episodic (not associated with contractions) decelerations, and changes or trends of the FHR pattern over time.[8,10]

NICHD Terminology and Definitions[8,9]

FETAL HEART RATE AND UTERINE ACTIVITY CHARACTERISTICS AS PER NICHD

Term	Definition
Baseline Rate	Approximate mean FHR rounded to increments of 5 bpm during a 10-minute window excluding accelerations and decelerations and periods of marked variability. There must be ≥2 minutes of identifiable baseline segments (not necessarily contiguous) in any 10-minute window, or the baseline for that period is indeterminate. In such cases, one may need to refer to the previous 10-minute window for determination of the baseline.
Normal Baseline	Baseline rate between 110-160 bpm.
Bradycardia	Baseline rate of <110 bpm.
Tachycardia	Baseline rate of >160 bpm.
Baseline Variability	Determined in a 10-minute window, excluding accelerations and decelerations. Fluctuations in the baseline FHR that are irregular in amplitude and frequency and are visually quantified as the amplitude of the peak-to-trough in bpm.
Absent Variability	Amplitude range undetectable.
Minimal Variability	Amplitude range visually detectable but ≤5 bpm. (Greater than undetectable but ≤5 bpm)
Moderate Variability	Amplitude range 6–25 bpm.
Marked Variability	Amplitude range >25 bpm.
Acceleration	Visually apparent **abrupt** increase in FHR. Abrupt increase is defined as an increase from onset of acceleration to peak is <30 seconds. Peak must be ≥15 bpm, must last ≥15 seconds, but <2 minutes from the onset to return. Before 32 weeks of gestation, accelerations are defined as having a peak ≥10 bpm and duration of ≥10 seconds.
Prolonged Acceleration	Acceleration ≥2 minutes but <10 minutes in duration. Acceleration lasting ≥10 minutes is defined as a baseline change.
Early Deceleration	Visually apparent, usually symmetrical, **gradual** decrease and return of FHR associated with a uterine contraction. The gradual FHR decrease is defined as one from the onset to FHR nadir of ≥30 seconds. The decrease in FHR is calculated from onset to nadir of 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.

Term	Definition
Late Deceleration	Visually apparent, usually symmetrical, **gradual** decrease and return of FHR associated with a uterine contraction. The gradual FHR decrease is defined as from the onset to FHR nadir of ≥30 seconds. The decrease in FHR is calculated from onset to the nadir of deceleration. The deceleration is delayed in timing, with 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 <30 seconds. The decrease in FHR is calculated from the onset to the nadir of deceleration. The decrease in FHR is ≥15 bpm, lasting ≥15 seconds, and <2 minutes in duration. When variable decelerations are associated with uterine contractions, their onset, depth, and duration commonly vary with successive uterine contractions. Variable decelerations have a depth criteria; they must drop at least 15 or more bpm to be considered a variable deceleration.
Prolonged Deceleration	Visually apparent decrease in FHR from baseline that is ≥15 bpm, lasting ≥2 minutes, but <10 minutes. A deceleration that lasts ≥10 minutes is a baseline change. Prolonged decelerations have a depth criteria; they must drop at least 15 or more bpm to be considered a prolonged deceleration.
Recurrent Decelerations	Occurring with ≥50% of contractions in any 20 minute window.
Intermittent Decelerations	Occurring with <50% of contractions in any 20 minute window.
Sinusoidal Pattern	Visually apparent, smooth, sine wave-like undulating pattern in FHR baseline with cycle frequency of 3-5/minute that persists for ≥20 minutes.
Uterine Activity	Uterine activity is assessed based on the number of contractions that are occurring in a 10 minute segment, averaged over a 30 minute period.
Normal Uterine Activity	5 or less contractions in a 10 minute segment, averaged over a 30 minute period.
Tachysystole	Excessive uterine activity; more than 5 contractions in a 10 minute segment averaged over a 30 minute period. Tachysystole can be the result of both spontaneous and stimulated labor.

Derived from: [8,9] Macones, G. A., Hankins, G. D., Spong, C. Y., Hauth, J. D., & Moore, T. (2008). The 2008 National Institute of Child Health Human Development workshop report on electronic fetal monitoring: Update on definitions, interpretations, and research guidelines. *Obstetrics & Gynecology*, 112(3), 661–666; and *Journal of Obstetric, Gynecologic and Neonatal Nursing*, 37(5), 510–515.

(See Appendix A for sample EFM tracings with each of these fetal heart rate characteristics)

(See Appendix B for sample EFM tracings with normal uterine activity and tachysystole)

(See Appendix C for sample EFM tracings with sinusoidal pattern)

Factors Affecting Fetal Heart Rate Patterns

There are many factors that have an effect on the fetal heart rate. These changes can relate to pre-existing or pregnancy-related conditions, substances used by the woman before labor, and medications given to the woman in labor. Other influences include maternal positioning, excessive uterine activity, and maternal pushing efforts. The changes may be transient and benign or require close monitoring and/or intervention/s. In the following two tables[12], factors that have an influence on the FHR and potential clinical causes of decreased uteroplacental blood flow and maternal–fetal exchange are identified.

INFLUENCES ON FETAL HEART RATE CONTROL

PHYSIOLOGY	EFFECT ON FETAL HEART RATE
Parasympathetic Nervous System (branch of the autonomic nervous system)	
• Originates in medulla oblongata • Vagus nerve (10th cranial innervates SA and AV nodes) • Stimulation releases acetylcholine • Pathway for transmission of FHR variability • Variability represents an intact central nervous system pathway through cerebral cortex, midbrain, vagus nerve, and normal cardiac conduction system	• Decreases FHR • With increasing gestational age, slow, gradual decrease in FHR and increase in FHR variability • Moderate variability indicates absence of metabolic acidemia • Modulates baseline FHR with sympathetic branch
Sympathetic nervous system (branch of the autonomic nervous system)	
• Nerve fibers widely distributed throughout myocardium at term • Stimulation releases catecholamines (norepinephrine, epinephrine) • Reserve mechanism to initially improve the heart's pumping ability during intermittent hypoxemia/stress • Blocking with propranolol results in approximately 10 bpm decrease in FHR • Catecholamines may also cause fetal vasoconstriction and hypertension	• Increases FHR • With intermittent hypoxemia, initial normal fetal compensatory response is increase in FHR or brief tachycardia • At term, tachycardia is not normal • In early gestation, sympathetic dominance results in slightly higher FHR and decrease in variability • Modulates baseline FHR with parasympathetic branch
Cardiac Output	
• In the adult, CO increases or decreases in response to changes in HR or SV as in the following equation: CO = HR x SV • Because the fetal heart appears to operate near the top of its cardiac function curve, SV does not fluctuate significantly. Hence, fetal CO is dependent on HR	• Small FHR variations within the normal FHR range (110-160 bpm) appear to have minimal effect on CO • With fetal tachycardia greater than 240 bpm or bradycardia less than 60 bpm, fetal CO and umbilical blood flow can be significantly decreased
Baroreceptors	
• Protective, stretch receptors • Located in aortic arch and carotid sinuses at bifurcation of external and internal carotid arteries • When arterial BP increases, baroreceptors quickly detect amount of stretch, sending impulses via vagus nerve to midbrain • Further vagal stimulation causes a sudden decrease in FHR, CO, and BP, thereby protecting fetus	• Abrupt decrease in FHR, CO, BP • Variable decelerations
Chemoreceptors	
• Central – located in medulla oblongata • Peripheral – located in aortic arch and carotid sinuses • Interaction of central and peripheral chemoreceptors poorly understood; combined effect FHR slowing • When blood flow falls below threshold for normal respiratory gas exchange, increased PCO_2 stimulates chemoreceptors to slow FHR • Deceleration is late due to circulation time from fetal-placental site to chemoreceptors	• Late decelerations • Variable decelerations resulting from umbilical cord occlusion coupled with hypoxemia • Prolonged deceleration coupled with hypoxemia

INFLUENCES ON FETAL HEART RATE CONTROL *(continued)*

PHYSIOLOGY	EFFECT ON FETAL HEART RATE
Hormonal Influences	
• Epinephrine and norepinephrine (adrenal medulla) – Reserve mechanism to initially improve the heart's pumping ability during intermittent hypoxemia/stress – In response to stress, fetal compensatory response shunts blood away from less vital organs and toward brain, heart, adrenal glands	• Increases FHR, strength of cardiac contractions, CO, arterial BP
• Renin-angiotensin system – Regulates normal fetal circulation by tonic vasoconstriction on peripheral vascular bed – Protects fetus during hemorrhagic stress	• Maintains systemic arterial BP and umbilical placental blood flow
• Prostaglandins – Prostaglandins and arachidonic acid metabolites found in fetal circulation and in many tissues – Maintains patency of fetal ductus arteriosus	• Regulation of umbilical blood flow
Sleep-Wake Patterns	
• Quiet sleep – Quiescence (occasional brief body movements) – Absent REM – FHR stable with narrow oscillation bandwidth	• Normal baseline FHR, minimal variability, accelerations absent • Non-reactive NST • Responds to external stimuli (vibroacoustic stimulation)
• Active (REM) sleep – Frequent gross body movements – Rapid darting eye movements (REM) – FHR with wider oscillation bandwidth and frequent accelerations with movements	• Moderate variability, accelerations present • Reactive NST • At term, duration of periods of active sleep are longer than quiet sleep

Key: AV, Atrioventricular; BP, blood pressure; bpm, beats per minute; CNS, central nervous system; CO, cardiac output; FHR, fetal heart rate; HR, heart rate; NST, non-stress test; PCO_2, partial pressure of carbon dioxide; PO_2, partial pressure of oxygen; REM, rapid eye movements; SA, sinoatrial; SV, stroke volume.

Derived from content in Blackburn, 2018a,b,c; Fineman & Maltepe, 2019; Freeman, Garite, Nageotte, Miller, 2012; King, 2018; King & Parer, 2000; Murata et al, 1985; Nageotte, 2019; Parer, 1997; Richardson, Harding & Walker, 2019; Rudolph, 1985

From: [12] O'Brien-Abel, N. (2020). Clinical implications of fetal heart rate interpretation based on underlying physiology. *MCN The American Journal of Maternal Child Nursing,* 45(2), 82-91. DOI:10.1097/NMC.0000000000000596

POTENTIAL CLINICAL CAUSES OF DECREASED UTEROPLACENTAL BLOOD FLOW AND MATERNAL-FETAL EXCHANGE

Maternal conditions
Chronic or gestational hypertension; preeclampsia
Cardiac disease
Maternal hypotension
Supine position (supine hypotensive syndrome)
Regional analgesia/anesthesia (sympathetic blockade)
Hemorrhage/hypovolemic shock
Placental changes
Degenerative (e.g., maternal hypertension, diabetes, nicotine, prolonged pregnancy)
Infection (e.g., chorioamnionitis)
Edema (e.g., hydrops fetalis)
Decreased surface area (e.g., abruptio placenta, small placenta, infarcts)
Excessive uterine activity
Tachysystole
Hypertonus
Medications that cause contractions (e.g., oxytocin, prostaglandins)
Abruptio placenta
Cocaine
Vasoconstriction
Endogenous (e.g., catecholamines)
Exogenous (e.g., most sympathomimetics, except ephedrine; cocaine, amphetamines)

From: [12] O'Brien-Abel, N. (2020). Clinical implications of fetal heart rate interpretation based on underlying physiology. *MCN The American Journal of Maternal Child Nursing,* 45(2), 82-91. DOI:10.1097/NMC.0000000000000596

Fetal Heart Rate Pattern Interpretation

The primary purpose for use of electronic fetal monitoring is to determine if the fetus is well oxygenated. Fetal heart rate patterns provide information about fetal acid-base status at the time they are observed.[8,9] Because the fetal condition is dynamic, frequent reassessment is required to monitor ongoing fetal status considering the context of the complete clinical situation. The three-tiered classification system was developed based on fetal acid-base status at time of observation with the assumption that the fetal heart rate tracing changes over time.[7,8] Fetal status can move from one category to another as a result of the individual clinical situation, maternal status and various intrauterine resuscitation measures that may be initiated in response to the fetal heart rate pattern.[8,9]

Moderate variability and/or the presence of accelerations are two features of fetal heart rate patterns that reliably predict the absence of fetal metabolic acidemia at the time observed.[8,9] However, it is important to note that the absence of accelerations or an observation of minimal or absent variability alone does not reliably predict the presence of fetal hypoxemia or metabolic acidemia.[8,9]

An analysis of 48,444 EFM tracings of women in term labor in 10 hospitals in the United States found over the course of labor the majority of fetuses will have FHR pattern characteristics that are both normal (category I) and indeterminate (category II).[13] Abnormal (category III) FHR patterns are rare (0.1%). Jackson et al. reported that when all of labor was considered, 77.9% of the time the tracings were a Category I, 22.1% of the time a Category II, and 0.004% of the time a Category III. In addition, Category II FHR tracings occurred in 84% of labors. Moderate variability and/or accelerations are generally an indication of a non-acidotic fetus when the FHR is indeterminate or category II. There are a wide range of clinical implications associated with the various types of FHR patterns within category II. For example, a FHR tracing with moderate variability and intermittent variable decelerations and a FHR tracing with minimal variability and recurrent late decelerations both meet criteria to be classified as category II FHR patterns. The underlying physiologic causative factors are different, as are the levels of concern for fetal well-being. Therefore, using the FHR category as a major factor to make clinical decisions related to fetal status during labor when the FHR is category II can present significant challenges. Nevertheless, there is evidence to suggest that the longer the FHR remains in category II, especially during the last two hours prior to birth, the greater the risk of neonatal morbidity.[13] Jackson et al. found if more than 50% of the time was spent in category II in the last two hours prior to birth, there was an increased risk of an Apgar score less than 7 and admission to the neonatal intensive care unit.

In 2013, an algorithm was developed by fetal monitoring researchers and expert clinicians led by Clark and colleagues[14] that included intrauterine resuscitation measures for management of indeterminant (category II) FHR patterns. One of the goals was to identify category II FHR patterns with characteristics that suggested fetal well-being by an evaluation of variability and accelerations, so labor could continue with careful monitoring. Another goal was to assess fetal status with consideration of the likelihood of a timely vaginal birth of a nonacidemic baby. A main objective was to promote the birth of the fetus, when possible, prior to the development of damaging degrees of hypoxemia or acidemia. The algorithm was designed to assist in delineation of FHR patterns in category II that may allow for careful observation from those that may warrant prompt action, based on the presence or absence of moderate variability or accelerations, "significant" decelerations and for how long; the phase and stage of labor; and response to the usual intrauterine resuscitation measures.[14] Significant decelerations were defined as any of the following: variable decelerations lasting longer than 60 seconds and reaching a nadir more than 60 bpm below baseline, variable decelerations lasting longer than 60 seconds and reaching a nadir less than 60 bpm regardless of the baseline, and any late decelerations of any depth.

Application of the algorithm retrospectively to a series of cases of babies born with metabolic acidemia by Clark and colleagues[15], found about 50% feasibly could be identified and have an expeditious birth under ideal conditions. They concluded that randomly occurring emergency events during labor along with more rapidly than anticipated worsening of acid-base status at times seen in some fetuses with nonemergent category II FHR tracings contribute to EFM being a valuable but imperfect tool.[15] Shields et al.[16] adapted the Clark[14] algorithm focusing on recurrent "significant" decelerations in FHR tracings with moderate or marked variability and used it in a prospective interventional trial in six hospitals. Compliance with use of the algorithm was high. Data from 23 hospitals in the same health system that did not use the standard management of FHR algorithm were compared. Shields et al.[16] found use of the adapted algorithm was associated with a 24% decrease in Apgar scores less than 7, a 26.6% decrease in severe unexpected newborn complications, and a slight but significant decrease in cesarean birth.[16] More research is needed on application of a standardized approach to FHR tracing interpretation and management, however these results are promising.

There was initial optimism about use of artificial intelligence to assist clinicians and improve human precision of FHR tracing interpretation, however so far results have been disappointing. In a large randomized clinical trial conducted in Ireland and England of over 47,000 labors and births, a computer assisted interpretation and warning system was not found to be helpful by clinicians or accurate in identifying FHR tracings that needed intervention.[17,18] There were no significant differences in poor neonatal outcomes between groups at birth and at two years of age.[17,18] Similarly, in the United States, nurses have noted that electronic fetal monitoring alarms are not that useful and reported a significant number of false alarms, generally based on loss of signal.[19] In a study of system alarms generated from EFM in 11 birthing hospitals in two health systems over three months, approximately 85% were due to loss of signal.[20] Enhancements in system design that support better accuracy will be needed before artificial intelligence in EFM interpretation, warning, and decision support can be useful. In the future, it is likely that computerized interpretation of the FHR and clinical decision support systems will be integrated into care during labor and birth once improvements are made.

Category II and category III tracings require evaluation of the possible etiology.[10,11] Initial assessment and intervention may include discontinuation of any labor stimulating agent, a vaginal examination, maternal repositioning, correction of maternal hypotension, an intravenous fluid bolus of lactated Ringer's solution, assessment for tachysystole (and if noted, reduction in uterine activity), amnioinfusion, and modification of maternal pushing efforts in second stage labor (e.g. pushing with every other or every third contraction or discontinuation of pushing temporarily).[10, 21] Maternal oxygen at 10 liters per minute using a nonrebreather face mask may be administered in the presence of minimal or absent variability or recurrent late decelerations that have not resolved with the initial intrauterine resuscitative measures.[21] Moderate variability reliably predicts the absence of fetal hypoxemia or metabolic acidemia at the time observed,[9] therefore, maternal oxygen administration is generally not necessary or appropriate if the FHR has moderate variability.[22]

When oxygen is chosen for intrauterine resuscitation, there is the assumption that other sources of potential fetal physiologic stress have been minimized; thus, oxytocin should not be infusing concurrently with maternal oxygen administration.[21,23]

FETAL HEART RATE PATTERN CLASSIFICATION AND INTERPRETATION[11]

Category	Interpretation	Features
I **Normal**	Tracings in this category are strongly predictive of normal acid-base status at the time of observation.	• Baseline rate 110 to 160 beats per minute • Baseline variability moderate • No late or variable decelerations • Early decelerations present or absent • Accelerations: present or absent
II **Indeterminate** All tracings not categorized as category I or III. May represent many tracings that are encountered in everyday clinical practice.	Tracings in this category are not predictive of abnormal acid-base status, however there are insufficient data to classify them as either category I or category III	• Baseline rate: Bradycardia not accompanied by absent baseline variability • Baseline rate: Tachycardia • Minimal variability • Absent variability without recurrent decelerations • Marked variability • Absence of induced accelerations after fetal stimulation • Recurrent variable decelerations with minimal or moderate variability • Prolonged deceleration • Recurrent late decelerations with moderate variability • Variable decelerations with "slow return to baseline", "overshoots" or "shoulders"
III **Abnormal**	Tracings in this category are predictive of abnormal acid-base status at the time of observation.	• Absent variability and any of the following: —Recurrent late decelerations —Recurrent variable decelerations —Bradycardia • Sinusoidal pattern

Derived from: [10]American College of Obstetricians and Gynecologists (2010, Reaffirmed 2015) Practice Bulletin, *Management of Intrapartum Fetal Heart Rate Tracings* (Practice Bulletin No 116), Washington, DC, ACOG doi: 10.1097/AOG.0b013e3182004fa9

(See Appendix C for sample EFM tracings in each of the categories)

INTRAUTERINE RESUSCITATION MEASURES[21]

Clinical Situation and/or FHR Characteristics	Goal	Techniques/Measures
Minimal or absent variability **Recurrent late decelerations** **Recurrent variable decelerations** **Prolonged decelerations** **Tachycardia** **Bradycardia** **Variable, late or prolonged decelerations occurring with maternal pushing efforts** **Tachysystole**	Promote fetal oxygenation	• Lateral positioning (either left or right) • IV fluid bolus of lactated Ringer's solution • Oxygen administration at 10 L/min via nonrebreather face mask; may be considered if there is minimal to absent variability and/or recurrent late decelerations or prolonged decelerations (discontinue as soon as possible based on fetal status) • Modification of pushing efforts; pushing with every other or every third contraction or discontinuation of pushing temporarily (during second stage labor) • Decrease in oxytocin rate • Discontinuation of oxytocin / removal of Cervidil insert / withholding next dose of misoprostol • If prolapsed umbilical is identified, elevate presenting fetal part while preparations are made for expedited operative birth
Tachysystole	Reduce uterine activity	• IV fluid bolus of lactated Ringer's solution • Lateral positioning (either left or right) • Decrease in oxytocin rate • Discontinuation of oxytocin / removal of Cervidil insert / withholding next dose of misoprostol • If no response, terbutaline 0.25 mg subcutaneously may be considered
Recurrent variable decelerations	Alleviate umbilical cord compression	• Repositioning • Amnioinfusion (during first stage labor) • Modification of pushing efforts; pushing with every other or every third contraction or discontinuation of pushing temporarily (during second stage labor)
Maternal hypotension	Correct maternal hypotension	• Lateral positioning (either left or right) • IV fluid bolus of lactated Ringer's solution • If no response, ephedrine 5 mg to 10 mg IV push may be considered

Derived from: [21]Simpson, K. R. (2015). Physiologic interventions for fetal heart rate patterns. Lyndon, A. & Ali, L. U. (Eds.) *AWHONN's Fetal heart monitoring*. 5th ed.: Washington, DC: Kendall Hunt, page 167.

Uterine Activity Assessment

Accurate assessment and management of uterine activity during labor is fundamental to safe and effective care during labor and birth.[24] Poor labor progress may be a result of inadequate uterine activity, while a negative effect on fetal oxygenation can be associated with too frequent contractions. Ideally, contractions are of sufficient strength and regularity to promote labor progress leading to a vaginal birth. Contractions that are occurring at a frequency of more than 5 in 10 minutes averaged over 30 minutes are defined as uterine tachysystole.[8,9]

The healthy term fetus experiences uterine contractions as a normal part of labor and birth. Uteroplacental blood flow is reduced by approximately 60% during contractions,[25] however when contractions occur at a frequency that allows for adequate fetal and placental reperfusion, and the fetus and placenta are healthy, intermittent decreases in uteroplacental blood flow are well tolerated.[25,26] When contractions are too frequent, decreased intervillous blood flow eventually leads to decreased oxygen transfer to the fetus.[27] If fetal oxygenation is impaired to such a degree that produces fetal metabolic acidosis from anaerobic glycolysis, direct myocardial depression occurs, and the FHR pattern becomes indeterminate (category II) or abnormal (category III).[28] There is risk of fetal hypoxia, acidosis, and ultimately asphyxia if the situation continues unresolved and the intermittent interruption in blood flow caused by excessive uterine activity exceeds a critical level.[25,28] Ideally and in the context of assessment of maternal and fetal status every 15 minutes for women receiving oxytocin as per standard and recommended practice,[29,30] identification and treatment of uterine tachysystole should be timely. Treatment is based on fetal status and may include maternal repositioning as a first step, followed by an intravenous fluid bolus of lactated Ringers solution, and a decrease or discontinuation of oxytocin.[10] An algorithm for treating tachysystole is offered by ACOG and AWHONN.[10, 23]

DEFINITIONS OF COMMON TERMS USED IN ASSESSING UTERINE ACTIVITY[24]

Frequency	Time, in minutes from the beginning of one contraction to the beginning of the next contraction. Frequency is generally evaluated over a minimum of 10 min. Frequency is considered normal when there are ≤5 contractions in 10 min, averaged over 30 min. A frequency of >5 contractions in 10 min averaged over 30 min is tachysystole. These terms apply to both spontaneous and stimulated labors
Duration	Time, in seconds, from the beginning of a uterine contraction to the end of a contraction
Relaxation time	Time, in minutes and/or seconds, between contractions; measured from the end of one uterine contraction to the beginning of the next uterine contraction
Strength/Intensity	Term that applies to both external monitoring using palpation and internal monitoring. When using palpation, strength is usually expressed as mild, moderate, or strong. When using an intrauterine pressure catheter, strength is usually expressed as the peak of the contraction in mm Hg
Resting tone	Intrauterine pressure during relaxation time, expressed in mm Hg when an intrauterine pressure catheter is in place. When assessing uterine activity with palpation, uterine resting tone is generally expressed as soft or firm

Adapted from: [24]Simpson, K. R. & Miller, L. A. (2011). Assessment and optimization of uterine activity during labor. *Clinical Obstetrics and Gynecology,* 54(1), 40-49. doi: 10.1097/GRF.0b013e31820a06aa.

Communication of Electronic Fetal Monitoring Data

When the FHR pattern is indeterminate (category II) or abnormal (category III), communication among members of the perinatal team is essential in ensuring appropriate and timely response to the clinical situation. Standardizing components of the data communicated can be useful in promoting patient safety. The following are suggested aspects of professional communication regarding fetal status when the FHR pattern is indeterminate or abnormal:

- Baseline rate, variability, presence or absence of accelerations and decelerations
- Clinical context of fetal heart rate pattern (e.g., cervical status, labor progress, oxytocin rate and recent titration, timing and amount of last dose of misoprostol, uterine activity, tachysystole, bleeding, timing and amount of last dose of intravenous pain medication, recent initiation or dosage change in regional anesthesia/analgesia, hypotension, length of time of ruptured membranes, amniotic fluid appearance, maternal fever, rapid labor progress, second stage labor pushing, umbilical cord prolapse; trial of labor attempting vaginal birth after cesarean birth)
- Intrauterine resuscitation measures initiated and the maternal-fetal response
- Fetal heart rate pattern evolution (e.g., how long has this been evolving?)
- Sense of urgency (e.g., come to the bedside now; as soon as you can; within 30 min)
- Who was notified and their response
- Next steps if there is no resolution of the fetal heart rate pattern

Labor Management Considerations to Support Maternal and Fetal Well-being

The cesarean birth rate in the United States has risen dramatically (>600%) over the past five decades from 4.5% in 1965 to 31.9% in 2018 (last year for which data are available).[31,32] Of particular concern is the corresponding rate increase for healthy women (women at term having their first baby with a singleton fetus in vertex presentation). These women represent the largest group for which strategies to decrease risk of cesarean birth may be effective. The two most common reasons for primary cesarean are labor dystocia and concern for fetal status based on interpretation of the FHR tracing.[2] Rates of vaginal birth after cesarean birth have increased slightly in the past several years.[3]

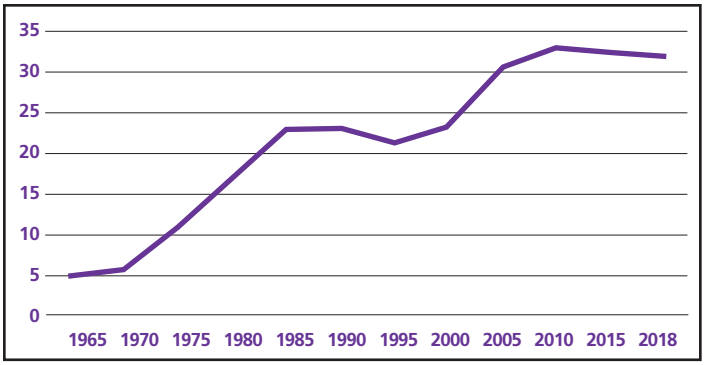
Past natality data from birth certificates on timing of births in the United States[33] indicate that spontaneous labor generally occurs equally over the course of the day with some slight decreases in the middle of the night. Births after spontaneous labor generally occur equally over the course of the week including Saturday and Sunday, whereas cesarean births and births following induced labor occur at peaks based on physician office hours and hospital scheduling to accommodate physician and patient preferences. Interventions and scheduling continue to influence time of birth. In 2018, approximately 60% of births occurred during the hours between 6 am and 6 pm. Thursday is the day with the highest number of births, while Sunday has the lowest number of births.[32] Artificial peaks in patient volume and acuity can be minimized with promotion of spontaneous labor since births after spontaneous labor occur naturally over the course of the day and the week, therefore reducing nurse staffing challenges caused by procedures scheduled electively on selected days of the week.[34]

TIMING OF BIRTHS IN THE UNITED STATES 2017-2018 BY HOUR, DAY AND MONTH

	2017	2018
12 am to 5:59 am	17.7%	17.6
6 am to 11:59 am	28.9%	28.9%
12 pm to 5:59 pm	30.6%	30.6%
6 pm to 11:59 pm	22.9%	22.8%
Day with highest number of births	Thursday	Thursday
Day with lowest number of births	Sunday	Sunday
Month with highest number of births	August	August
Month with lowest number of births	February	February

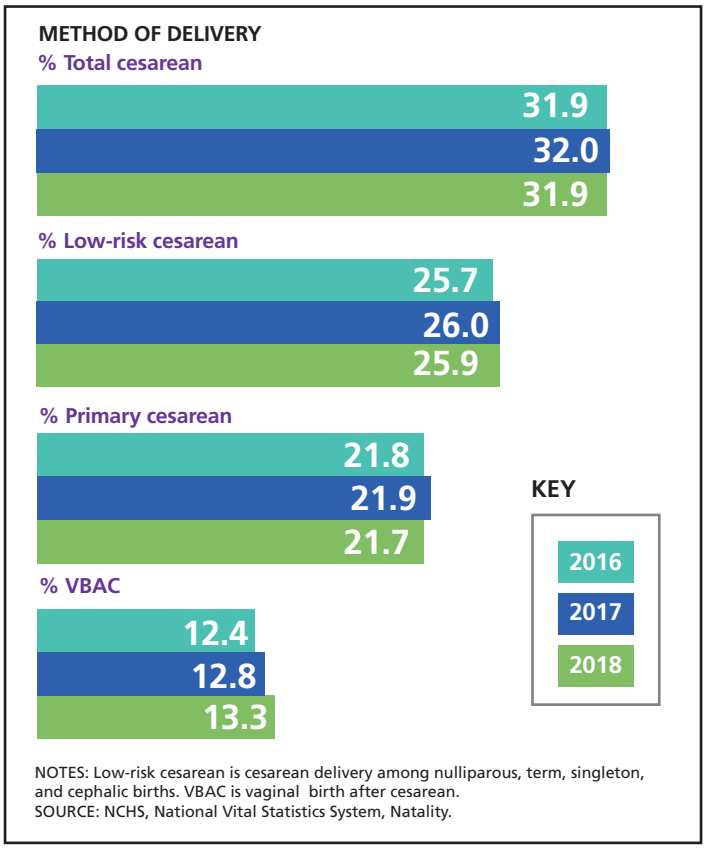
Compiled from data in: [32]Martin, J. A., Hamilton, B. E., Osterman, M. J. K., & Driscoll, A. K. (2019). Births: Final data for 2018. *National Vital Statistics Reports,* 68(13), 1–47.

TRENDS IN CESAREAN BIRTH IN THE UNITED STATES FROM 1965 TO 2018



Trends in cesarean birth in the United States from 1965 to 2018. (Compiled from data from Centers for Disease Control and Prevention/ National Center for Health Statistics, National Vital Statistics System.)

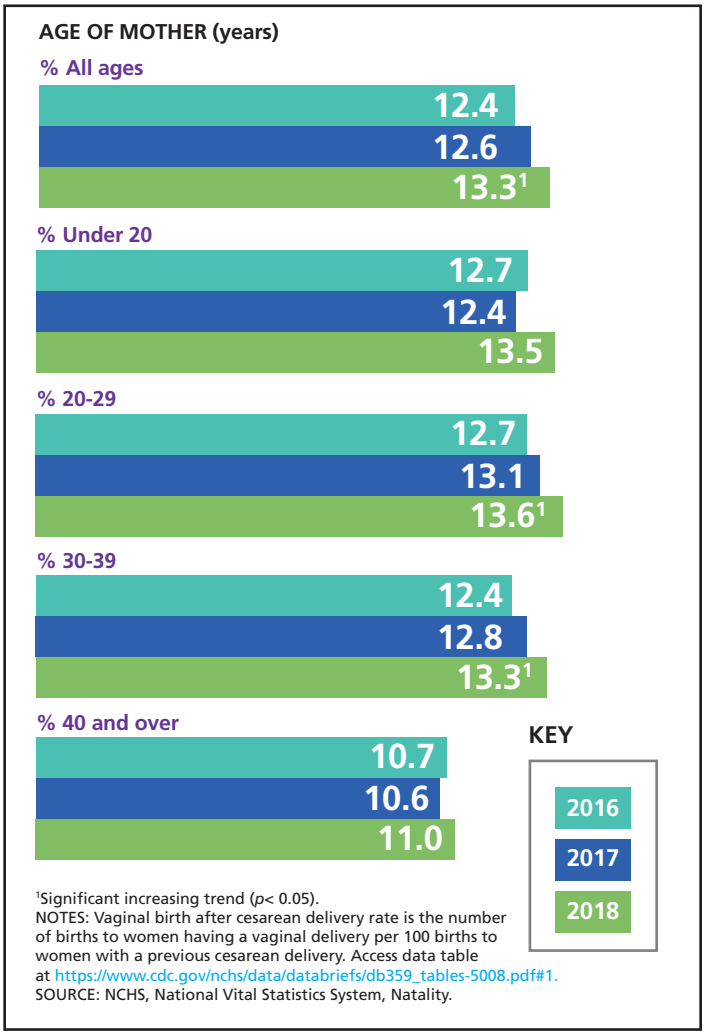
METHOD OF BIRTH; UNITED STATES, 2016-2018



NOTES: Low-risk cesarean is cesarean delivery among nulliparous, term, singleton, and cephalic births. VBAC is vaginal birth after cesarean.
SOURCE: NCHS, National Vital Statistics System, Natality.

From [32]Martin, J. A., Hamilton, B. E., Osterman, M. J. K., & Driscoll, A. K. (2019). Births: Final data for 2018. *National Vital Statistics Reports,* 68(13). Hyattsville, MD: National Center for Health Statistics.

RATES OF VAGINAL BIRTH AFTER CESAREAN DELIVERY BY AGE OF MOTHER, UNITED STATES, 2016-2018



[1]Significant increasing trend ($p < 0.05$).
NOTES: Vaginal birth after cesarean delivery rate is the number of births to women having a vaginal delivery per 100 births to women with a previous cesarean delivery. Access data table at https://www.cdc.gov/nchs/data/databriefs/db359_tables-5008.pdf#1.
SOURCE: NCHS, National Vital Statistics System, Natality.

From [3]Osterman, M. J. K. (2020). Recent trends in vaginal birth after cesarean delivery: United States, 2016–2018. (NCHS Data Brief, No 359). Hyattsville, MD: National Center for Health Statistics. 2020.

Labor Management Guidelines from ACOG and SMFM

In 2012, the NICHD, SMFM, and ACOG convened a workshop of perinatal experts to discuss potential solutions to minimize risk of primary cesarean birth.[1] Available evidence of possible contributing factors to primary cesarean birth was reviewed. Summaries of potentially modifiable obstetric, maternal and fetal indications were offered. Algorithms for spontaneous labor and induced labor were included, based on the most recent data about time frames that reflect normal labor progress in contemporary obstetric practice from the Consortium for Safe Labor project.[1] Recommendations were made to minimize risk of primary cesarean birth and monitor outcomes.[1] Suggestions were offered for appropriate candidates for elective induction of labor based on cervical status and gestational age. Definitions of failed induction and arrest of labor disorders were incorporated into the recommendations.

Encouragement of patience and a reconsideration of the parameters of normal labor progress for nulliparous women were major findings. In 2014, ACOG and SMFM co-published a consensus statement Safe Prevention of the Primary Cesarean Delivery[2] in which these recommendations were further detailed and enhanced.

Summary of Findings in ACOG and SMFM *Obstetric Care Consensus: Safe Prevention of the Primary Cesarean Delivery*[2]

- Induction of labor < 41 0/7 weeks gestation generally should be limited to women with maternal and/or fetal indications.
- Induction of labor at ≥41 0/7 weeks gestation is recommended to minimize risk of cesarean birth and risk of perinatal morbidity and mortality.
- Cervical ripening should be used for women being induced with an unfavorable cervix.
- Active labor is more accurately defined as beginning at 6 centimeters (cm) cervical dilation.

(continued)

Summary of Findings in ACOG and SMFM *Obstetric Care Consensus: Safe Prevention of the Primary Cesarean Delivery*[2]

- Neither active phase labor protraction nor labor arrest should be diagnosed before the cervix is 6 cm dilated.
- Most women with a prolonged latent phase will eventually begin active phase of labor with expectant management.
- A prolonged latent phase (e.g., > 20 hours in nulliparous women and > 14 hours in multiparous women) should not be an indication for cesarean birth.
- Slow but progressive labor in the first stage should not be an indication for cesarean birth.
- Women with ≥6 cm of cervical dilation and ruptured membranes who do not progress after 4 hours of adequate uterine activity, or at least 6 hours of oxytocin administration with inadequate uterine activity and no cervical change, may have active phase arrest in first stage labor and may need cesarean birth.
- Intrauterine resuscitation measures may be useful in maintaining fetal well-being and thereby avoiding cesarean birth for indeterminate or abnormal fetal status.
- The ideal length of second stage labor is unknown
- Diagnosis of arrest of second stage labor should not be made until at least 2 hours of pushing in multiparous women and at least 3 hours of pushing in nulliparous women (assuming maternal and fetal well-being are maintained).
- Labor epidurals may be associated with longer second stage labors.
- Operative vaginal birth and manual rotation of the fetal occiput in the context of fetal malposition in second stage labor may be viable alternatives to cesarean birth.

Labor patterns have changed over the past five decades.[35] Some of the changes are associated with the characteristics of laboring women who are now on average 2½ years older and have a higher body mass index, while others are associated with practices such as a much higher use of oxytocin and labor epidurals.[35] When compared to 50+ years ago, first stage labor is longer by 2.6 hours in nulliparous women and by 2 hours in multiparous women even after adjusting for maternal and pregnancy characteristics.[35]

Using 6 cm rather than 4 cm as the beginning of active labor is based on evidence that progressing from 4 cm to 6 cm often takes longer than previously thought[35,36,37] and likely represents latent phase activity that will eventually result in vaginal birth.[2] The active upward slope of labor progress generally occurs beginning at 6 cm for most women in labor.[2] Applying the ACOG and SMFM[2] criteria for cesarean birth for an arrest of active first stage labor may offer women having a longer than average (but still within normal limits) labor the ability to have a vaginal birth. The median and upper and lower limits of nulliparous women in spontaneous, induced and augmented labor are displayed in the following table.[36] These data are similar to findings from other researchers about the normal length of labor for contemporary women.[35,37] Note that some women may need several hours to progress from 4 cm to 5 cm and from 5 cm to 6 cm, even those having spontaneous labor. Induced and augmented labor progression from 4 cm to 6 cm can take 11 to 12 hours for selected women. Labor duration from 3 cm to full dilation could last 16 to 17 hours for some nulliparous women having induced or augmented labor and still be considered within normal limits.[36]

The ideal length of the second stage labor to promote best outcomes for mothers and babies is unknown.[2] However, some recommendations were offered as general guidelines. If maternal and fetal conditions permit, clinicians should allow for at least 2 hours of pushing for multiparous women and at least 3 hours of pushing for nulliparous women before making the diagnosis of second stage labor arrest that may lead to operative vaginal birth or cesarean birth.[2] It was acknowledged that second stage care should be individualized because some women may have longer second stage durations such as those with epidural analgesia or with fetal malposition. Fetal well-being and progress should be assessed and documented in these cases.[2]

RANGE OF LABOR PROGRESS WITHIN NORMAL LIMITS FOR NULLIPAROUS WOMEN BASED ON TYPE OF LABOR; MEDIAN (5th percentile, 95th percentile)[36]

N = 5,388 women in 1 hospital from 2004 to 2008 who reached second-stage labor.

CCMS	Spontaneous (Hours) (5th / 95th percentiles)	Induction (Hours) (5th / 95th percentiles)	Augmented (Hours) (5th / 95th percentiles)
4-10	**3.8** (1.2, 11.8)	**5.5** (1.8, 16.8)	**5.4** (1.8, 16.8)
3-4	**0.4** (0.1, 2.3)	**1.4** (0.2, 8.1)	**1.2** (0.2, 6.8)
4-5	**0.5** (0.1, 2.7)	**1.3** (0.02, 6.8)	**1.4** (0.3, 7.6)
5-6	**0.4** (0.06, 2.7)	**0.6** (0.1, 4.3)	**0.7** (0.1, 4.9)
6-7	**0.3** (0.03, 2.1)	**0.4** (0.05, 2.8)	**0.5** (0.06, 3.9)
7-8	**0.3** (0.04, 1.7)	**0.2** (0.03, 1.5)	**0.3** (0.05, 2.2)
8-9	**0.2** (0.03, 1.3)	**0.2** (0.03, 1.3)	**0.3** (0.05, 2.0)
9-10	**0.3** (0.04, 1.8)	**0.3** (0.04, 1.9)	**0.3** (0.05, 2.4)

Derived from: [36]Harper L. M., Caughey A. B., Odibo, A. O., Roehl K. A., Zhao Q., Cahill, A. G. (2012). Normal progress of induced labor. *Obstetrics & Gynecology*,119(6):1113-1118. DOI: 10.1097/AOG.0b013e318253d7aa

Oxytocin Protocols for Labor Management

Research is ongoing about the most effective and safe protocols for oxytocin during induction and augmentation of labor. There was much interest in high-dose oxytocin 30 years ago with the intent to minimize risk of cesarean birth. The interest was generated from results of an active management of labor protocol in Ireland involving high-dose oxytocin that showed low rates of labor dystocia and cesarean birth.[38] Three randomized clinical trials were conducted in the United States using a protocol similar to that of the National Maternity Hospital in Dublin, however none found active management of labor with high-dose oxytocin reduced the rate of cesarean birth when compared to standard care.[39,40,41] Other researchers conducted randomized trials during the same time frames using various protocols for oxytocin defined as high- or low-dose by each study team. A meta-analysis of those studies produced the same results as the randomized trials of active management of labor.[42] In general, higher doses of oxytocin and shorter intervals between dose increases led to more tachysystole and indeterminate or abnormal FHR patterns and did not result in a clinically significant decrease in length of labor or a decrease in cesarean birth.[42]

Although there remains no consensus on the ideal oxytocin rate, more recent data continue to support these findings. The latest Cochrane review[43] concluded high-dose compared to low-dose oxytocin did not increase rate of vaginal birth within 24 hours but increased rate of "hyperstimulation." A multicenter randomized trial of 1295 women comparing high-dose with low-dose oxytocin found no difference in cesarean birth rates however, more frequent tachysystole and "fetal distress" in the high dose group.[44] An observational study of 2336 women[45] comparing high dose and low dose oxytocin, found no differences in length of labor or infant outcomes, however, there were more "non-reassuring" FHR tracings and maternal fevers in the high-dose group and more fetal malposition and operative vaginal birth in the low-dose group. A secondary analysis of data from the ARRIVE trial[7] compared outcomes of 2145 women induced with low-dose oxytocin to 899 women induced with a mid-to high dose.[46] A composite outcome that included 5-minute Apgar score <3, hypoxic ischemic encephalopathy, seizure, infection, meconium aspiration syndrome, birth trauma, need for respiratory support within 72 hours after birth, intracranial or subgaleal hemorrhage, hypotension requiring vasopressor support or perinatal death was used to evaluate results between groups. There were significantly more adverse neonatal outcomes in the group induced with the mid- to high-dose oxytocin protocol than in the low-dose group, and no differences in cesarean birth rates.[46]

Several studies published in the last few years suggest for some women, discontinuing oxytocin once active labor has been established is worth consideration. In a systematic review of oxytocin discontinuation after the active phase of induced labor that included nine randomized controlled trials, uterine "hyperstimulation", cesarean birth, and "nonreassuring" FHR tracings were significantly higher among women with continued oxytocin in active labor compared to women with discontinued oxytocin in active labor.[47] A Cochrane systematic review of 10 randomized trials[48] found discontinuing oxytocin once reaching active labor was associated with less uterine tachysystole with "abnormal" FHR tracings and a possible reduction in cesarean birth. Discontinuing oxytocin at 5 cm was associated with reduced risk of tachysystole and cesarean birth when compared to continuing oxytocin, based on a meta-analysis and systematic review of nine randomized trials.[49] In a randomized trial of 200 laboring women, excessive uterine activity and FHR abnormalities were decreased when oxytocin was discontinued at 5 cm when compared to continuing oxytocin.[50] In a 2020 study, researchers found an oxytocin rest of ≥8 hours may be beneficial in deceasing risk of cesarean birth for women in prolonged latent phase labor.[51]

Implications of the ARRIVE Trial for Labor Management

The ARRIVE trial[7] was a rigorously designed multicenter randomized clinical trial of 6106 low-risk nulliparous women of whom 3062 were randomized to elective induction of labor and 3044 were randomized to expectant management. For the elective induction group, induction was to occur between 39 0/7 weeks to 39 4/7 weeks gestation and for the expectant management group, elective birth was not to occur before 40 5/7 weeks, however be initiated no later than 42 2/7 weeks. The primary outcome was a neonatal composite measure that included perinatal death or severe neonatal complications and consisted of one or more of the following during the antepartum or intrapartum period or during the birth hospitalization: need for respiratory support within 72 hours after birth, Apgar score of 3 or less at 5 minutes, hypoxic ischemic encephalopathy, seizure, infection (confirmed sepsis or pneumonia), meconium aspiration syndrome, birth trauma (bone fracture, neurologic injury, or retinal hemorrhage), intracranial or subgaleal hemorrhage, or hypotension requiring vasopressor support.[7]

Results confirmed that awaiting spontaneous labor was safe for low-risk nulliparous women as there were no differences in the primary outcome between groups.[7] Additional analysis included the rate of cesarean birth, which was 18.6% in the elective induction group, compared to 22.2% in the expectant management group.[7] Based on their results, elective induction

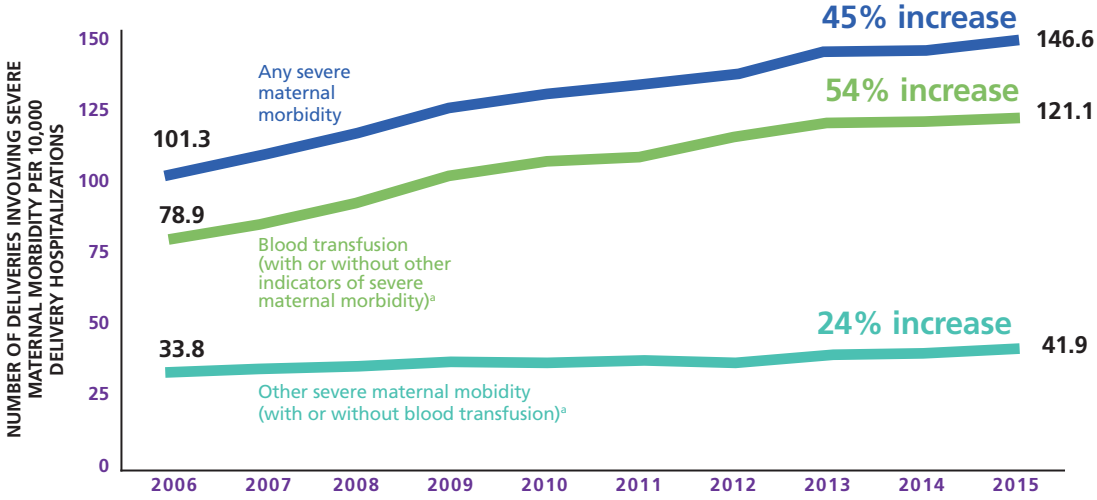
of labor for low-risk, nulliparous women does not increase risk of cesarean birth in the context of a labor management protocol that includes: a) cervical ripening for a modified Bishop score <5, b) at least 12 hours in the latent phase after completion of cervical ripening, c) rupture of membranes, and d) use of oxytocin before considering the induction failed.[7] In the ARRIVE trial, the length of stay in the intrapartum setting averaged 20 hours for the elective induction group and 14 hours for the expectant management group. They estimated that 28 low-risk, nulliparous women would need to be induced to avoid one cesarean birth.[7] These findings may result in more physicians and more patients requesting elective induction of labor. Implications of more women with longer labors on inpatient unit operations and nurse staffing have not yet been determined. Recommendations from AAP, ACOG, and AWHONN for the nurse-to-patient ratio for induction of labor with oxytocin are 1 registered nurse to 1 woman in labor.[29,52]

Minimizing Risk of Maternal Morbidity and Mortality by Promoting Vaginal Birth

Cesarean birth has contributed to the increase in maternal morbidity and mortality, in large part because of hemorrhage and placental abnormalities in subsequent pregnancies.[2,53,54] Cesarean birth is associated with more risk to the mother than vaginal birth.[2,53, 55] These risks include higher rates of maternal death, overall severe morbidity, placental abnormalities, postpartum hemorrhage, blood transfusions, unplanned hysterectomy, uterine rupture, and admission to the intensive care unit.[2,6,53,55] As the number of cesareans a woman has increases so does risk of morbidity such as hysterectomy, blood transfusions, adhesions, surgical injuries, and placental problems including placenta previa, and placenta accreta.[53,54,56] Costs of cesarean and the associated length of stay in the hospital are twice that of vaginal births.[6] This public health problem represents a current and future burden on the health care system and affected women because of maternal morbidity and mortality risks and increased use of financial health resources that could otherwise be allocated to improving maternal and infant outcomes.[6]

The labor management guidelines from ACOG and SMFM[2] are aimed at reducing risk of cesarean birth. In a recent study, nursing care during labor consisting of bedside attendance and interventions such as repositioning and use of the peanut ball was associated with lower cesarean birth rates when included as part of a comprehensive program that incorporated the ACOG and SMFM[2] labor management guidelines.[57] Randomized trials of nurses' use of the peanut ball during labor found shorter labors and decreased risk of cesarean birth.[58,59] A project using the ACOG and SMFM[2] labor guidelines that promoted a unit culture of bedside nursing attendance during labor was associated with fewer cesareans.[60] Supportive nursing care such as increased ambulation, upright positioning, peanut

TRENDS IN DELIVERY HOSPITALIZATIONS INVOLVING SEVERE MATERNAL MORBIDITY, 2006-2015



[a] If a delivery involved blood transfusion and 1 of the other 20 types of severe maternal morbidity, the delivery was counted in both categories).
SOURCE: Agency for Healthcare Research and Quality (AHRQ), Center for Delivery, Organization, and Markets, Healthcare Cost and Utilization Project (HCUP), State Inpatient Databases (SID), 2006-quarter 3, 2015, weighted to provide national estimates using the same methodology as the Nationwide Inpatient Sample (NIS), 2011
and prior years

From: [55]Fingar, K. F., Hambrick, M. M., Heslin, K. C., & Moore, J. E. (2018). *Trends and disparities in delivery hospitalizations involving severe maternal morbidity, 2006-2015* (Statistical Brief No. 243). Rockville, MD: Agency for Healthcare Research and Quality.

balls, and interpersonal coaching as part of a project by the California Maternal Quality Care Collaborative using the labor guidelines[2] led to less cesareans for low risk nulliparous women.[61] Success in part is due to the team approach. When perinatal collaboratives and health care systems coordinate multihospital projects with a common purpose and well stated objective, they can be successful because the efforts are not led by individual physicians, nurses, or hospital administrators; rather, they are initiated by clinicians, researchers, and public health experts with a stake in perinatal outcomes such as midwives, perinatal and neonatal nurses, obstetricians, maternal–fetal medicine specialists, neonatologists, pediatricians, and family medicine physicians.[62] The ongoing results of perinatal quality collaboratives provide evidence that clinicians from many professional disciplines can work successfully together for a common goal.

Creating and Supporting a Culture of Safety to Support Maternal and Fetal Well-being During Labor and Birth

Teamwork, collaboration, mutual respect, and care based on rigorous evidence and science are essential aspects of a culture of safety in which fetal monitoring, labor management, and adoption of care bundles can be successfully integrated into safe, effective, and respectful care for mothers and babies. One way to promote perinatal safety is to collaborate in developing evidence-based clinical guidelines that are able to be flexibly adapted to local hospitals, health systems, and state-wide perinatal quality collaboratives. The AIM program of the Council on Patient Safety in Women's Health Care is a coalition that has partnered with most of the leading professional organizations for maternal health in the United States including AWHONN, ACNM, ACOG, SMFM, the American Academy of Family Physicians, and the Health Resources and Services Administration Maternal and Child Health Bureau of the U.S. Department of Health and Human Services. They are working to collectively promote safe maternity care for all women through maternal patient safety research, programs and tools, education, dissemination, and promotion of a culture of respect, transparency, and accountability. A number of evidence-based patient safety bundles and tools have been developed by this coalition. The goal is to avoid preventable adverse outcomes.

A culture of safety in perinatal services is founded on colleagues working together in teams with mutual respect, support, and consideration with priority on the best interests of mothers and babies. Support from administrative leaders and clinical leaders is critical, including accountability and financial resources. Threats to patient safety can be categorized by stakeholders and setting. Common threats include lack of administrative and budgetary support, disruptive behavior, inadequate nurse staffing, and an unwillingness to apply and integrate standards, guidelines, and evidence into clinical care. There are still some clinicians who are averse to standardization. Some clinicians remain committed to hierarchy and silos based on professional discipline in care and communication. Still others do not value pregnant women and new mothers as full partners in care and decision-making. Progress has been made, but more change is needed.

In a culture of safety, clinical team members have the ability to discuss interpretation of FHR data and associated interventions without fear of hierarchical implications or assumptions that one discipline is more knowledgeable than another. There is no fear of retaliation when speaking up or voicing an alternative perspective. Conversations are collegial. Clinical disagreements may occur but they are resolved respectfully. Partnership with women and their families is highly valued and encouraged. All women are treated with respect. Recommendations and strategies for improvement are listed in the table below.[63]

COUNCIL ON PATIENT SAFETY IN WOMEN'S HEALTH CARE

Patient Safety Bundles and Tools
Maternal Metal Health: Depression and Anxiety
Maternal Venous Thromboembolism (+AIM)
Obstetric Care for Women with Opioid Use Disorder (+AIM)
Obstetric Hemorrhage (+AIM)
Postpartum Care Basics for Maternal Safety • From Birth to the Comprehensive Postpartum Visit (+AIM) • Transition from Maternity to Well-Woman Care (+AIM)
Prevention of Retained Vaginal Sponges After Birth
Reduction of Peripartum Racial/Ethnic Disparities (+AIM)
Safe Reduction of Primary Cesarean Birth (+AIM)
Severe Hypertension in Pregnancy (+AIM)
Severe Maternal Morbidity Review (+AIM)
Support After a Severe Maternal Event (+AIM)

From: Council on Patient Safety in Women's Health Care Available at https://safehealthcareforeverywoman.org/patient-safety-bundles/

THREATS TO PERINATAL PATIENT SAFETY AND HIGH-QUALITY MATERNITY CARE WITH RECOMMENDATIONS/POTENTIAL STRATEGIES FOR IMPROVEMENT

Stakeholder/ Setting	Threat/Risk	Recommendations/Potential Strategies for Improvement
Hospitals/ Health Care Systems	Prioritizing cost, convenience, or provider preferences over what is best for mothers and babies	Each unit operation should be based on the answer to the question "What is best for mothers and babies?" Cost, convenience, and provider preferences should be secondary considerations in a high-quality health care system. All women deserve respectful maternity care.
	Prioritizing graduate medical education over what is best for mothers and babies	Administrative and clinical leaders must acknowledge that quality evidence-based patient care, patient safety, and optimal patient outcomes are the primary goals of hospitals and health care systems. Graduate medical education is a secondary and compatible goal. Proper supervision of trainees and patient consent are essential as part of the process.
	Failure to hold leaders accountable for adopting evidence-based national standards and guidelines	Evidence-based national standards and guidelines are the hallmark of safe, high quality perinatal care. Establish processes in which new standards and guidelines promulgated by professional associations and other pertinent bodies are reviewed on monthly basis and plans made for adoption in a timely manner.
	Failure to financially and administratively support clinician leaders in participating in perinatal quality care collaboratives and quality improvement initiatives	Participation in quality care collaboratives and other similar quality improvement processes often meet with resistance. Active participation requires support including a person designated to lead the project, a person/s to monitor practices, allocation of time for lead participants, and resources for data collection.
	Failure to hold leaders accountable for professional behavior and not acting in the context of disruptive clinician behavior including sexual harassment	Zero-tolerance polices similar to those recommended by Joint Commission (2016) and professional organizations such as ACOG (2017) and ANA (2015b) should be in place. https://www.jointcommission.org/sentinel_event_alert_issue_40_behaviors_that_undermine_a_culture_of_safety/ https://www.acog.org/Clinical-Guidance-and-Publications/Committee-Opinions/Committee-on-Patient-Safety-and-Quality-Improvement/Behavior-That-Undermines-a-Culture-of-Safety https://www.nursingworld.org/practice-policy/nursing-excellence/official-position-statements/id/incivility-bullying-and-workplace-violence/
	Failure to support and protect clinicians who speak up in the context of threats to patient safety	The ANA Code of Ethics for Nurses details nursing responsibilities for speaking up to advocate for the rights, health, and safety of patients and the nurse's primary commitment to the patient. Administrative and clinical leaders must support the nurse in these efforts and protect them from retaliation if it occurs. American Nurses Association. (2015a). Code of ethics for nurses with interpretive statements. Silver Spring, MD: ANA https://www.nursingworld.org/coe-view-only ACOG (2009; reaffirmed 2019) committee opinion on patient safety outlines how all clinicians have responsibility of speaking up and should be able to do so without fear of retribution. https://www.acog.org/Clinical-Guidance-and-Publications/Committee-Opinions/Committee-on-Patient-Safety-and-Quality-Improvement/Patient-Safety-in-Obstetrics-and-Gynecology A joint publication from AWHONN, ACNM, ACOG, and SMFM offers further guidance on effective professional communication and support of those who speak up as needed to promote and protect patient safety. Lyndon, A., Johnson, M. C., Bingham, D., Napolitano, P. G., Joseph, J., Maxfield, D. G. & O'Keefe, D. F. (2015). Transforming communication and safety culture in intrapartum care: A multi-organizational blueprint. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 44(3), 341-349.

THREATS TO PERINATAL PATIENT SAFETY AND HIGH-QUALITY MATERNITY CARE WITH RECOMMENDATIONS/POTENTIAL STRATEGIES FOR IMPROVEMENT *(continued)*

Stakeholder/ Setting	Threat/Risk	Recommendations/Potential Strategies for Improvement
Hospitals/ Health Care Systems **(continued)**	Failure to financially support following the AWHONN (2010), AAP & ACOG (2017) nurse staffing guidelines for safe, quality care during hospitalization for childbirth	Administrative team leaders should review, budget for, and support following the nurse staffing guidelines. Association of Women's Health, Obstetric and Neonatal Nurses. (2010). *Guidelines for Professional Registered Nurse Staffing for Perinatal Units.* Washington, DC: AWHONN. American Academy of Pediatrics and American College of Obstetricians and Gynecologists. (2017). *Guidelines for perinatal care* (8th ed). Elk Grove Village, IL: AAP.
	Failure to financially support offering continuing education for the clinical team, including a nurse responsible for orientation and continuing education	The importance of education, training, and competence validation care is critical to the provision of safe high-quality care. Accreditation bodies require evidence of this process.
Perinatal Services	Failure to have policies, procedures, protocols, and algorithms based on national standards and guidelines	Guidelines for Perinatal Care (AAP & ACOG, 2017) detail the need for perinatal services to have these types of resources available. AWHONN, ACNM, AAP, ACOG, ASA, SMFM each offer numerous publications and clinical guidelines available on their website. Some require membership to access; most do not.
	Failure to make sure all clinicians are competent in knowledge and skills for the responsibilities they are assigned	AWHONN offers details of knowledge and skills require to care for childbearing women (2013). Guidelines for Perinatal Care (AAP & ACOG, 2017) detail the need for all clinicians to be competent in their area of practice. Association of Women's Health, Obstetric, and Neonatal Nurses (2013). Basic, high-risk, and critical care intrapartum nursing (5th edition). Washington, DC: AWHONN.
	Failure to follow the AWHONN (2010), AAP & ACOG (2017) nurse staffing guidelines for safe quality care during hospitalization for childbirth; Specific areas of concern include1 nurse to no more than 3 patients for OB triage; 1 nurse for each woman in labor with complications; 1 nurse for each woman in labor receiving IV oxytocin, at least 2 nurses at every birth (1 for mother and 1 for baby), a full two-hour recovery after every birth with a nurse in attendance and no other patient assignment; no more than 3 mother-baby couplets per nurse; a nurse and a nursery available to care for newborns as per the mother's choice; a nurse with knowledge and skill to help women achieve their breastfeeding goals	Review, budget for, and support following the nurse staffing guidelines. AWHONN (2010). AAP and ACOG (2017)
	Inflexible, restrictive policies and practices and unit operations that inhibit the choices of childbearing women and families including visitors/support persons, 24-hour mandatory rooming-in, video recording	Support women in their choices for childbirth. Respect their autonomy. Treat them with respect. Offer information that is comprehensible, literacy-level appropriate, and in language they understand (provide interpretive services as necessary). If patient safety precludes granting their requests, thoroughly explain rationale and offer alternatives. National Quality Forum. (2018). National quality partners playbook: *Shared decision making in healthcare*. Washington, DC: NQF.

THREATS TO PERINATAL PATIENT SAFETY AND HIGH-QUALITY MATERNITY CARE WITH RECOMMENDATIONS/POTENTIAL STRATEGIES FOR IMPROVEMENT *(continued)*

Stakeholder/ Setting	Threat/Risk	Recommendations/Potential Strategies for Improvement
Clinicians	Failure to keep up with evidence, standards and guidelines specific to their area of clinical practice	Membership in professional organizations specific to area of practice such as AWHONN, ACNM, ACOG, ASA, AAP, SMFM is an essential aspect of keeping up with current evidence, standards, and guidelines. Develop processes to actively seek information about new evidence, standards and guidelines as they are published. Seek certification in specific area of practice such as EFM, inpatient obstetric nursing.
	Failure to follow national standards and guidelines	National standards and guidelines are available; unit policies, procedures, practices, protocols, and algorithms should offer details. Safe high-quality care is based on standardized evidence-based national standards and guidelines. AWHONN, ACNM, AAP, ACOG, ASA, SMFM each offer numerous publications and clinical guidelines available on their website. Some require membership to access; most do not.
	Disruptive behavior	Each clinician has a personal responsibility to act in a professional manner in all professional interactions. These resources can be helpful in offering review of behaviors and expectations. ANA (2015a; 2015b) https://www.nursingworld.org/coe-view-only https://www.nursingworld.org/practice-policy/nursing-excellence/official-position-statements/id/incivility-bullying-and-workplace-violence/ ACOG (2009; reaffirmed 2019) https://www.acog.org/Clinical-Guidance-and-Publications/Committee-Opinions/Committee-on-Patient-Safety-and-Quality-Improvement/Patient-Safety-in-Obstetrics-and-Gynecology A joint publication from AWHONN, ACNM, ACOG, and SMFM offers further guidance on effective professional communication and support of those who speak up as needed to promote and protect patient safety Lyndon et al. (2015).
	Attitudes and care practices that do not respect autonomy of childbearing women	Be open; listen to women. Support women in their choices for childbirth. Respect their autonomy. Treat them with respect. Offer information that is comprehensible, literacy-level appropriate, and in a language they understand (provide interpretive services as necessary). If patient safety precludes granting their requests, thoroughly explain rationale and offer alternatives. National Quality Forum. (2018).

From [63]Simpson, K. R. (2020). Perinatal quality and safety. In K. R. Simpson, P. A. Creehan, N. O'Brien-Abel, C. Roth, & A. Rohan (Eds.). *AWHONN's Perinatal nursing* (5th ed.). Philadelphia: Wolters Kluwer.

Conclusion

Electronic fetal monitoring can be useful in assessing fetal status during labor. While EFM has limitations and benefits,[64] it has the potential to be most helpful when all members of the perinatal team who are providing care to women in labor use standardized language such as that published by NICHD and supported by ACOG and AWHONN in communicating data obtained from the fetal monitor. The value of a standardized set of definitions and classifications for fetal heart rate pattern interpretation and professional communication is that everyone on the team is speaking and hearing the same language and is more likely to have the same understanding of fetal status based on the fetal heart rate pattern tracing. Expectations for intrauterine resuscitative measures and bedside evaluation by the primary care provider should be based on the NICHD definitions and classifications. Timely and appropriate response based on the FHR pattern and the entire clinical picture is needed to promote optimal outcomes.[64] Interdisciplinary case review using the EFM tracing as a basis for discussion and considering parity and the stage, phase and progress of labor can be useful to support ongoing education and teamwork. Standardized communication of fetal data is one method to promote perinatal patient safety by minimizing risk of errors and avoiding miscommunication among members of the perinatal team during labor. Labor guidelines may be helpful in promoting vaginal birth by allowing labor to progress based on more recent evidence about normal labor parameters of the contemporary population of childbearing women. More evidence has emerged in the last few years about safe and effective use of oxytocin for labor induction and augmentation. Elective induction of labor for low risk nulliparous women may be an option in the context of adequate nurse staffing and other facility resources, and should not increase the risk of cesarean birth when labor guidelines are used. Creating and supporting a culture of safety in which all members of the perinatal team are collaborative and respectful to each other and to women in childbirth and their families is essential for optimal outcomes.

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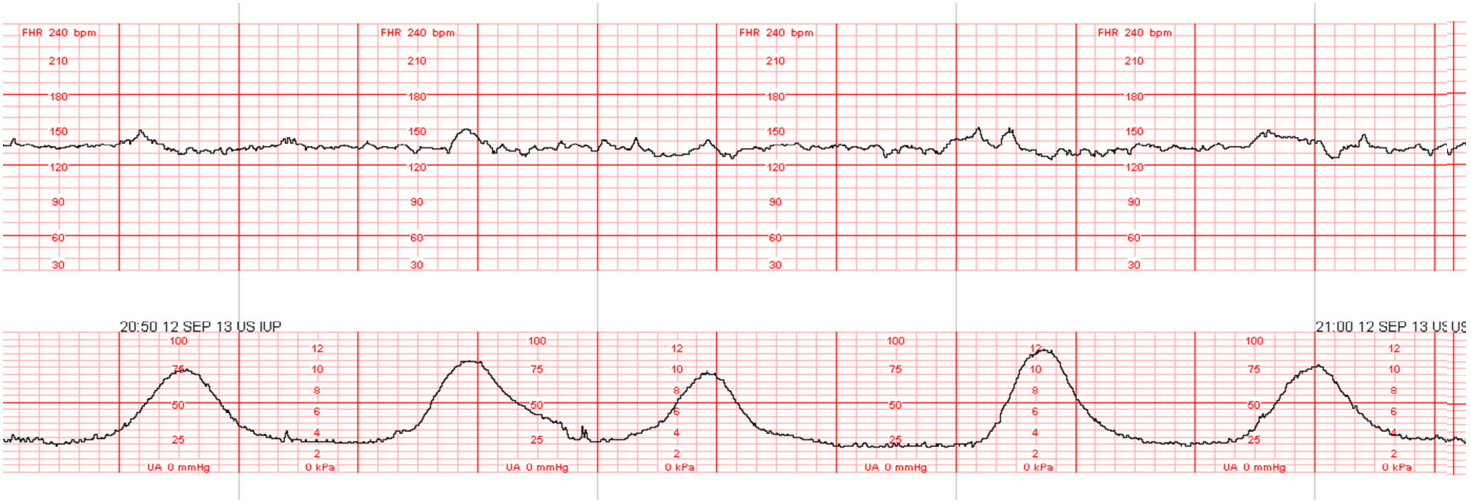
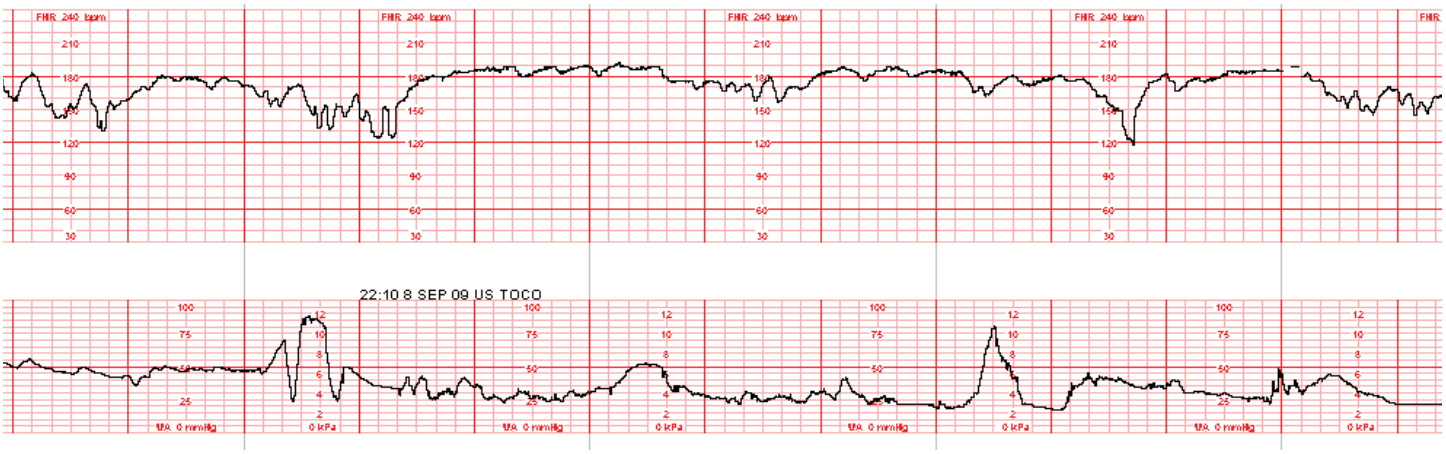
Appendix A - Characteristics of Fetal Heart Rate Patterns

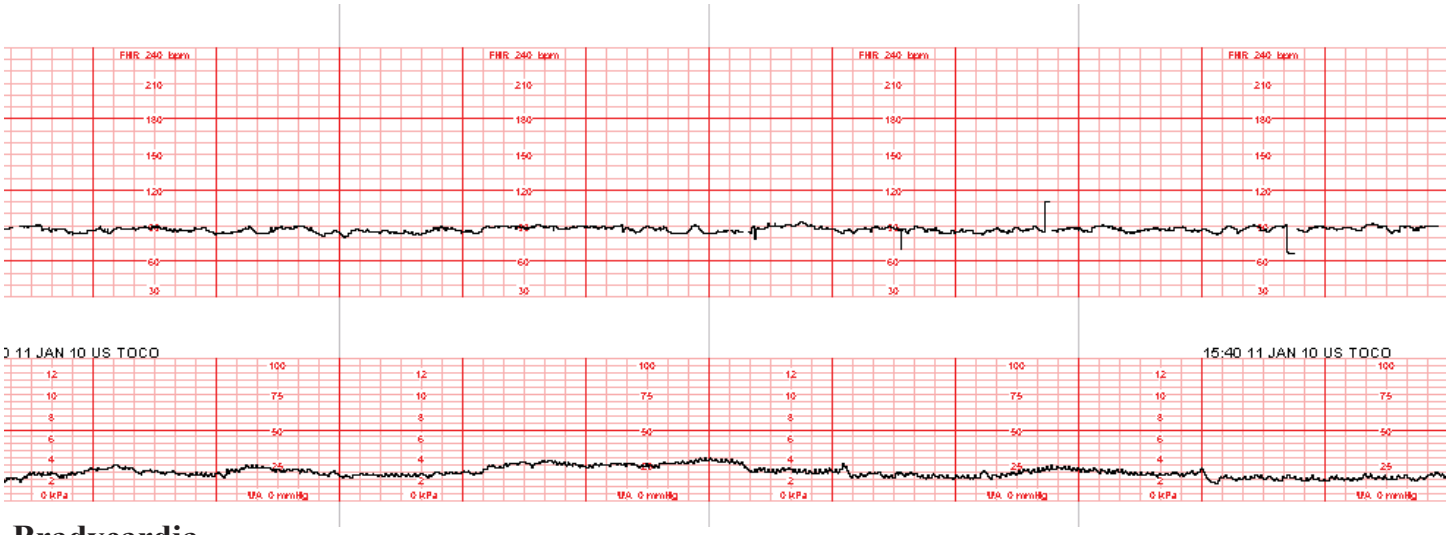
Baseline



Normal



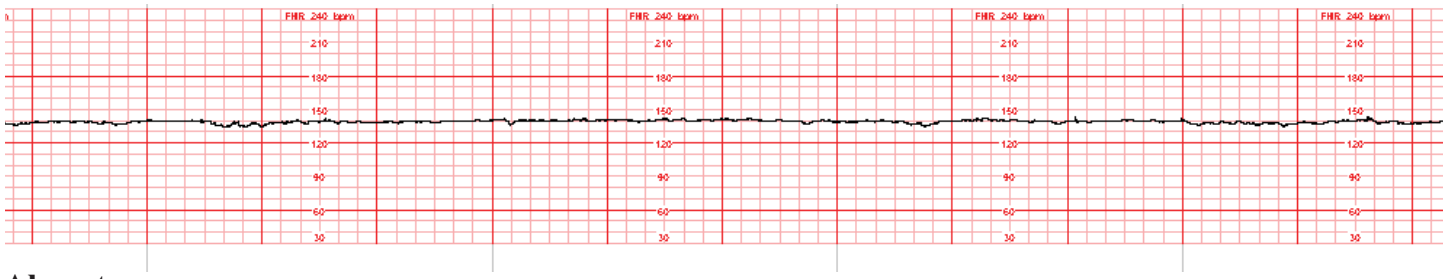
Tachycardia



Bradycardia

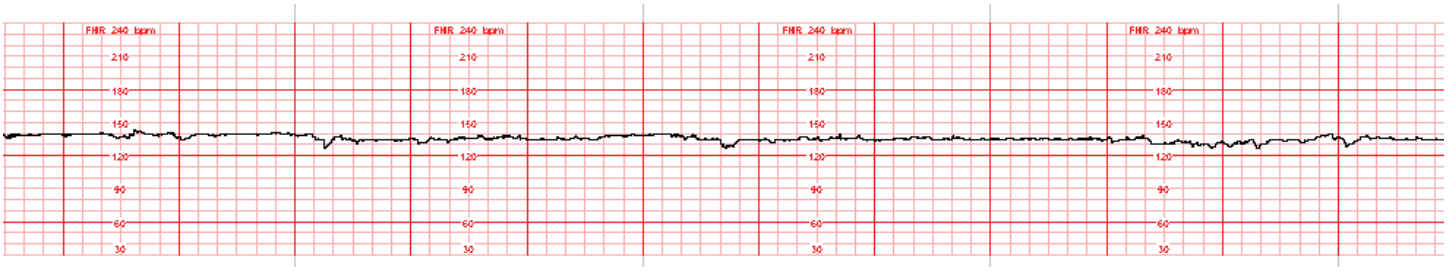
Appendix A - Characteristics of Fetal Heart Rate Patterns

Baseline Variability



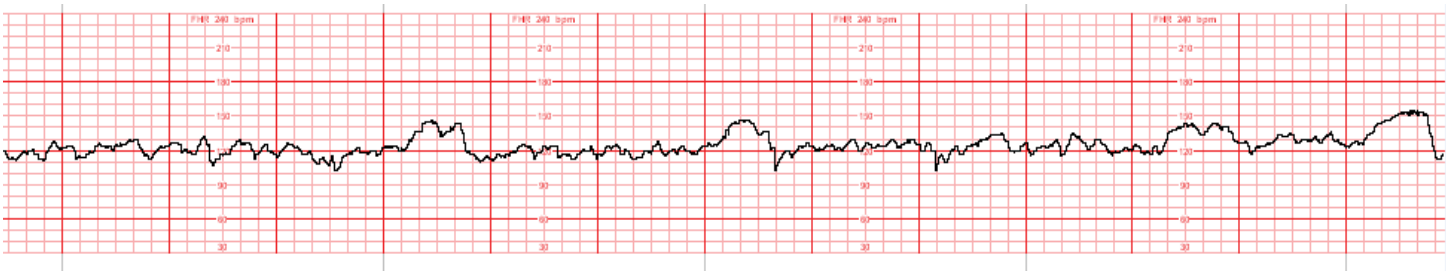
Absent

Undetectable from baseline



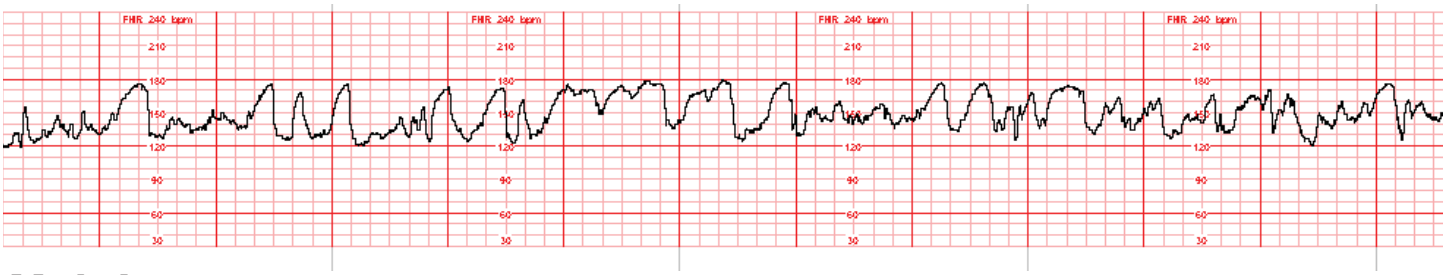
Minimal

Undetectable from baseline - ≤ 5 bpm



Moderate

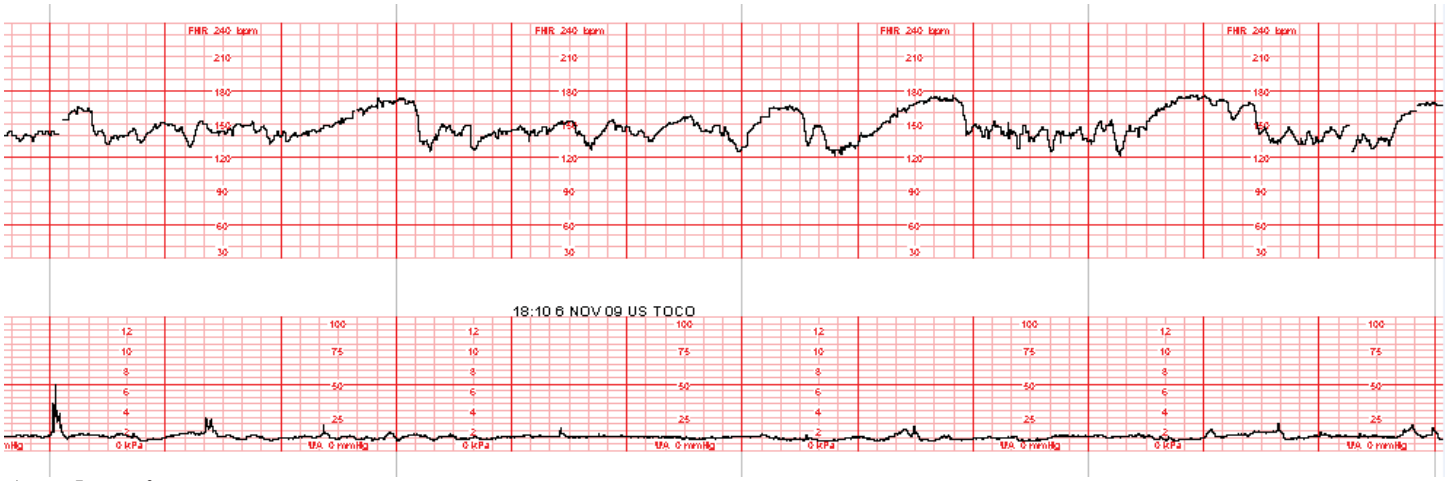
6 – 25 bpm



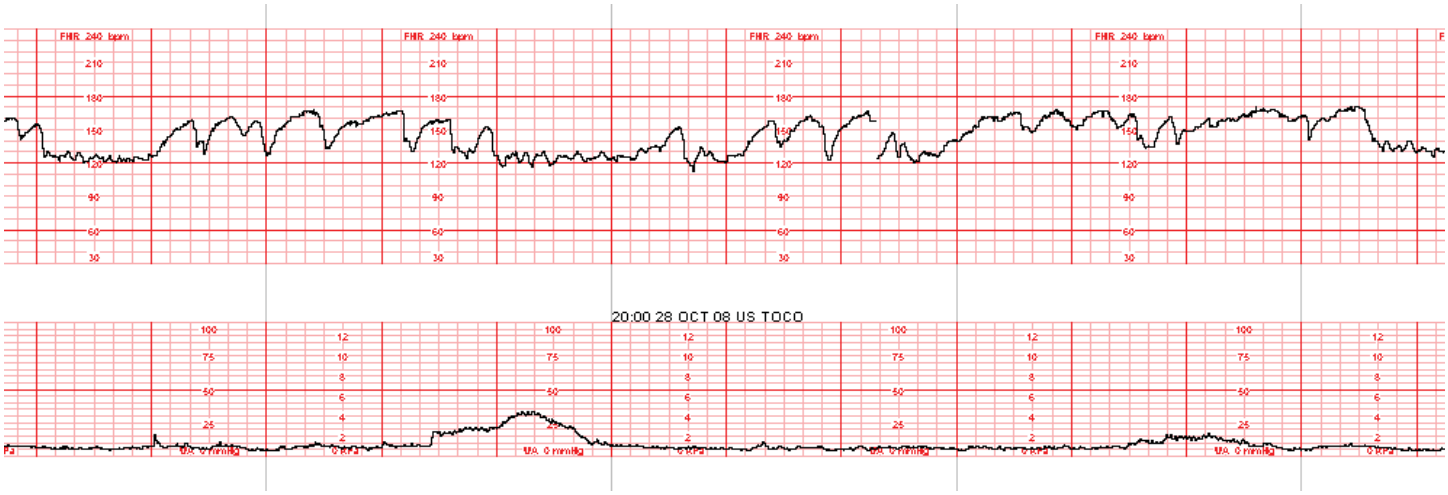
Marked

>25 bpm

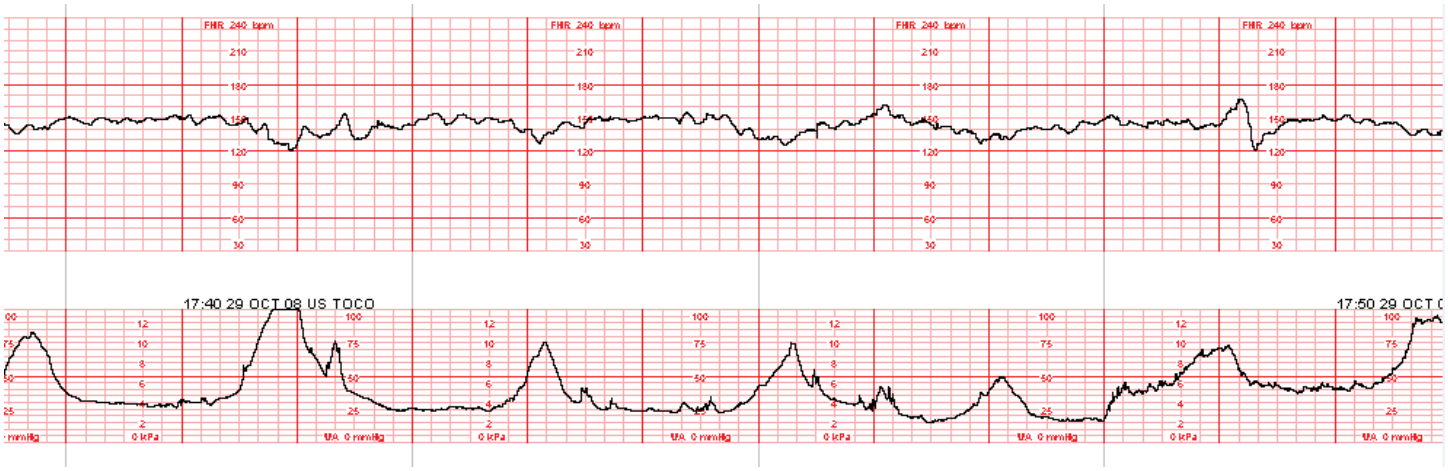
Appendix A - Characteristics of Fetal Heart Rate Patterns



Accelerations

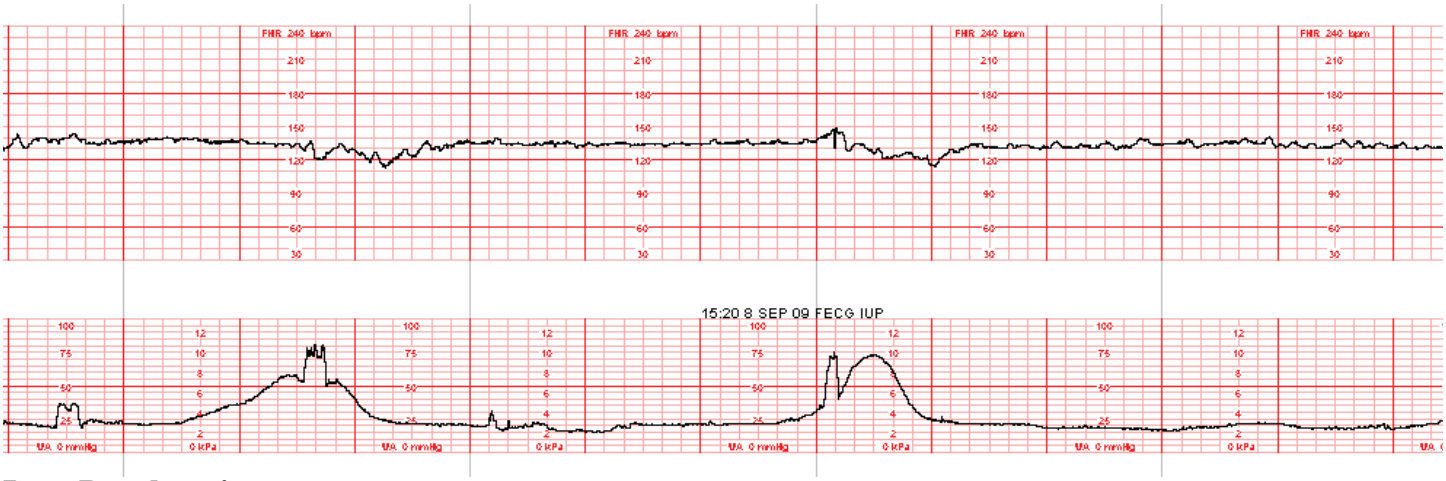


Prolonged Accelerations

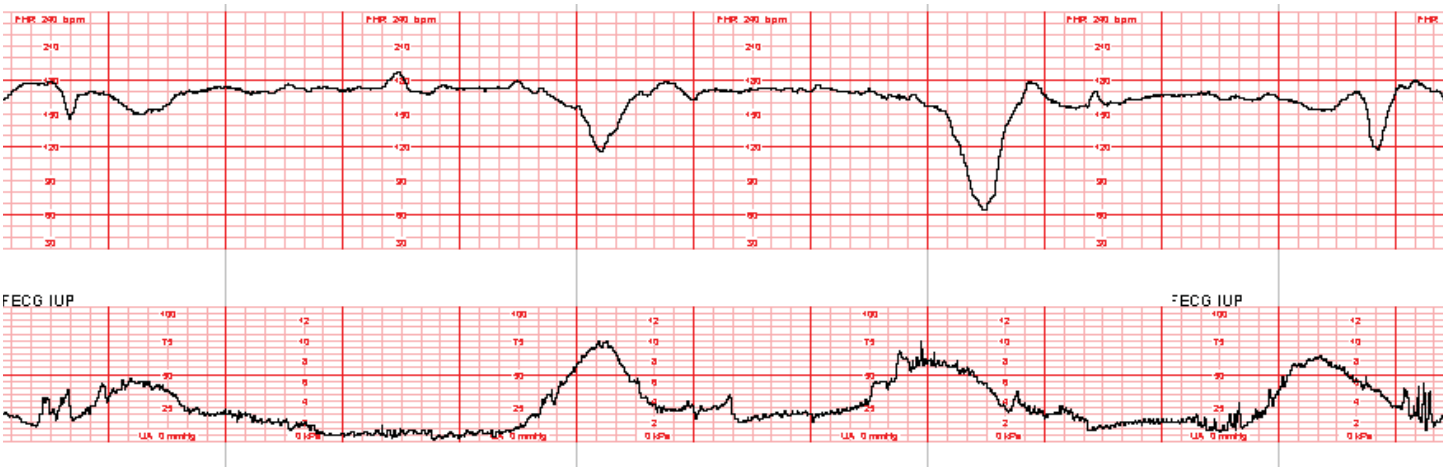


Early Decelerations

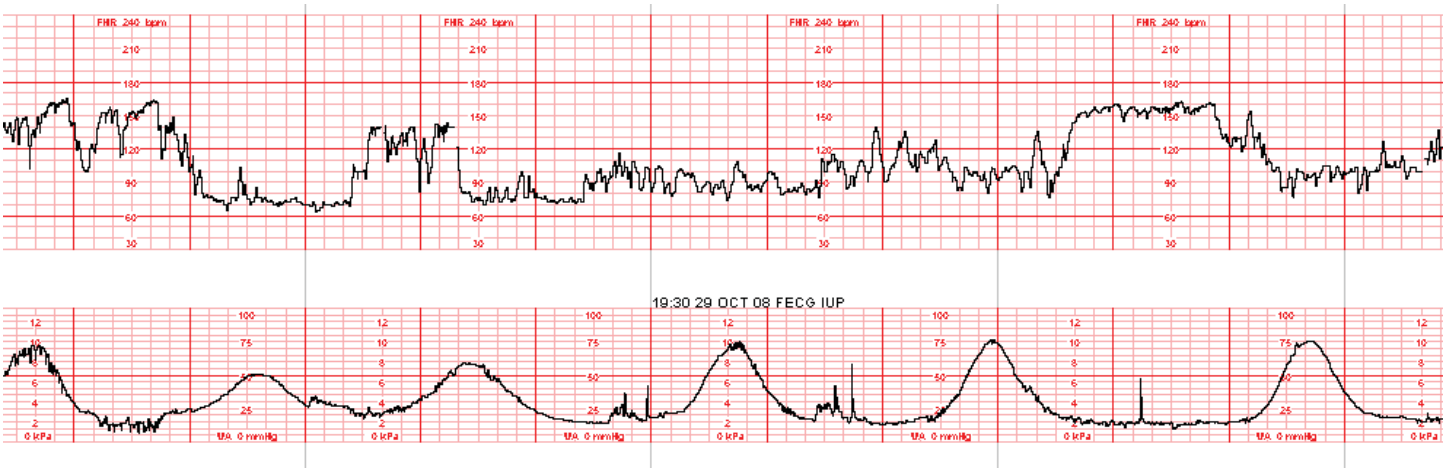
Appendix A - Characteristics of Fetal Heart Rate Patterns



Late Decelerations

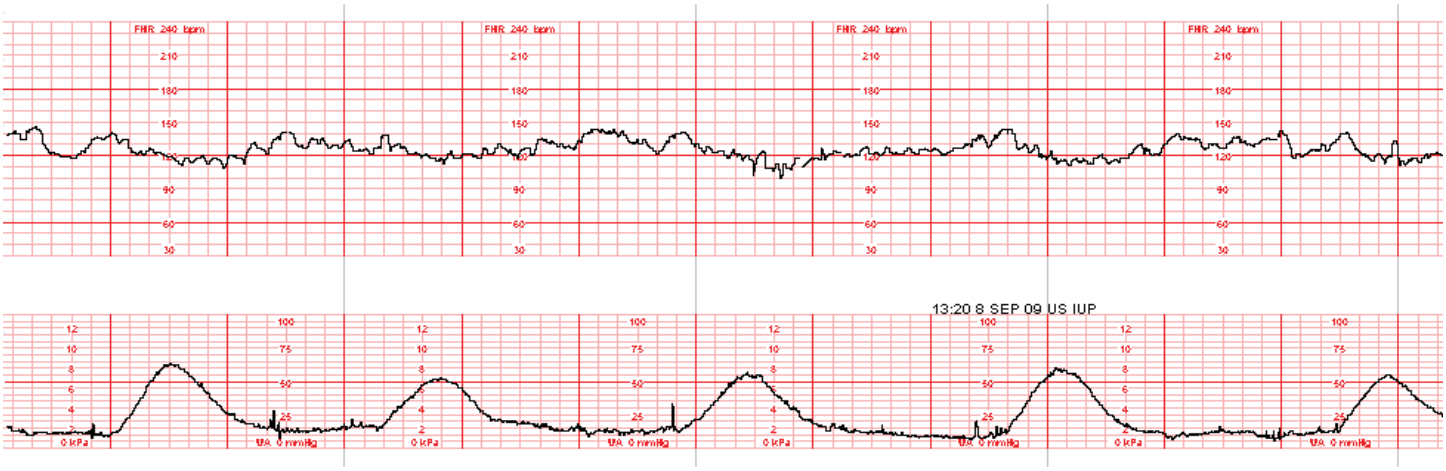


Variable Decelerations

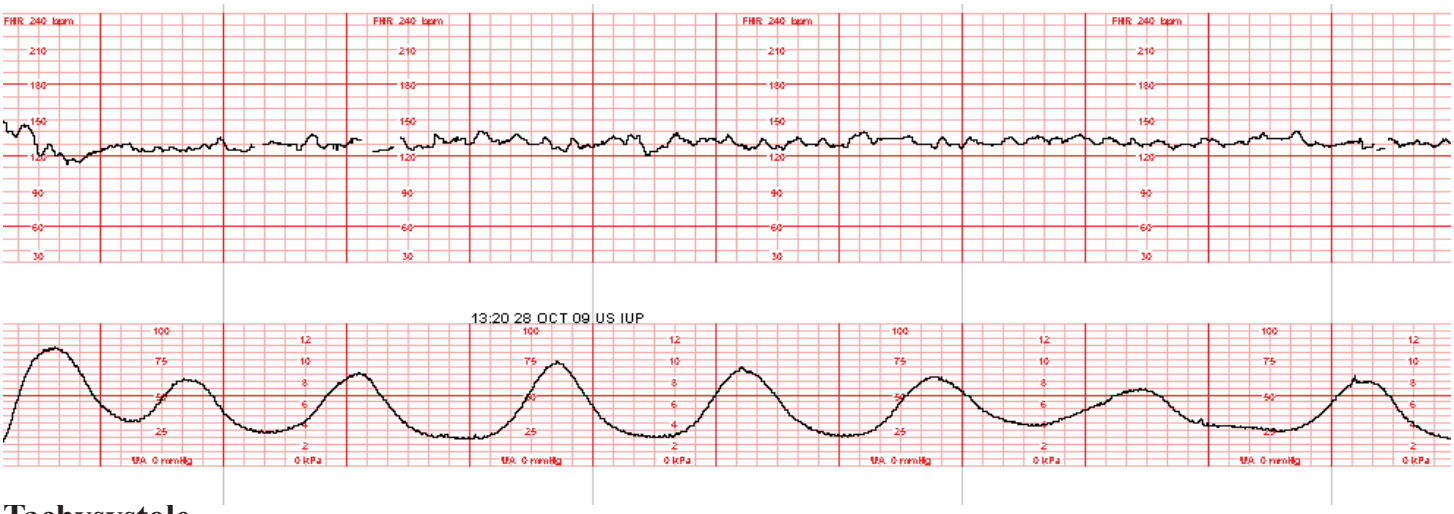


Prolonged Deceleration

Appendix B - Uterine Activity



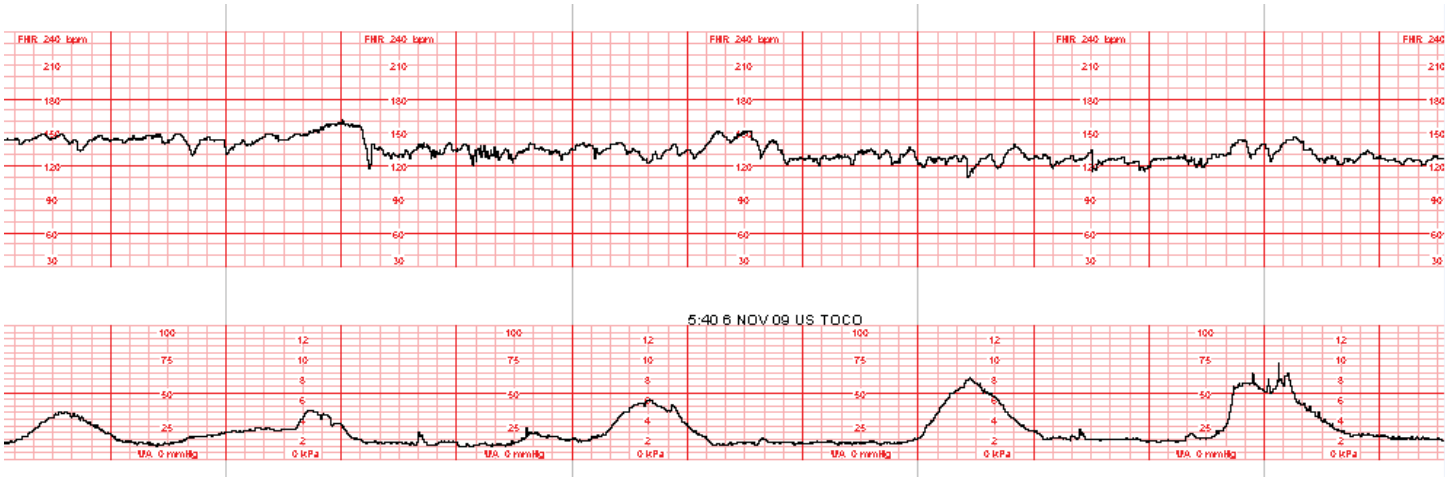
Normal Uterine Activity

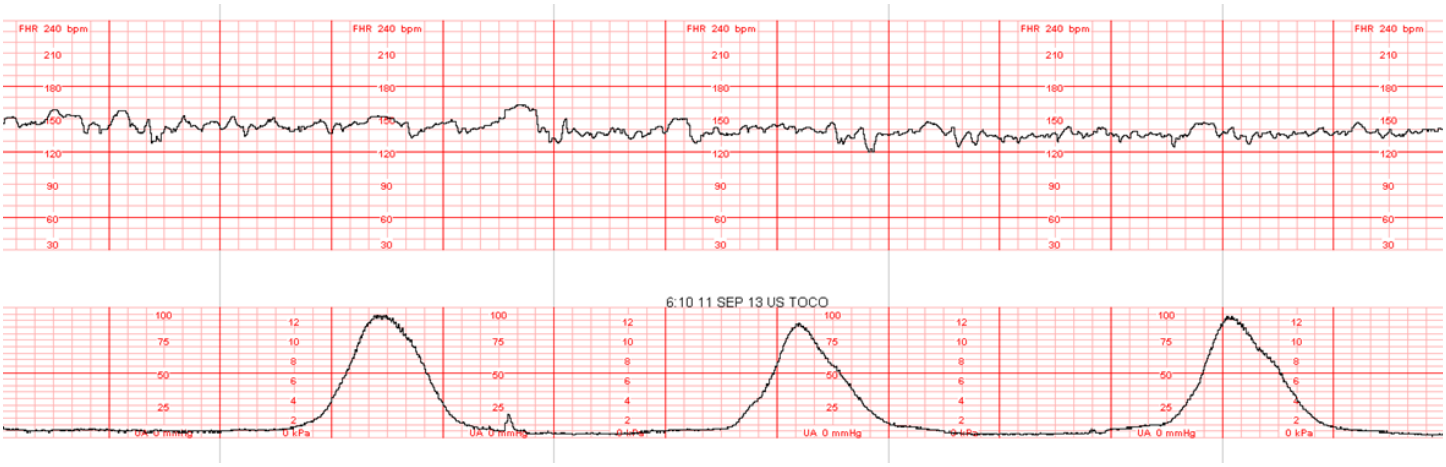


Tachysystole

Appendix C - Categories of Fetal Heart Rate Tracings

Category I (Normal) Tracing

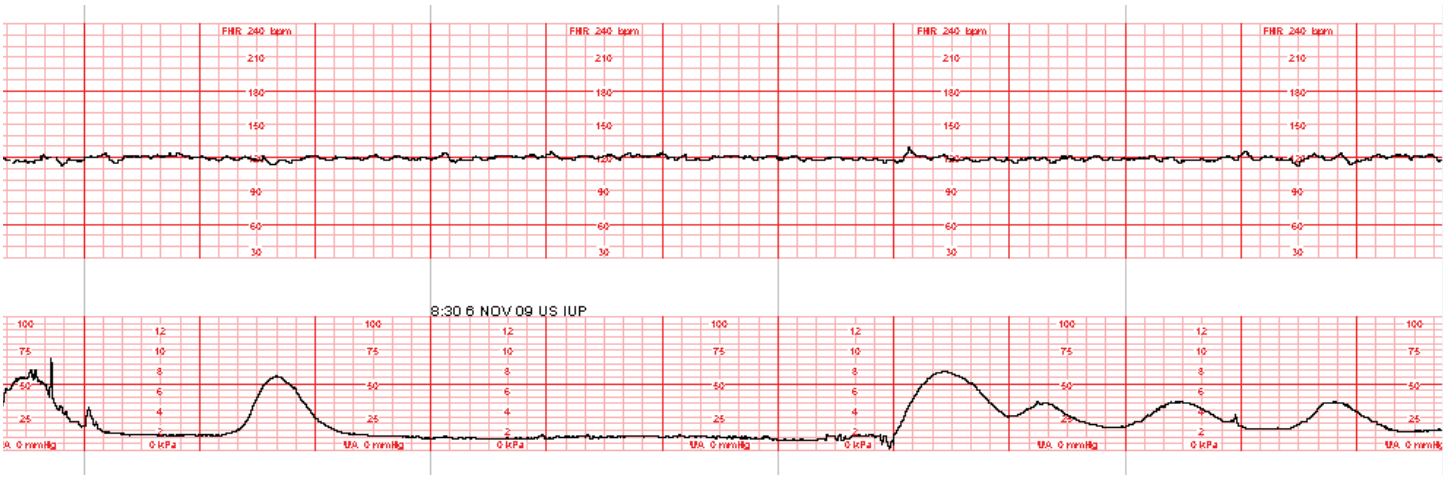




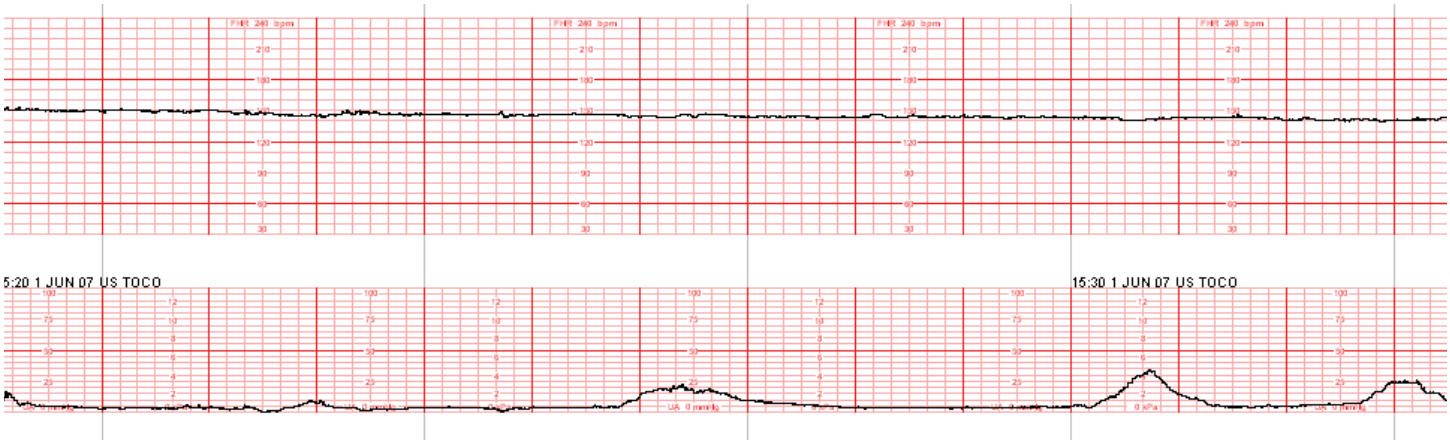
Criteria: Baseline rate 110 to 160 beats per minute; baseline variability moderate; late or variable decelerations absent; early decelerations present or absent

Appendix C - Categories of Fetal Heart Rate Tracings

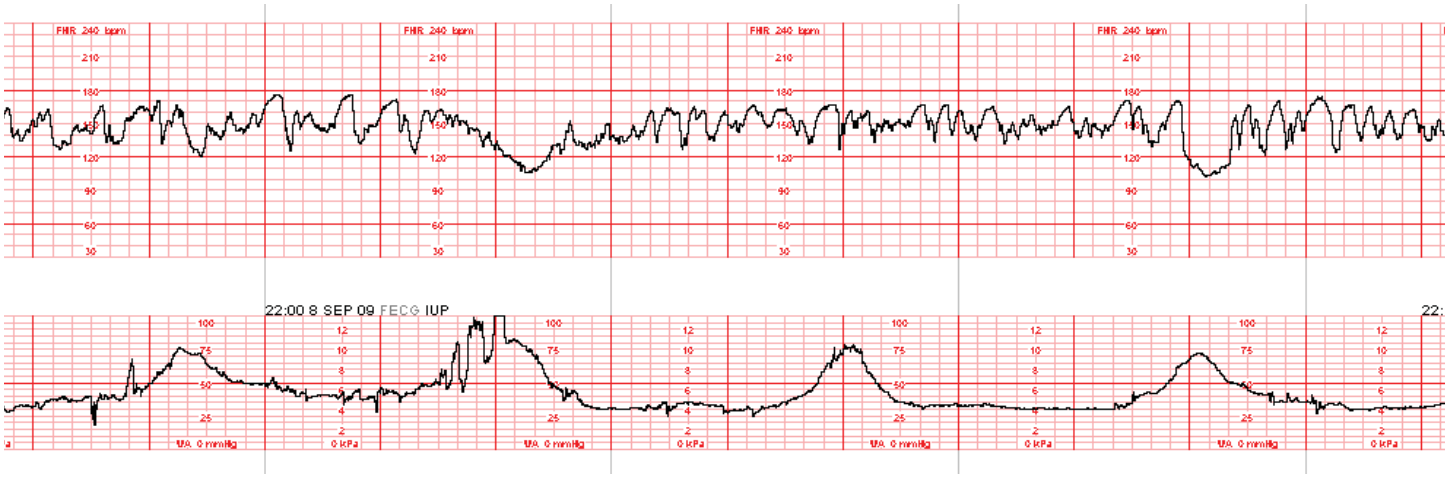
Category II (Indeterminate) Tracings



Criteria: Minimal variability



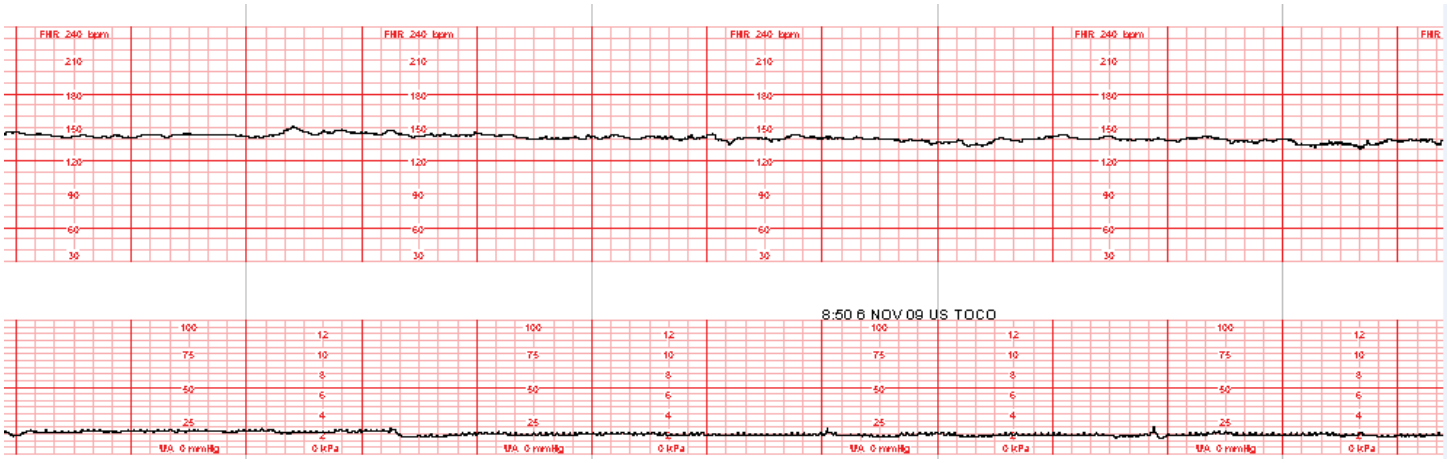
Criteria: Absent variability without recurrent decelerations



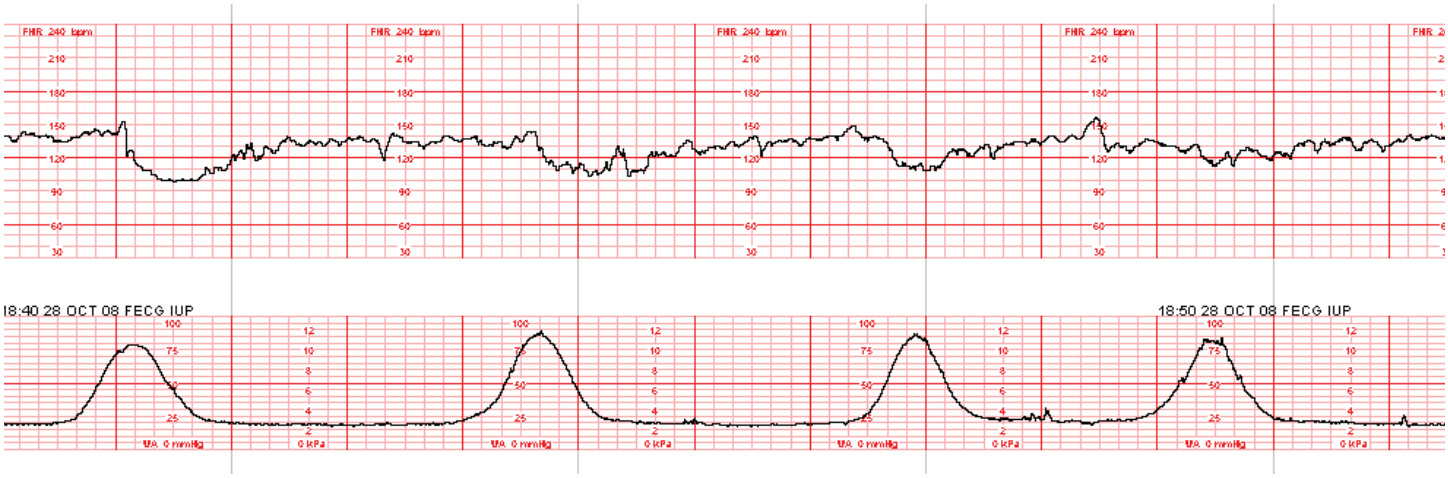
Criteria: Marked variability

Appendix C - Categories of Fetal Heart Rate Tracings

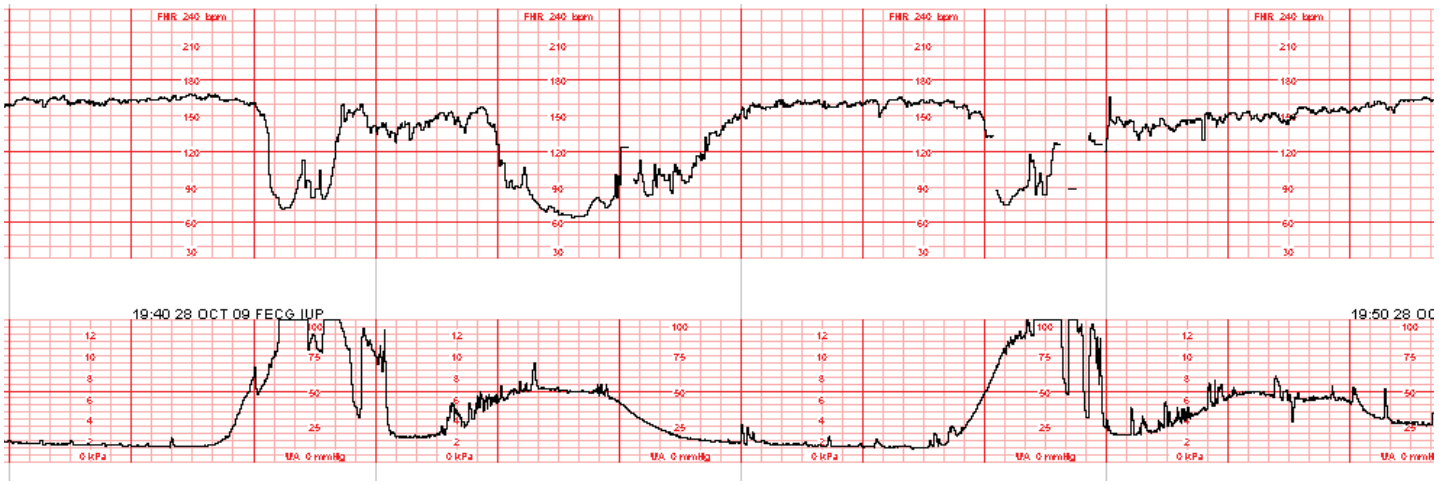
Category II (Indeterminate) Tracings



Criteria: Absence of induced accelerations after fetal stimulation



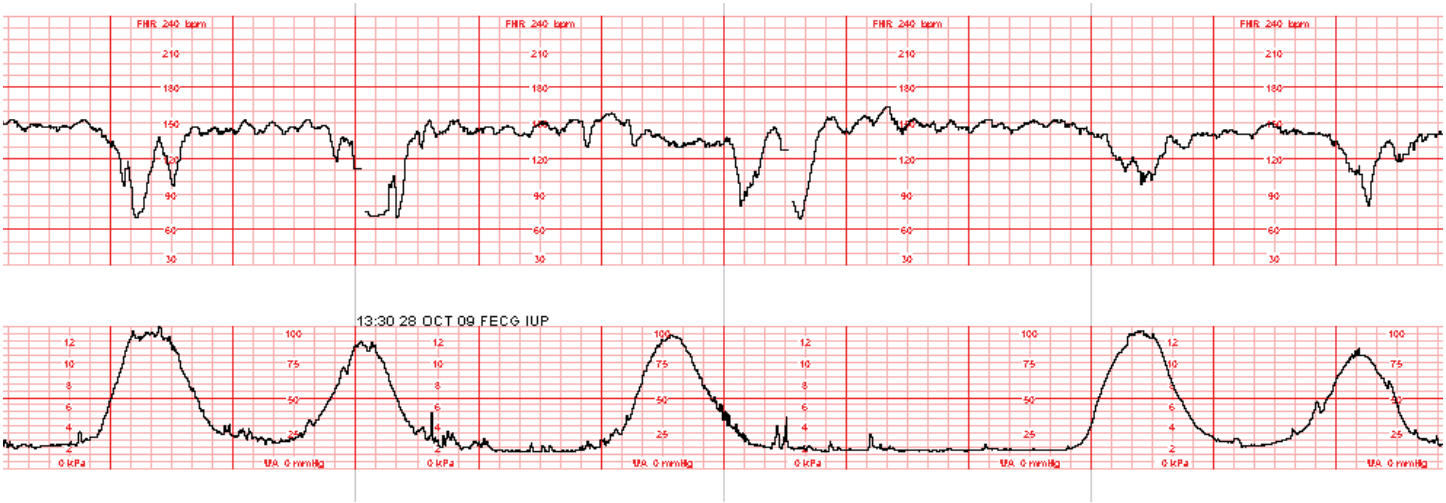
Criteria: Recurrent late decelerations with moderate variability



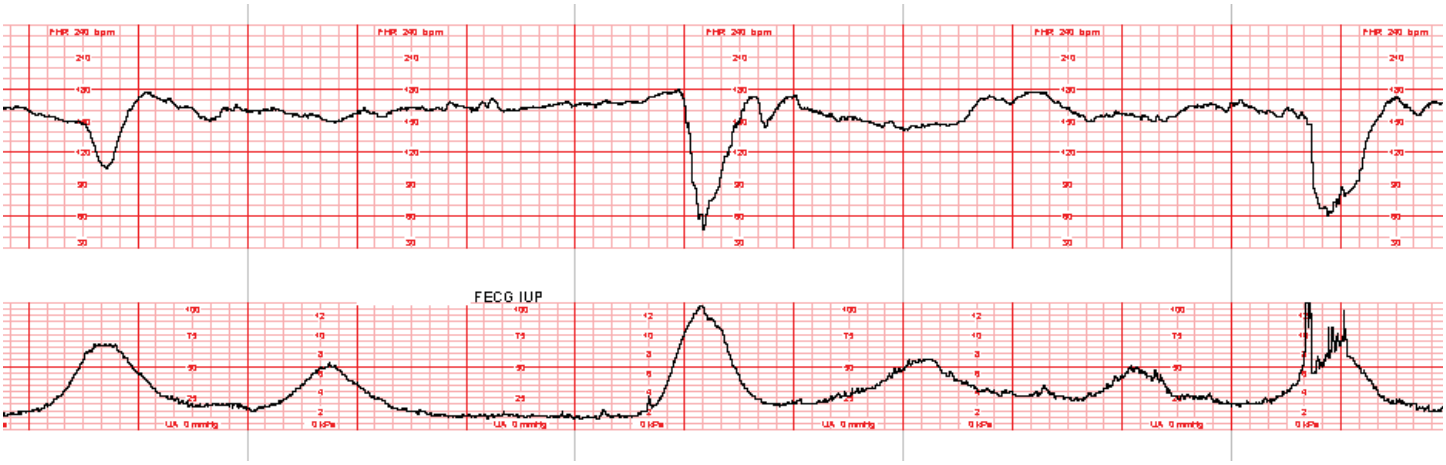
Prolonged deceleration

Appendix C - Categories of Fetal Heart Rate Tracings

Category II (Indeterminate) Tracings



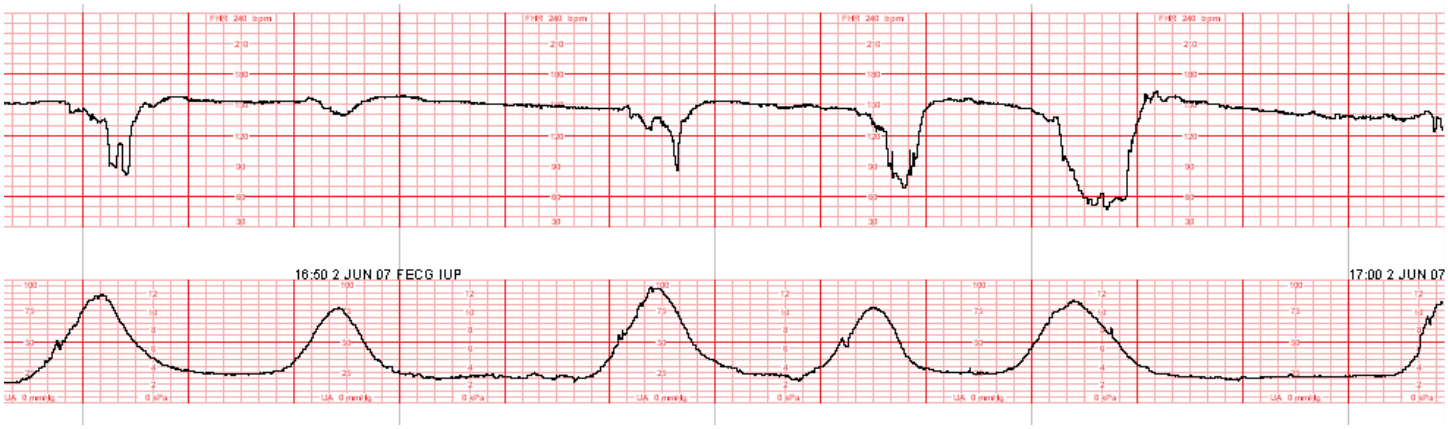
Criteria: Recurrent variable decelerations with moderate variability



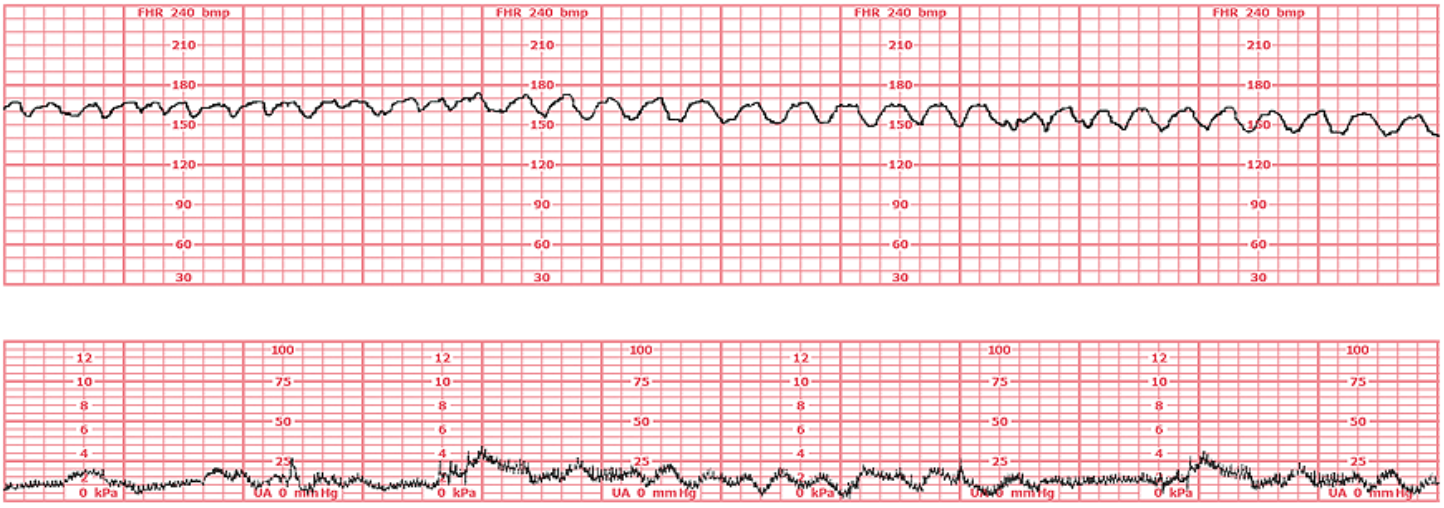
Criteria: Variable decelerations with “slow return to baseline”, “overshoots” or “shoulders”

Appendix C - Categories of Fetal Heart Rate Tracings

Category III (Abnormal) Tracings



Absent variability and recurrent variable decelerations



Sinusoidal pattern

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