Background

- Monitoring the FHR intends to determine if a fetus is well oxygenated because the brain modulates the heart rate.

- FHR monitoring = fetal brain monitoring

- 1980: 45 % of laboring women
- 1988: 74 % of laboring women
- 2002: 85 % of laboring women
• Low risk EFM
• review every 30 min. in first stage of labor
• review every 15 min. in second stage of labor

• High risk EFM
• review every 15 minutes in first stage of labor
• review every 5 minutes in second stage of labor

• Long-term variability and short-term variability are visually determined and considered one entity.
Baseline Fetal Heart Rate

**Definition**
- Average FHR rounded to 5 bpm during a 10 minute period, but excludes
  - Periods of marked increased FHR variability
  - Segments of baseline that differs by more than 25 bpm
- Must compromise at least 2 minutes out of 10 minute segment
- Normal range is 110 – 160 bpm (NICHD)
- Always documented as a range
Fetal Heart Rate Baseline

- Set by atrial pacemaker
- Balanced interplay of sympathetic and parasympathetic autonomic nervous system
- Developing parasympathetic nervous system slows baseline during advancing gestational age
- Ideally assess baseline when: fetus not moving, fetus not stimulated, between contractions
Fetal Tachycardia

- **Definition**
  - Baseline FHR of 160 bpm or greater > 10 minutes (NICHD)

- **Description**
  - Increase in sympathetic and/or decrease in parasympathetic tone, sometimes associated with decrease in FHR variability

- **Etiology**
  - Fetal hypoxia
  - Maternal fever
  - Drugs
  - Amnionitis
  - hyperthyroidism
  - Fetal anemia
Fetal tachycardia

• Significance
  • Usually hypoxemia is not the reason, especially in a term fetus and a identifiable cause such as maternal fever or drugs
  • Can be a non reassuring sign if associated with late decelerations or absent variability
  • If > 220 bpm consider SVT

• Intervention
  • Maternal fever: can be reduced by antipyretics and IV hydration
  • Maternal oxygenation: supersaturation with O2 by facemask
  • NRFS: expeditiously deliver
Fetal Bradycardia

- **Definition**
  - FHR of 110 bpm or less for > 10 minutes

- **Etiology**
  - Late (profound) fetal hypoxemia
  - Beta blocker
  - Anesthetics
  - Maternal hypotension
  - Prolonged umbilical cord compression
Fetal bradycardia

- Clinical significance
  - Associated with loss of variability or late decelerations: NRFS
  - Substantial bradycardia (< 90 bpm) especially if prolonged and uncorrectable is a sign of impending fetal acedemia
  - Mild bradycardia 90-110 bpm with moderate variability and absence of late decelerations is generally reassuring
- Intervention: correction of underlying etiology, if not correctable usually emergent C/S
Variability

• Definition
  • Fluctuation in the baseline FHR of 2 or more cycles per minute
  • Quantify amplitude as follow:
    • Absent: undetectable
    • Minimal: 5 or less bpm
    • Moderate: 6 to 25 bpm
    • Marked: > 25 bpm
Variability

- Description
  - Normal irregularity of cardiac rhythm
  - Balancing interaction of the sympathetic and parasympathetic nervous system
  - Results from sporadic impulses of the cerebral cortex
  - Moderate variability reflects an intact neurological pathway, optimal fetal oxygenation and adequate tissue oxygenation
Variability

- **Short term variability**
  - Beat to beat change in FHR from one heart beat to the next
  - Described as absent or present
  - Only measurable by FSE
  - Controlled by parasympathetic nervous system
  - Present STV: reassuring for fetal oxygenation
Variability

- Long term variability
  - Influenced by sympathetic nervous system
  - Visually examined of rise and fall of FHR by counting of cycles within 1 minute and determining amplitude
  - Presence of LTV gives indication of fetal oxygenation
- Generally LTV and STV increase or decrease together, exceptions can be:
  - Fetal sleep: minimal LTV, present STV
  - Fetal anemia: moderate LTV, absent STV
Variability

- Marked variability
  - Mild hypoxemia
  - Fetal stimulation (contractions, SVE, FSE…)
  - Meds: Terbutalin, Albuterol
  - Drugs: Cocaine, methamphetamine, nicotine

Significance: unknown, not in itself a sign of NRFS

Intervention: observe FHT for non reassuring signs, changes in baseline, consider FSE
Variability

• Etiology of decreased variability
  • Hypoxemia / Acedemia
  • Meds: narcotics, barbiturates, anesthetics, parasympatholytics
  • Fetal sleep cycle (20-40 minutes)
  • Congenital anomalies
  • Fetal cardiac arrhythmias
  • Extreme prematurity (< 24 weeks)
Variability

- Significance and Intervention for decreased Variability
  - Depends on cause
  - No intervention if transient secondary to fetal sleep cycle or CNS depressants
  - If hypoxemia suspected: try to improve fetal blood oxygenation:
    - maternal positioning,
    - hydration,
    - correcting maternal hypotension,
    - maternal oxygenation,
    - elimination of uterine hyperstimulation
Sinusoidal Pattern

- Sine wave with undulating baseline
  - Regular oscillation with an amplitude of 5-15 bpm
  - 2 – 5 cycles per minute
  - Minimal or absent short term variability
  - Absence of accelerations
  - Extreme regularity and smoothness

- Etiology: fetal hypoxemia from fetal anemia, often secondary to Rh isoimunization
- Pseudosinusoidal pattern: sine wave is less uniform and STV present (narcotics, amnionitis, thumb sucking)
Accelerations

- **Definition**
  - Abrupt increase in FHR above baseline
  - Onset to peak:< 30 seconds
  - Peak : 15 bpm above most recent baseline (32 weeks and more)
  - Peak : 10 bpm above most recent baseline (< 32 weeks)
  - Duration (from increase to return to baseline) : 15 seconds, but < 2 minutes
  - Prolonged acceleration : 2- 10 minutes
  - Acceleration > 10 minutes: new baseline
Acceleration

- **Description**
  - Episodic (spontaneous) accelerations
  - Periodic accelerations (with contractions)

- **Etiology**
  - Stimulation of sympathetic autonomous nervous system
  - Spontaneous fetal movement
  - Vaginal examination
  - Abdominal palpation
  - Environmental stimuli (noise)
  - Scalp or vibroacoustic stimuli
  - Uterine contraction
  - Insertion of IUPC or FSE
Acceleration

- Clinical significance
  - Sign of intact fetal nervous system and reassuring FWB
  - Some fetal monitors have movement sensors
  - Repetitive accelerations: contractions compress umbilical cord and cause transient fetal hypotension -> baroreceptor-induced increase in FHR
Decelerations

- Early deceleration
- Late deceleration
- Variable deceleration
- Prolonged deceleration
Early deceleration

- **Definition**
  - Gradual decrease (onset to nadir > 30sec) of FHR and return to baseline
  - Nadir at time of uterine contraction peak

- **Description**
  - **shape:** uniform, mirror image of contraction phase
  - **Onset:** early in contraction
  - **Recovery:** with return of contraction to baseline
  - **Deceleration:** rarely < 110 bpm or 30 bpm below baseline
  - **Variability:** usually moderate
  - **Occurrence:** repetitious with each contraction, usually in active phase of labor or passive 2\textsuperscript{nd} stage
Early deceleration

• Etiology
  • Uterine contraction: Fetal head compression leads to altered cerebral blood flow, leads to vagal stimulation
  • CPD (especially when occurs early in labor)
  • Persistent occiput posterior position

• Significance
  • No pathologic significance
  • Do not occur in all labors
Late decelerations

- **Definition**
  - **Onset**: late in contraction phase, onset to nadir > 30 sec, nadir after peak of contraction
  - **Recovery**: returns to baseline after end of contraction
  - **Deceleration**: rarely < 100 bpm, may be subtle (3-5 bpm)
  - **Variability**: often associated with decreased variability, rising baseline or tachycardia
  - **Occurrence**: repetitive with each contraction
Late Deceleration

- **Physiology**
  - Uterine hyperactivity or maternal hypotension
  - Decreases intervillous space blood flow during contraction
  - Decreases maternal /fetal oxygen transfer
  - Fetal hypoxia and myocardial depression
  - Vagal response -> cardio deceleration
Late Deceleration

- Etiology: uteroplacental insufficiency
  - Uterine hyperstimulation
  - Maternal supine hypotension
  - Gestational HTN
  - Chronic HTN
  - Postterm gestation
  - Amnionitis
  - IUGR
  - Poorly controlled maternal diabetes
  - Placenta previa
  - Abruption / maternal shock
  - Spinal anesthesia
Late Deceleration

• Clinical Significance
  • Non reassuring sign when persistent and uncorrectable
  • When associated with decreased variability and/or tachycardia: sign of fetal acidemia
  • As myocardial depression increases, depth of late deceleration decreases, becoming more subtle
  • Single deceleration is not clinical significant if rest of tracing is reassuring
Intervention for late deceleration

- Change maternal position to lateral
- Correct maternal hypotension
  - Legs up, head down
  - IV fluid bolus
  - Vasopressors
- Correct uterine hyperstimulation
  - Stop pitocin
  - Remove Cervidil
  - Consider tocolytic (0.2 – 0.5 mg Terbutalin iv)
- Hyperoxygentate maternal blood with O2
- Cervical exam
  - Labor status
  - Fetal scalp stimulation (only when FHR at baseline)
  - Consider FSE
- If repetitive and uncorrectable: expeditious delivery
Variable deceleration

- Characteristics
  - Shape: variable, (V, U, W), may not be consistent
  - Onset: onset to beginning of nadir (< 30 seconds)
  - Recovery: rapid return to baseline
  - Deceleration: > 15 bpm, often > 100 bpm
  - Duration: > 15 seconds, < 2 minutes
  - Occurrence: typically late in labor with descent of head, and in 2nd stage of labor
Variable decelerations

- Umbilical cord compression
- Partial occlusion (umbilical vein)
- Decreased venous return
- Decreases FSBP
- Baroreceptor mediated acceleration
- Complete occlusion (umbilical vein + arteries)
- Increases FSBP
- Baroreceptor mediated deceleration
Variable deceleration

- **Etiology**
  - Maternal position (cord between fetus and pelvis)
  - Cord around fetal neck or other body part
  - Short cord
  - True knots
  - Prolapsed cord
  - Oligohydramnios
  - After ROM
Variable deceleration

• Interpretation
  • Progression is more important than absolute parameters

• Grading
  • mild
    • < 30 seconds or
    • > 70 bpm + 30-60 seconds or
    • > 80 bpm for any duration
  • moderate
    • <70 bpm + 30-60 seconds
    • 70-80 bpm for > 60 seconds
  • severe
    • < 70 bpm for > 60 seconds
Variable declaration

- Reassuring features
  - Mild to moderate variable deceleration
  - Rapid return to baseline
  - Normal, not increasing baseline
  - Moderate variability

- Non-reassuring features
  - Severe variable deceleration
  - Prolonged return to baseline
  - Increasing baseline
  - Absent or minimal variability
Prolonged deceleration

- **Definition**
  - >15 bpm for > 2 minutes, < 10 minutes
- **Characteristics**
  - Shape: variable
  - Deceleration: almost always below normal FHR range, except in fetus with tachycardia
  - Variability: often lost
  - Recovery: often followed by period of late deceleration and or rebound tachycardia
  - Some fetuses don’t recover- > terminal bradycardia
Prolonged deceleration

• Etiology
  • Cord prolapse
  • Maternal hypotension (supine or regional anesthesia)
  • Tetanic uterine contractions
    • Pitocin
    • Abruption
    • cocaine
  • Maternal hypoxemia
    • Seizures
    • Narcotic overdose
    • Magnesium sulfate toxicity
    • High spinal anesthetic
  • Fetal head compression or stimulation can produce strong vagal response
    • FSE, pelvic exam, sustained maternal Valsalva, rapid fetal descent

• Significance: Depending on recovery and post deceleration FHR tracing
Meta-analysis of 9 RCT comparing EFM to auscultation

- EFM increased the overall C/S rate (OR 1.5) and C/S rate for suspected fetal distress (OR 2.5)
- EFM increased the use of vacuum assisted (OR 1.2) and forceps assisted (2.4) operative vaginal delivery
- EFM use did not reduce overall perinatal mortality (OR 0.8, CI 0.57-1.33), but perinatal mortality caused by fetal hypoxia appeared to be reduced (OR 0.4)
Does EFM reduce cerebral palsy?

- The positive predictive value of a nonreassuring pattern to predict cerebral palsy among singeltons with birth weights > 2500 g is 0.14%.
- Out of 1000 fetuses with a nonreassuring FHR pattern only 1-2 will develop CP.
- False positive rate is 99%.
- Available data suggests EFM does not reduce CP.
- Occurrence of CP has been stable over time despite widespread introduction of EFM.
- 70% of CP cases occur before onset of labor.
- 4% only can solely attributed to intrapartum events.
What is the interobserver and intraobserver variability of electronic FHR assessment?

- Wide variation in the way obstetrician interpret EFM tracings.
- 4 OB’s examined 50 EFM tracings and agreed in only 22% of the cases.
- 2 months later reviewing the same 50 tracings they interpreted 21% of the tracings differently than they did during the first evaluation.
- There is greater agreement if the EFM is reassuring.
What medications affect the FHR?

- **Epidural**: can lead to sympathetic blockage -> maternal hypotension -> transient uteroplacental insufficiency -> alterations in FHR

- **Parenteral narcotics**: decreased FHR variability, less accelerations

- **Corticosteroids**: transiently decreases FHR variability with return by the 4.-7. day and may reduce rate of accelerations.
What findings on EFM reassure fetal status?

- **Accelerations**: ensures that the fetus is not acidemic.
- **Variability** (sparse data): in case of normal (moderate) FHR variability and late decelerations umbilical arterial pH > 7 in 97% of cases.

→ In most cases normal FHR variability provide reassurance about fetal status.
What ancillary tests can reassure fetal status?

- Decreased or absent variability without spontaneous accelerations:
- Make an effort to elicit an acceleration with:
  - Digital scalp stimulation
  - Allis clamp scalp stimulation
  - Vibroacoustic stimulation
  - Fetal scalp sampling