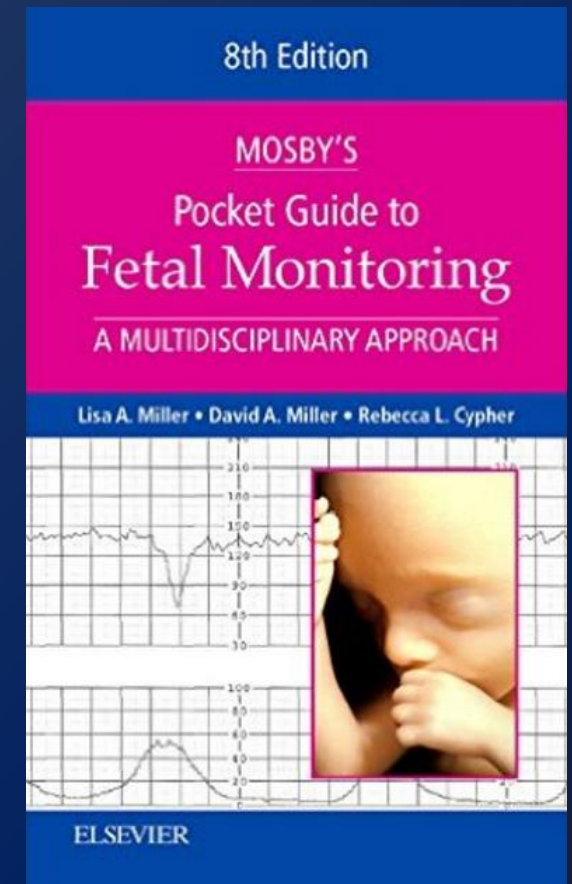


Advanced Principles in EFM Speaking The Language of the Fetus

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Disclosures

- In addition to education and consulting services I have a professional relationship with
 - Elsevier: Co-author
 - Clinical Computer Systems: Education
 - AWHONN: 2019 President Elect
 - Opinions are my own and do not necessarily reflect those of AWHONN
- I may discuss off label medications or products



EFM: Screening Test



Expected Outcomes

- ↓ incidence of cerebral palsy
- ↓ incidence of intrapartum stillbirth

What Really Happened

- No change in cerebral palsy rates
- No change in intrapartum stillbirth
- ↑ interventions (cesarean birth)
- Neonatal seizures decreased with EFM

Objective of fetal heart monitoring is to prevent fetal injury that might result from interruption of adequate oxygenation during labor.



NICHD Terminology

- NICHD: 1997
- ACOG: 2005
- AWHONN: 2005
- ACNM: 2006
- NICHD Reaffirmed: 2008

Late
Variables

Skewed
Contractions

BTBV

Hyperstimulation

Variability

Minimal variability

- “More of a flat strip, where you don't see as big of accelerations in the heartbeat, or you'll see -- you won't see as many **jiggles** in the line
- Marked variability
 - ” You're going to see **big, tall accelerations and decelerations** within a short period of time

The 2008 National Institute of Child Health and Human Development Workshop Report on Electronic Fetal Monitoring: Update on Definitions, Interpretation, and Research Guidelines

George A. Macones, MD, Gary D. V. Hankins, MD, Catherine Y. Spong, MD, John Hauth, MD and Thomas Moore, MD

FHR Tracing Evaluation

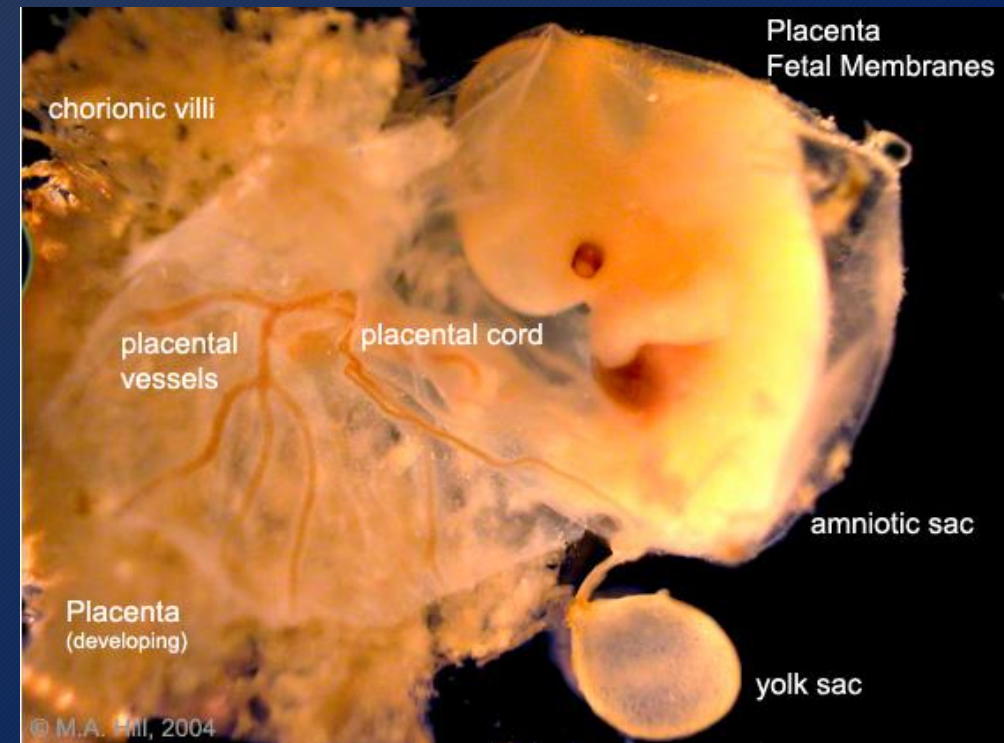
- Qualitative & quantitative description of:
 - Baseline rate
 - Baseline variability
 - Presence of accelerations
 - Periodic or episodic decelerations
 - Changes or trends over time
 - Uterine contraction evaluation

Maternal-Fetal Physiology



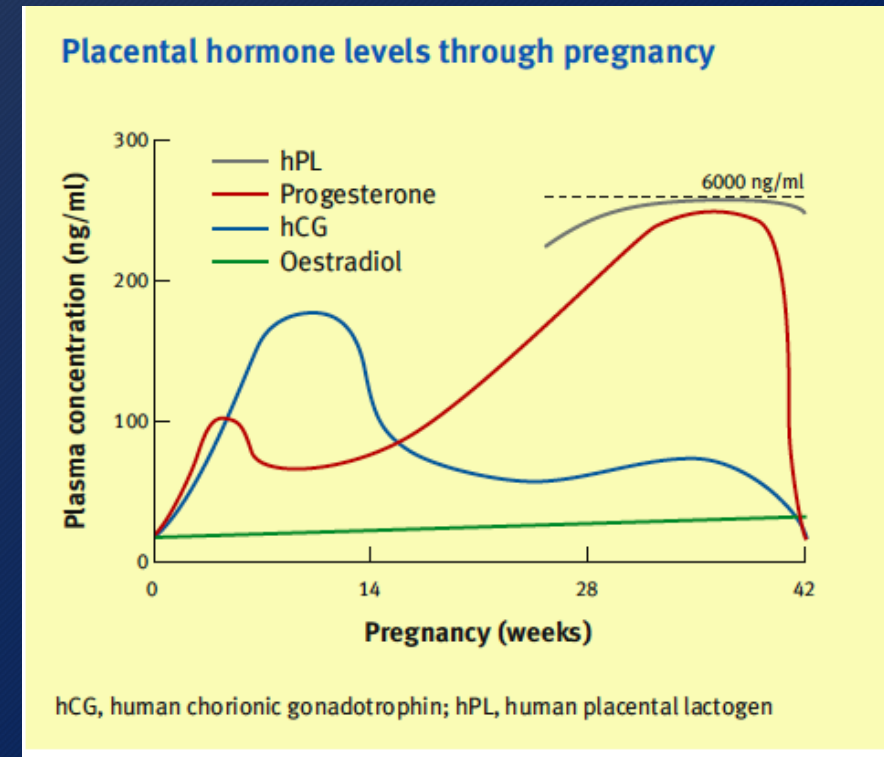
Placenta As An Endocrine Organ

- Feto-placental circulation: 3 weeks
 - Vessels join placenta=embryo
- Maternal-fetal fetus origin
 - Fetal contribution: Chorion
 - Maternal: Decidua (endometrium)



Placental Development and Function

- Growth more rapid than fetal growth
 - \downarrow ~ 18-20 weeks
- \uparrow Thickness after 20 weeks
- Secretes peptide and steroid hormones
 - Maintains pregnancy
 - Parturition and lactation preparation



Placental Function

- **Respiration**

- O₂ in maternal blood crosses placental barrier (membrane)
 - Enters fetal blood supply (diffusion)
 - CO₂ returns to maternal circulation across placental barrier

- **Nutrition**

- Water, inorganic salts, carbohydrates, fats, proteins, and vitamins
- Enzymatic carriers: maternal circulation via placental barrier
- Metabolizes glucose; stores glycogen until fetal liver functions

Placental Function

- **Storage**

- Carbohydrate, proteins, calcium, iron

- **Excretion**

- Waste crosses placental barrier to enter maternal circulation
- Minimal fetal waste due to dominant anabolic metabolism

Placental Function

- **Protection**

- Prevents transfer of harmful maternal substances
- Transfer of maternal immunity

- **Hormonal production**

- Secretes hormones for pregnancy maintenance and fetal development
- Hormones: steroid, estrogen, progesterone, protein, HCG, HPL, thyrotropin

Peptide Hormonal Action

- **Human chorionic gonadotrophin (hCG)**
 - Prolongs corpus luteum growth = maintains progesterone secretion
 - Prevents endometrial shedding
 - 6-8 weeks: placenta takes over progesterone production
- **Human placental lactogen (hPL)**
 - Promotes breast tissue growth for lactation
 - Metabolic effect by antagonizing maternal glucose use

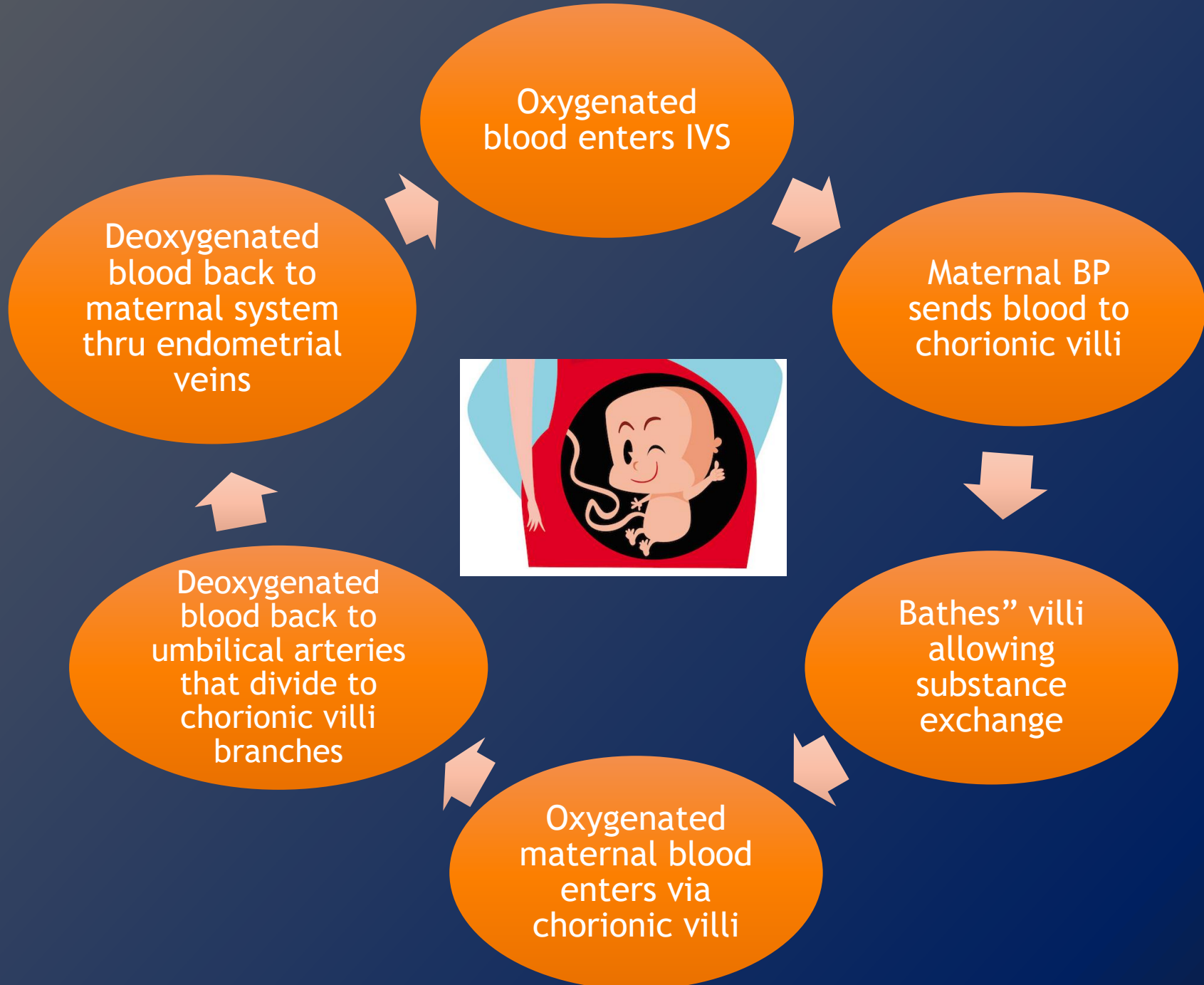
Steroid Hormonal Action

- **Estrogen**

- Increases blood flow to uterus
- Stimulates uterine muscle growth
- Factor in labor onset and lactation

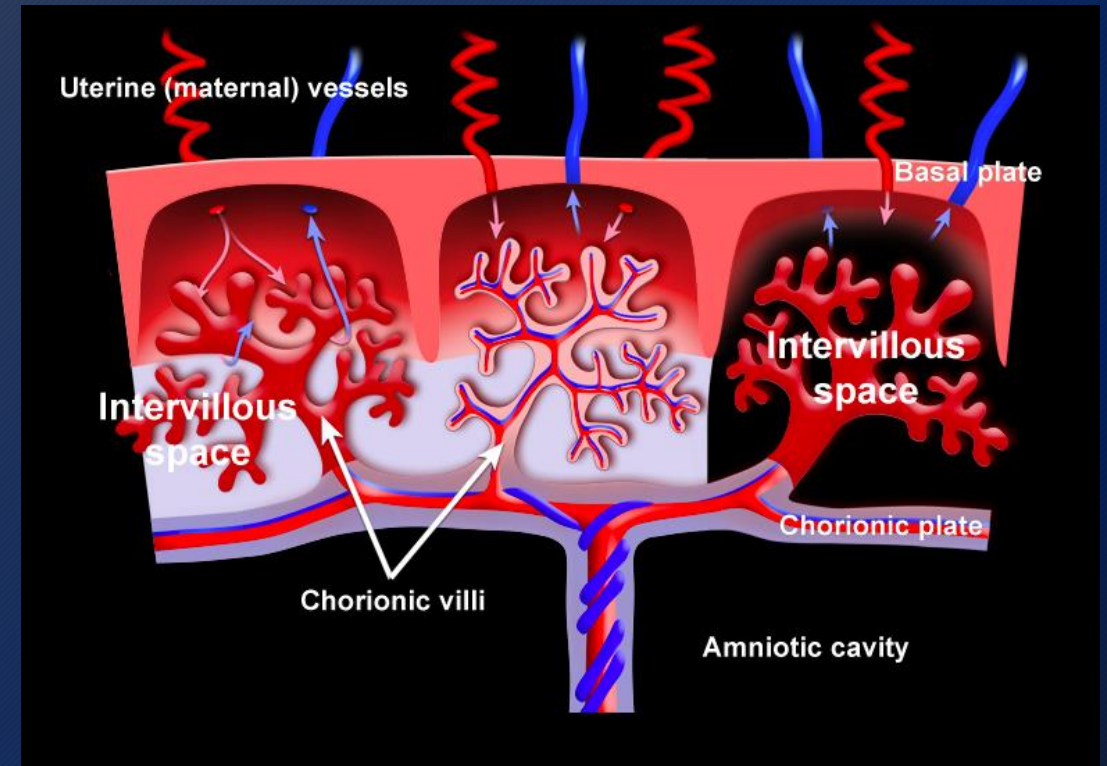
- **Progesterone**

- Maintains endometrium
- Reduces myometrial activity
- Suppresses maternal immunological response to fetal antigens

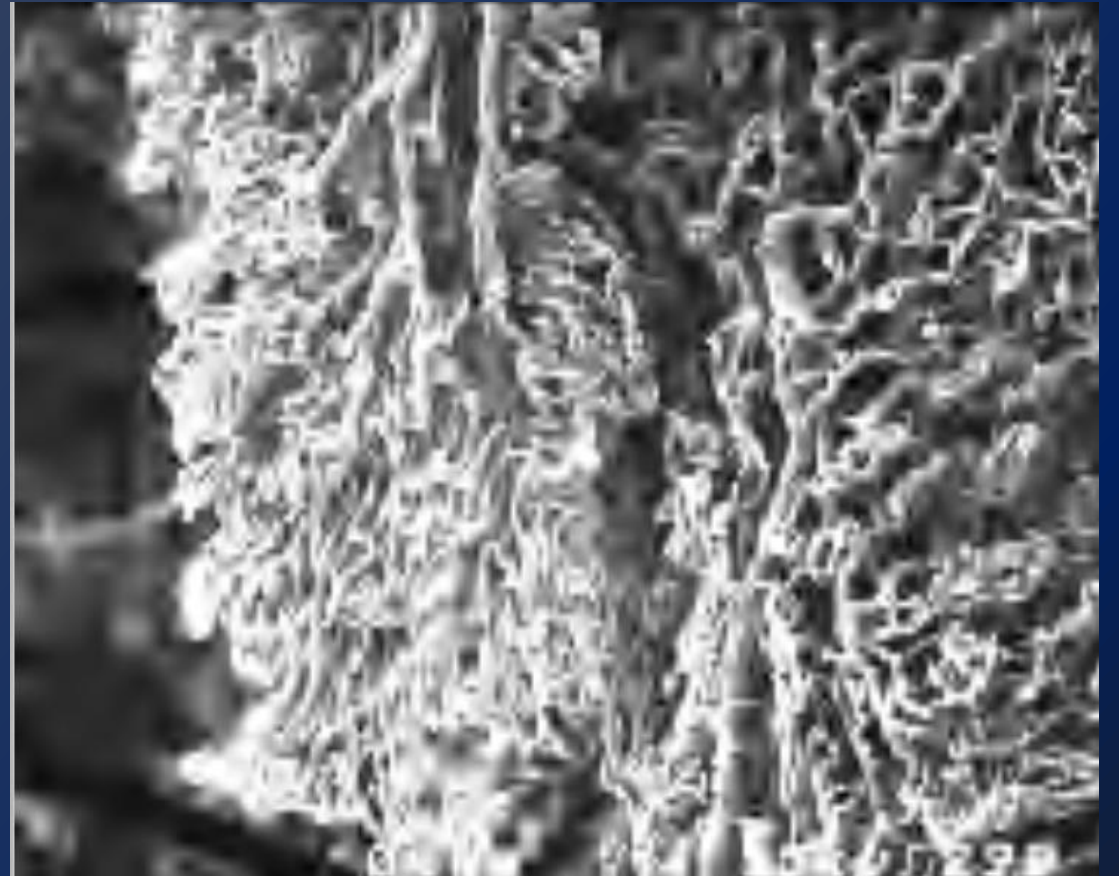
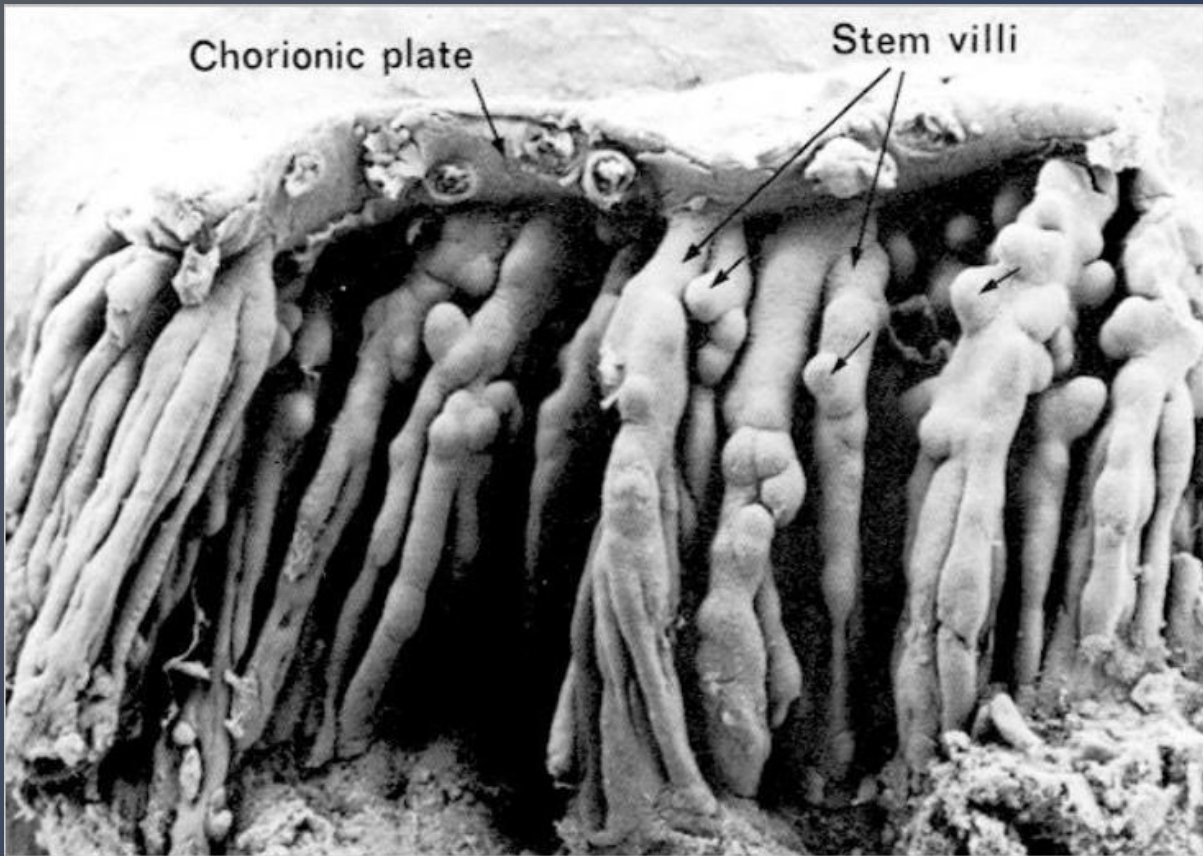


Placental Intervillous Space

- Uterine perfusion
 - 700-800 mL/min at term
 - 10-15% of maternal CO
- Fetal tissue protrusions
 - Exposed to maternal blood
 - Bathes chorionic villi
- Factors impacting volume
 - Contractions, abruption



Maternal-Fetal Placental Circulation



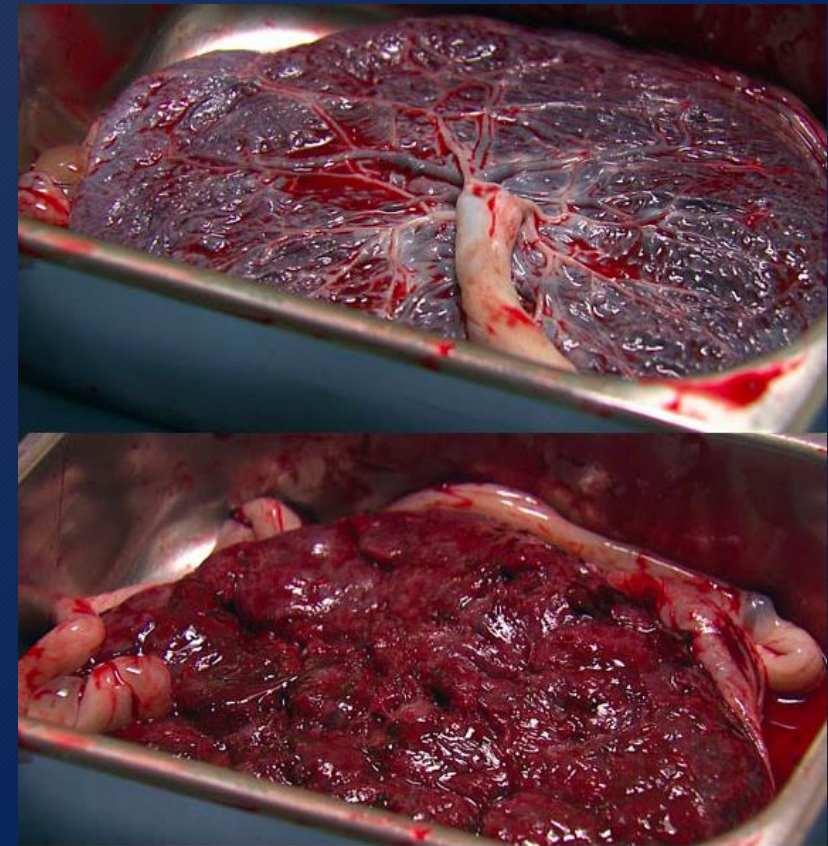
Term Placenta

- Round and flat
 - ~ Diameter: 15-20 cm
 - Thickness: 1-2 cm
- Weight: 400-500 grams
 - Minus cord/membranes

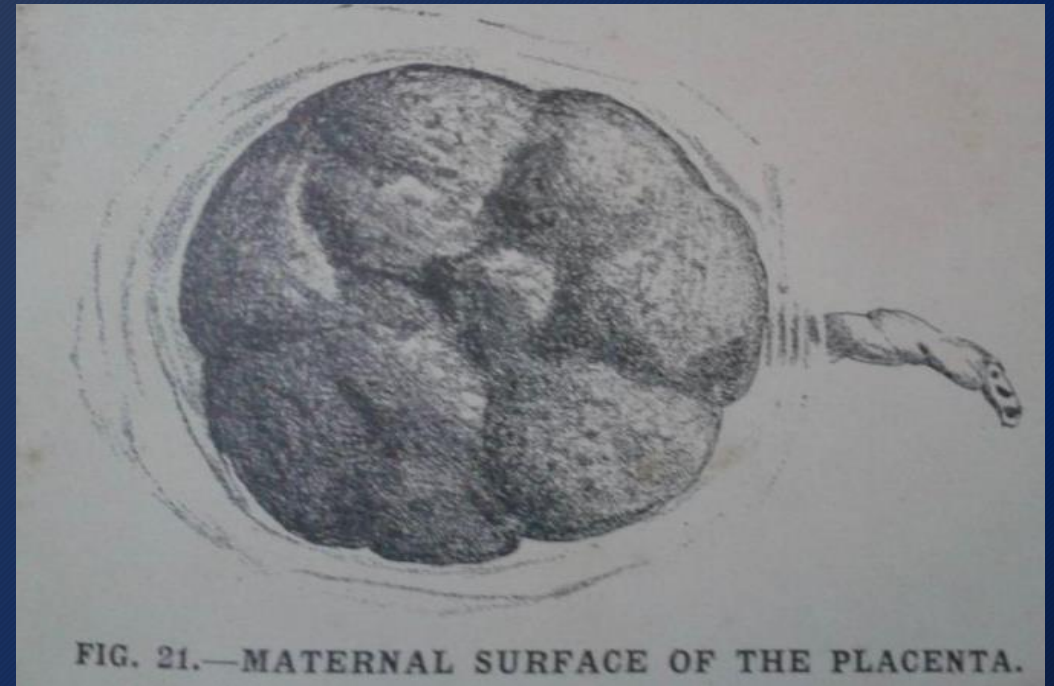


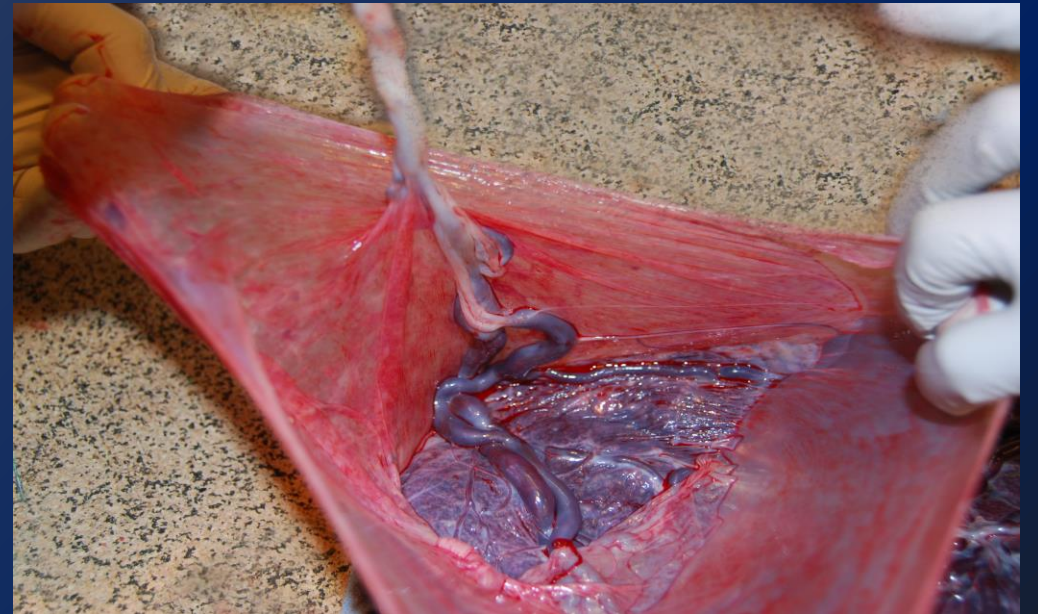
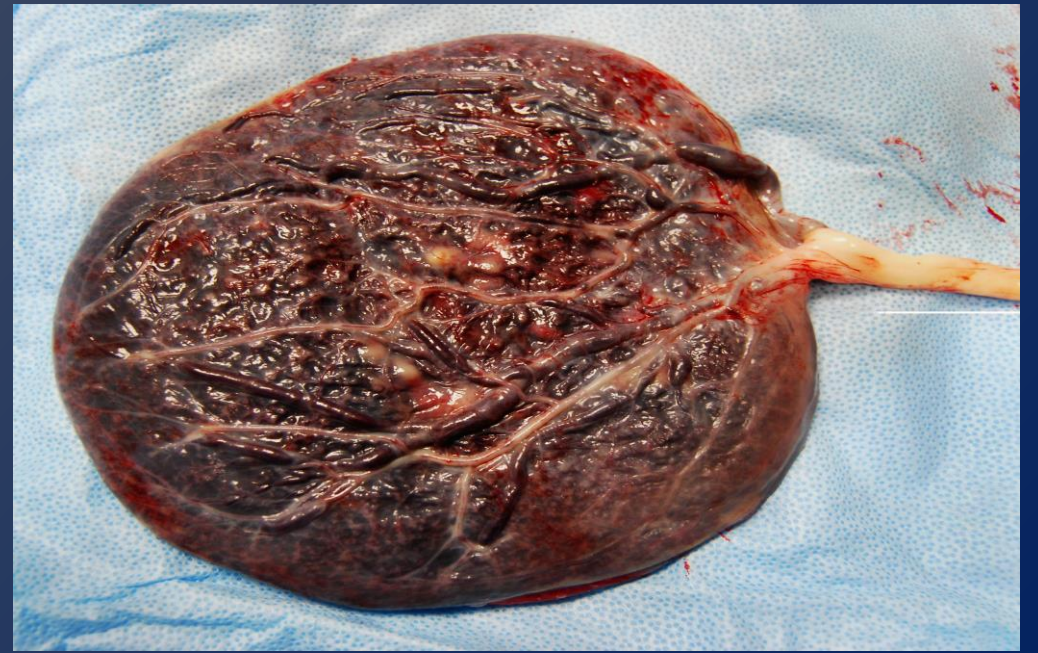
Term Placenta

- Maternal surface (Duncan)
 - Red / blue in appearance
 - Arises from decidua basalis
 - Region between blastocyst and myometrium
 - Multiple lobules (cotyledons)
- Fetal surface (Schultz)
 - Smooth, white and shiny
 - Develops from chorionic villi
 - Contains umbilical vein/artery branches



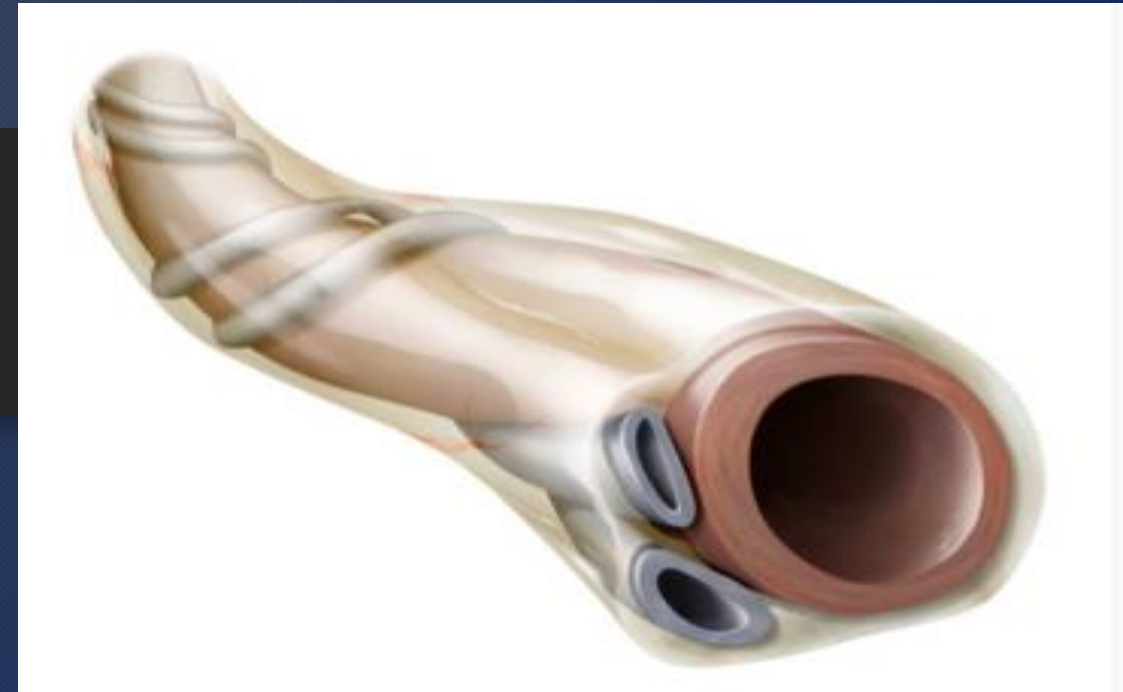
15-20 Cotyledons or Lobules
Act as a maternal-fetal circulatory subunit



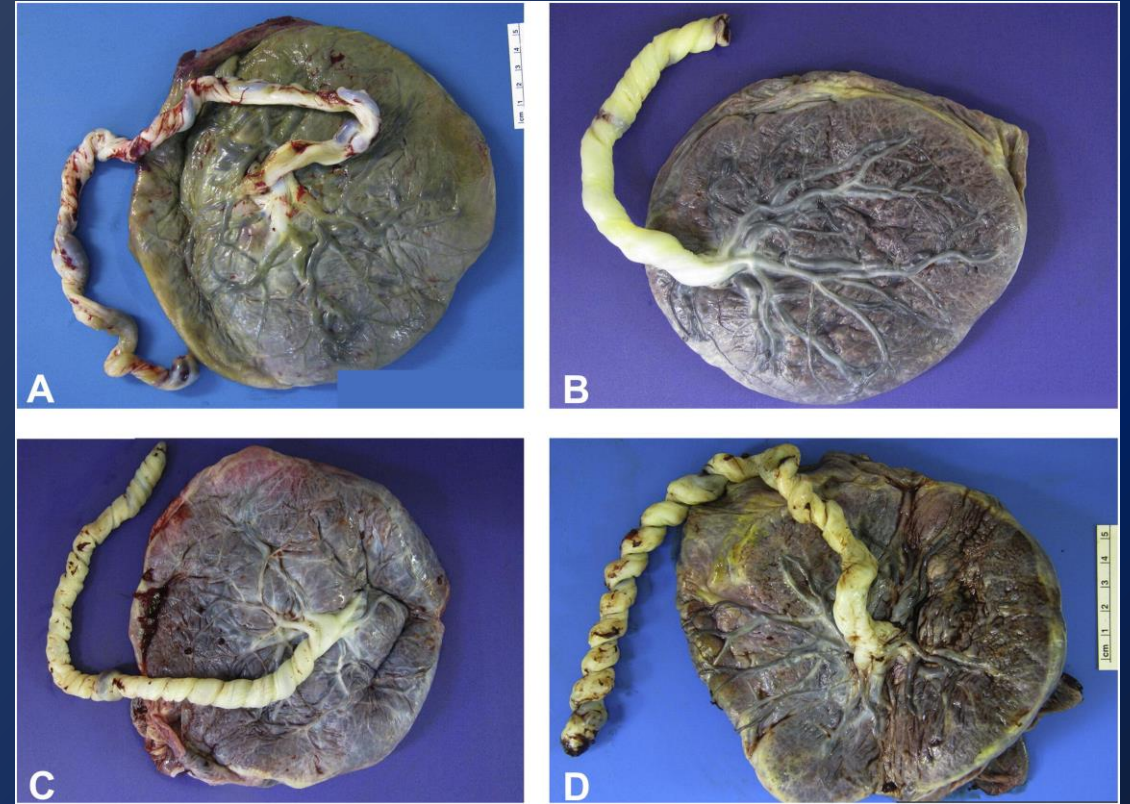
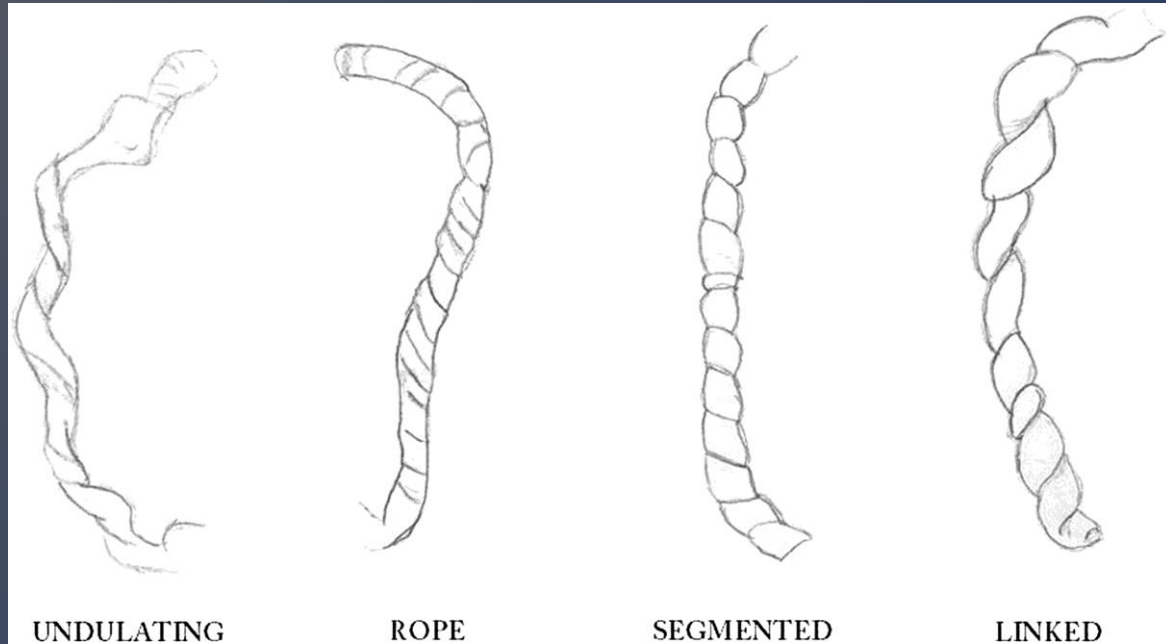


Umbilical Cord

- Large vein and 2 small arteries
- Wharton's jelly
 - Gelatin-like substance
 - Prevents compression
- Centrally located



Umbilical Cord Coiling



Umbilical Cord Coiling

- One coil/5 cm (0.2 ± 0.1 coils completed per cm)
- < 10th percentile (0.1 cm) (Strong)
 - ↑ karyotypic abnormalities, meconium, operative intervention
- <10th or >90th percentile (≥ 0.3 cm)
 - ↑ Variable decelerations
- Hypocoiling (≤ 0.26 coils cm)
 - PTL, oligohydramnios, FHR changes, operative vaginal delivery, LBW
- Hypercoiling (≥ 0.46 coils/cm)
 - FGR, FHR changes, LBW

Machin, Geoffrey A., Jeanne Ackerman, and Enid Gilbert-Barnes. "Abnormal umbilical cord coiling is associated with adverse perinatal outcomes." *Pediatric and Developmental Pathology* 3.5 (2000): 462-471

Strong, Thomas H., et al. "The umbilical coiling index." *AJOG* 170.1 (1994): 29-32.

Mittal, A., Nanda, S., & Sen, J. (2015). Antenatal umbilical coiling index as a predictor of perinatal outcome. *Archives of gynecology and obstetrics*, 291(4), 763-768.

Chorion and Amnion

- Chorion
 - Outer layer
 - Covers fetal surface
 - Contains umbilical vessels
- Amnion
 - Inner layer
 - Covers inside of chorion
 - Forms umbilical cord covering



Importance of Intact Membranes

Membranes

- ✓ Barrier to infection
- ✓ Maintain amniotic fluid
- ✓ Phosphoglycerolipid storage site

Shock Absorber

- ✓ Distributes pressure
- ✓ Uterine activity
- ✓ Maternal movement

Amniotic Fluid

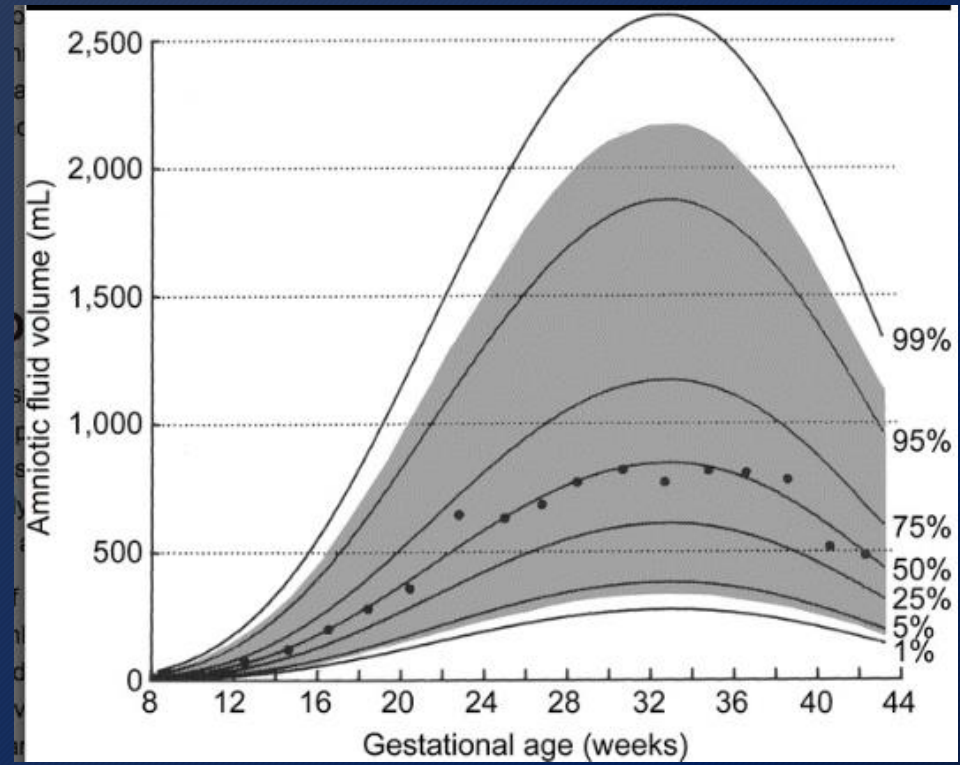
- ✓ Protective barrier
- ✓ Temperature control
 - ✓ Cord floats freely
- ✓ O₂, nutrients and waste flow

2nd and 3rd Trimester

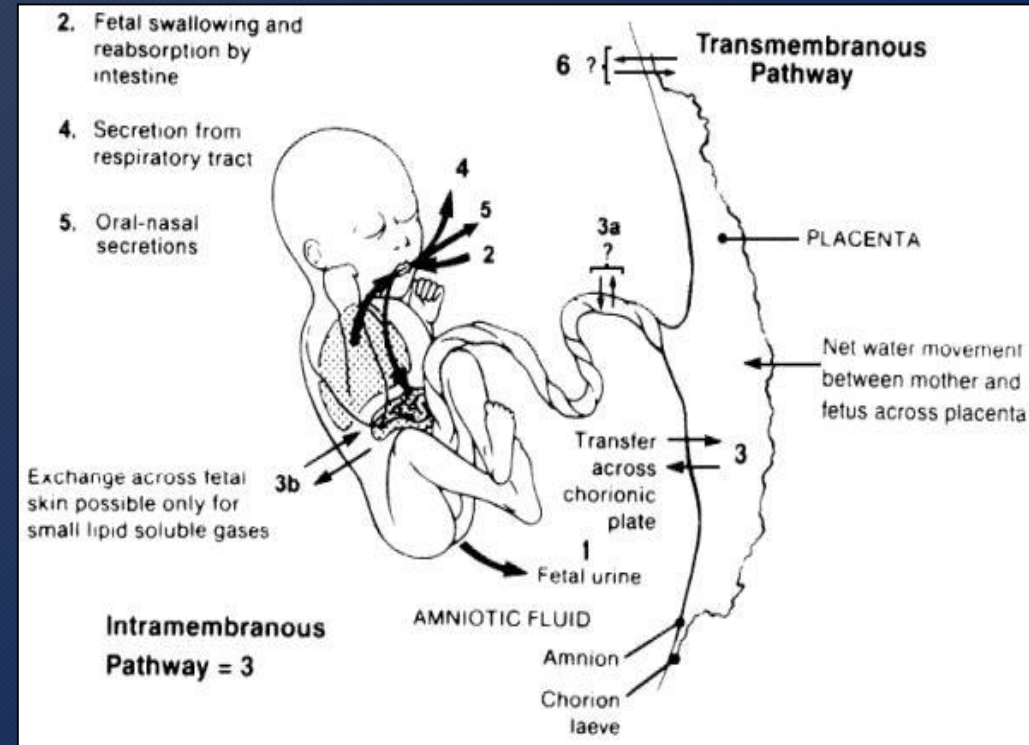
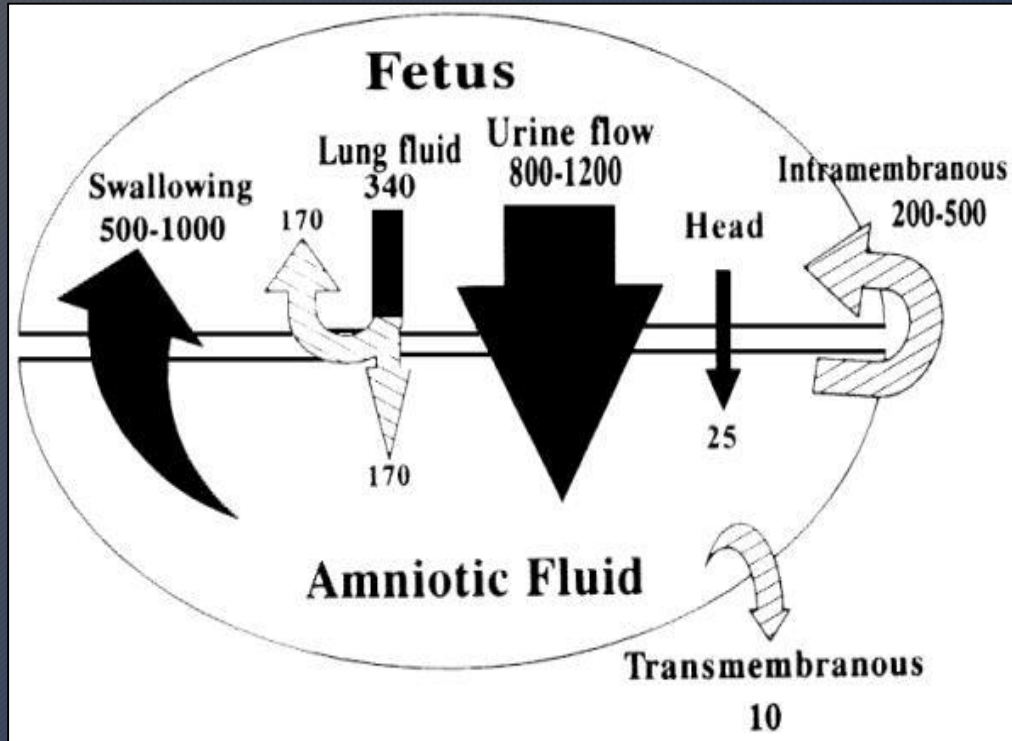
- ✓ Fetal movement and growth
 - ✓ Develop muscle tone

Amniotic Fluid Volume Changes

- Normal volume: 800-1200 mL
- Linear distribution
 - 1st trimester 30 weeks
 - Slows from 30- 36/38 weeks
 - ↓ 36/38 weeks until delivery
 - >40 weeks: ↓ 8-33%



Amniotic Fluid Influences



- ❖ Amniotic fluid osmolality
- ❖ Intramembranous/Transmembranous
- ❖ Fetal Urination and Fetal Swallowing
- ❖ Fetal Lung Fluid

Fetal Urination and Swallowing

- Primary source of fluid
 - Abnormal production
 - Structural: Renal agenesis
 - Oxygenation disruption
 - Diabetes / hydrops
- Swallowing
 - Major fluid removal mechanism
 - 500-1,000 mL/day

Physiology: Extrinsic and Intrinsic Factors

Extrinsic

“Outside” Influence

- Maternal / uteroplacental characteristics affect blood flow
 - Maternal impact
 - Uteroplacental impact
 - Umbilical circulation
 - Amniotic fluid features

Intrinsic

“Inside” influence

- Assists with maintaining fetal homeostasis when stressed
 - Fetal circulation
 - Autonomic nervous system
 - Baroreceptors
 - Chemoreceptors
 - Hormonal responses

Physiologic Extrinsic Influence

- Maternal influences
 - Positioning: compressed inferior vena cava → ↓ venous return
 - ↓ Maternal blood flow to uterus
 - Contractions: ↓ uterine blood flow
 - Compensatory hypotension (i.e. epidural)
- Placental influences
 - Amount of surface area for maternal-fetal O₂ exchange
 - Damaged cotyledons, smoking, vessel constriction from medications

Physiologic Extrinsic Influence

- Umbilical Cord
 - Structural defects (knots, 2 vessel cord)
 - Mechanical function (partial or complete compression)
- Amniotic Fluid
 - ↓ Placental function ⇒ ↓ Fetal kidney perfusion
 - Shunts blood away from kidneys
 - Causing oligohydramnios

Physiologic Intrinsic Influence

- Designed to interact / ensure adequate oxygenation to vital organs
- Autonomic Nervous System: Parasympathetic and Sympathetic
 - Responds to fetal oxygenation status and fetal BP
 - Parasympathetic Nervous System: “Pokey”
 - Influences FHR variability
 - \uparrow tone and \downarrow FHR baseline with advancing gestational age
 - Sympathetic Nervous System: “Speedy”
 - Stimulation \uparrow FHR and may be promoted by hypoxemia
 - FHR baseline \downarrow when blocked

Physiologic Intrinsic Influence

- Central Nervous System
 - Controlled by cerebral cortex and medulla oblongata
 - Intact well oxygenated brainstem
 - Normal range FHR baseline, moderate variability and + /- accelerations

Physiologic Intrinsic Influence

- **Chemoreceptors**

- Respond to changes in fetal O₂, CO₂ and pH levels
- ↑ CO₂ or ↓ O₂ ⇒ Fetal BP/FHR changes
 - Severe enough ⇒ Bradycardia

- **Baroreceptors**

- Stretch receptors respond to changes in fetal BP
 - Located in aortic arch and carotid arteries
- ↑ BP will ↓ FHR resulting in BP decrease
- ↓ BP stimulates an increase in FHR

Physiologic Intrinsic Influence

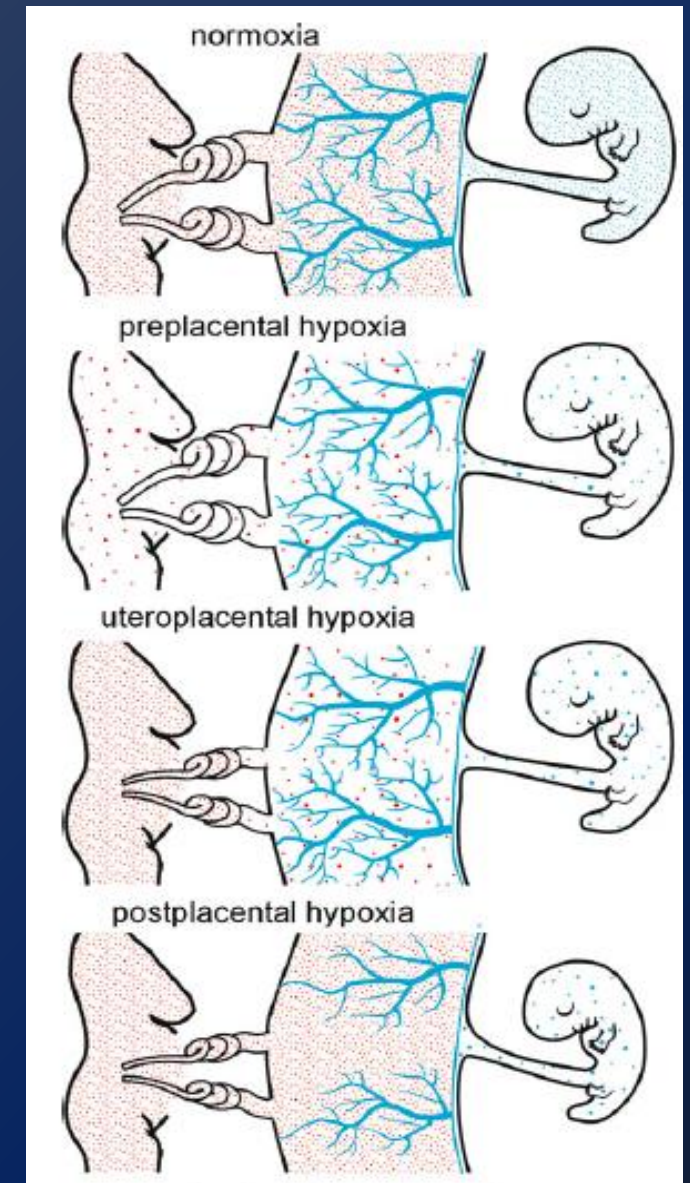
- Hormones (epinephrine, norepinephrine, vasopressin)
 - Response to stressors \Rightarrow FHR changes
 - Stress caused by lower PO₂
 - Epinephrine and norepinephrine released
 - \uparrow FHR: blood shunted to brain/heart
 - Stress caused by hypoxemia/hypovolemia: vasopressin is released
 - Impacts fetal kidneys \uparrow intravascular volume and peripheral resistance
 - \uparrow Fetal BP

Fetal Activity

Biophysical Characteristic	Central Nervous System Control	Gestational Age
Tone	Cortex: Subcortical	7.5 to 8.5 weeks
Movement	Cortex: Nuclei	9 weeks
Breathing	Ventral Surface, 4 th ventricle	20-21 weeks
Fetal Heart Rate	Posterior Hypothalamus Medulla	28-32 weeks

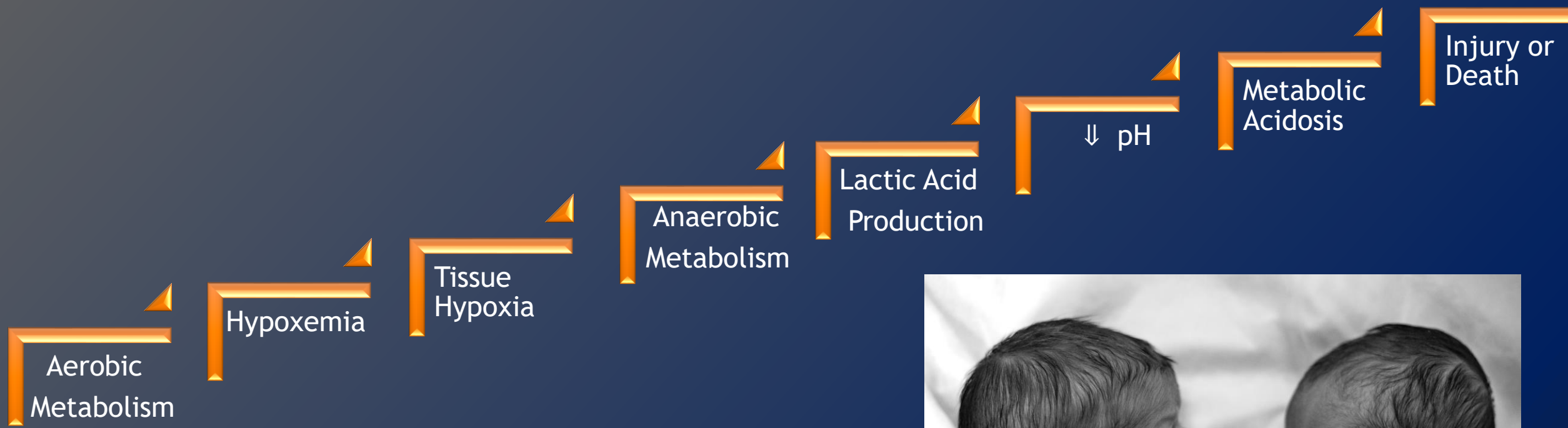
Origins of Fetal Hypoxia

- **Pre-placental:** ↓ O₂ content in maternal blood
 - Hypoxic placenta and fetus
 - High altitudes, cyanotic cardiac disease
- **Utero-placental:** Normal O₂ content
 - Restricted flow into uteroplacental tissue
 - **Contractions**, preeclampsia, occlusions
- **Post-placental:** Normal O₂ content
 - Villi fail to transfer oxygen to fetus
 - Abnormal placentation



Hypoxia: Fetal Defense Mechanisms

- Sustain metabolic requirements
- Redistribution of blood to vital organs
- Decreased oxygen consumption
 - Myocardium uses less O₂
 - FHR changes
- If no improvement in oxygenation
 - Convert to anaerobic metabolism



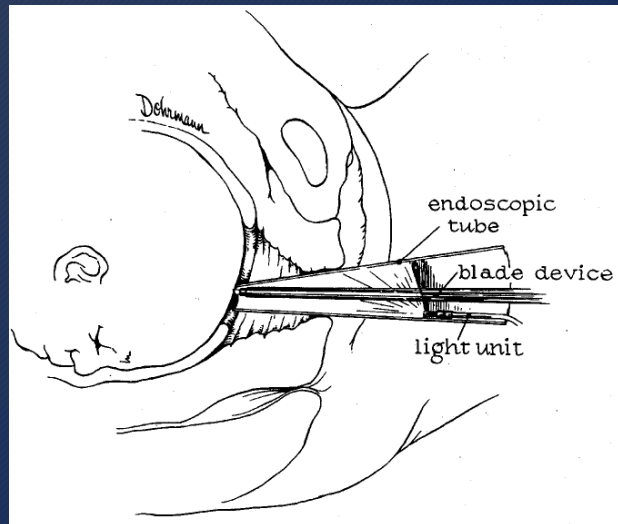
Measurement of Fetal Acid Base Status

Indirect Methods

Fetal Scalp Stimulation
Vibroacoustic Stimulation

Direct Methods

Fetal Scalp Sampling
Umbilical Cord Blood Sampling

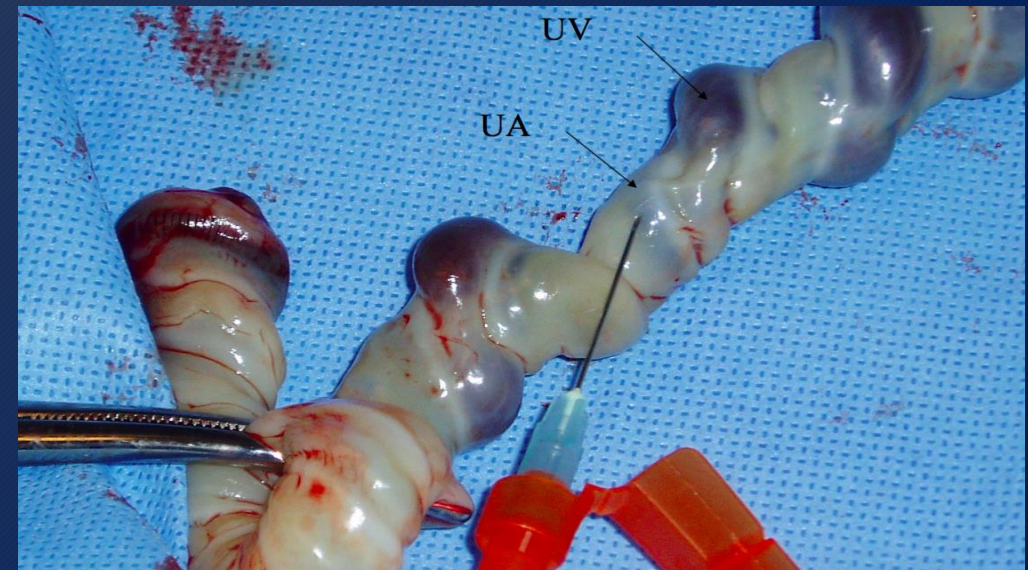


Fetal Scalp Stimulation

- Noninvasive procedure for acid-base status
- Used for Category II FHR (indeterminate)
 - i.e. no spontaneous acceleration, minimal variability
- Performed during segments of baseline
 - Not during decelerations or bradycardia
- **NOT** a method of intrauterine resuscitation

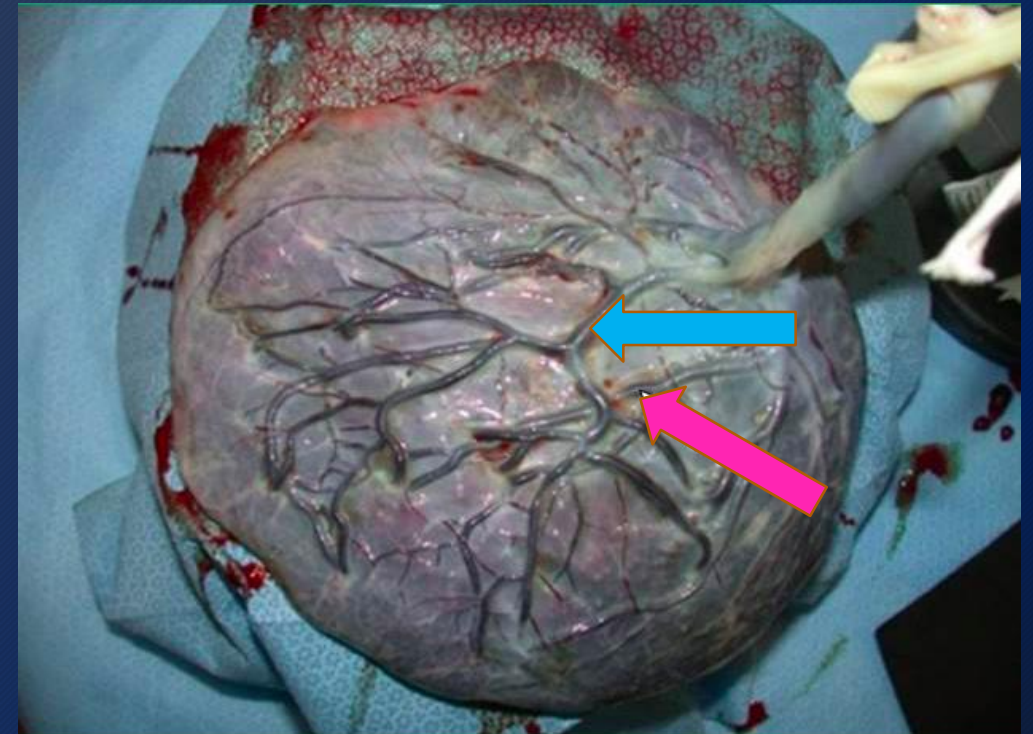
Collection Double Clamped Segment

- Stable at room temperature 1 hour
- Delayed cord clamping
 - At/below placenta: 30-60 seconds
- Clinical neonatal benefits
- Timely resuscitation
- Adjunct to Apgar scores
 - Immediate neonatal condition
 - Plan management



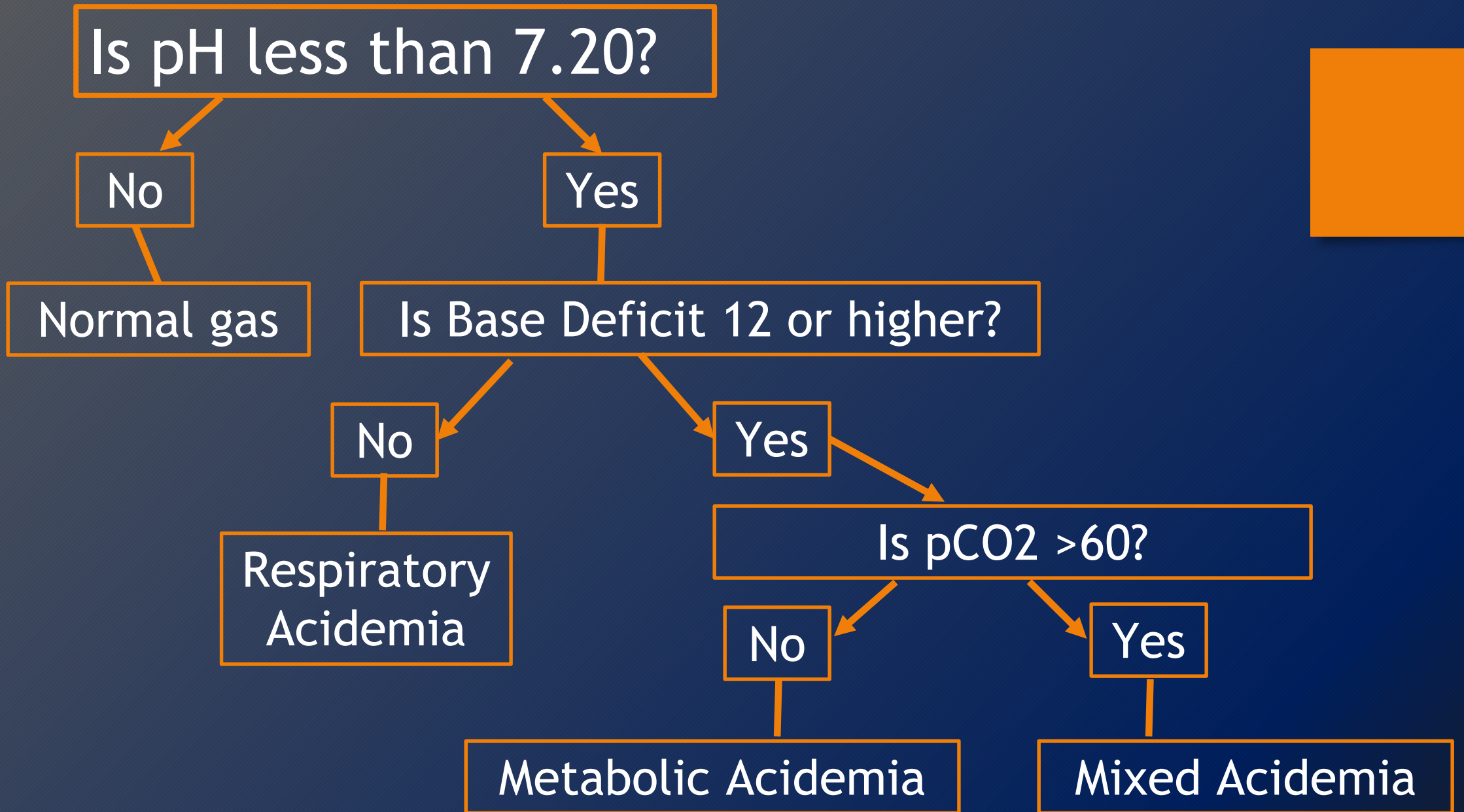
Umbilical Cord Gas Sampling

- Arterial and venous samples
 - Comparison and more accurate
- **Artery: Deoxygenated blood from fetus**
 - Presence /severity of fetal acidosis at/near birth
 - Smaller lumens, thick vessel walls, less blood
 - Arteries cross over veins
- **Vein: Oxygenated blood to fetus**
 - Placental tissue acid-base status at/near birth
 - Distended vessel helps to support artery



Single Digit Values (Term Gestation)

Components	Normal Value	Metabolic Acidemia	Respiratory Acidemia
pH	≥ 7.20	<7.20 Significant is <7.0	< 7.20
PO ₂ (mmHg)	≥ 20	<20	Variable
PCO ₂ (mmHg)	<60	<60	>60 (elevated)
HCO ₃ (mEq/L) Buffer	≥ 22	<22	≥ 22
Base Deficit (mEq/L)	≤ 12	>12	<12
Base Excess (mEq/L) Amt of H ⁺ ions to return pH to normal	≥ -12	< -12	> -12



Case Study Application

	Normal	Metabolic Acidemia	Respiratory Acidemia
pH	≥ 7.20	<7.20	< 7.20
PO2	≥ 20	<20	Variable
PCO2	<60	<60	>60
HCO3	≥ 22	<22	≥ 22
Base Deficit	≤ 12	>12	<12
Base Excess	≥ -12	< -12	> -12

- pH / PO2 / pCO2 / BE
- Venous Result
- Arterial Result

Case Study #1

- 29 year old G3 P2
- 39 1/7 weeks: AROM clear fluid in active labor
 - 6/80/-1
- EFM
 - Cat I FHR during labor evolving to Cat II FHR in 2nd stage
 - FHR tachycardia, minimal variability and late decelerations
- 2nd stage
- Pushing x30 minutes
- Vacuum delivery for Category III FHR tracing with Apgars 2, 3, and 5

Case Study #1: Umbilical Cord Gas Result

	Normal	Metabolic Acidemia	Respiratory Acidemia
pH	≥ 7.20	< 7.20	< 7.20
PO ₂	≥ 20	< 20	Variable
PCO ₂	< 60	< 60	> 60
HCO ₃	≥ 22	< 22	≥ 22
Base Deficit	≤ 12	> 12	< 12
Base Excess	≥ -12	< -12	> -12

- pH
 - V = 6.94 A = 6.86
- P_O₂
 - V = 17 A = 6
- PCO₂
 - V = 45 A = 55
- BE
 - V: 20 A: 21.1

Case Study #2

- 39 year old G8 P7
- 41 5/7 weeks: IOL with oxytocin with SROM clear fluid at 4 cm
- EFM
 - Category II throughout labor mostly related to variable decelerations
- 2nd stage
- Pushed x 10 minutes
- Apgars 7 and 9

This arterial cord gas is

- pH 7.17
- pO₂ 10
- pCO₂ 70
- HCO₃ 21
- BD 11

- A. Respiratory acidemia
- B. Mixed acidemia
- C. Metabolic acidemia

Base Excess During Normal Labor

- Assuming “normal” stresses of active phase labor and “commonly” occurring variable decelerations in 2nd stage
 - Average fetus enters labor
 - -2 mmol/L
 - Active labor
 - Decreases by 1 mmol/L per 3-6 hours
 - Second stage
 - Decreases 1 mmol/L per hour

Category II and III Fetal Heart Rate Tracings

- "Recurrent typical severe variable decelerations that may or may not prompt physician intervention"
 - ↓ Buffer by ~ 1 mmol/L per 30 minutes
- "Subacute fetal compromise"
 - ↓ Buffer by 1 mmol/L per 6 - 15 minutes
- "Acute, severe compromise (terminal bradycardia)"
 - ↓ Buffer as much as 1 mmol/L per 2-3 minutes

Fetal Bradycardia and Cord Arterial pH

- Deteriorates rapidly starting from bradycardia onset
- Irreversible group
 - 0.011mmol/L per minute
- Potentially reversible/unknown
 - No significant relationship between pH and delivery interval
 - 4-5% chance of <7.0 vs 26.8% in the irreversible group

Condition	Number of Cases (%)
Irreversible conditions	39 (16.6)
Placental abruption	9 (3.8)
Cord prolapse	21 (8.9)
Uterine rupture	0 (0)
Preeclampsia	3 (1.3)
Failed instrumental delivery	6 (2.6)
Potentially reversible conditions	22 (9.4)
Iatrogenic uterine hyperstimulation	13 (5.6)
Hypotension after epidural anesthesia	5 (2.1)
After external cephalic version (without abruption)	4 (1.7)
Aortocaval compression	0 (0)
Unknown cause for fetal bradycardia	174 (74.0)

“30 minute rule” Example

- Base excess **decrease**

- Q 3 minutes
- 1 mmol/L

- pH **decline**

- Q 1 minute
- 0.011 mmol/L

$$\text{BE} = -4 \text{ to } -14$$

- Base excess: $30/3 + 10$
- $-4 + -10 = -14$

$$\text{pH} = 7.2 \text{ to } 6.87$$

- $0.011 \times 30 = 0.330$
- pH: $7.2 - 0.333 = 6.867$

Acidemia & Fetal Injury

- It can take time for hypoxemia to progress to metabolic acidemia, although this varies widely
- Even when metabolic acidemia is present, neurologic injury is very uncommon
- Isolated fetal *RESPIRATORY* acidemia (elevated PCO₂) is *NOT* associated with neurologic injury
- When obtaining an cord blood gases, *ALWAYS* obtain both arterial and venous specimens and record all values!

Lactate

- Metabolite of anaerobic metabolism
- Sensitive marker for tissue hypoxia
 - Sepsis, trauma, necrotizing fasciitis
- Adults: Venous 0.5 - 2.2mM (dependent on lab)
 - 2.3 -3.9 mM: mild physiologic dysfunction
 - ≥ 4.0 mM: severe physiologic dysfunction

Umbilical Lactate

- Typically measured by scalp sampling
 - Associated with low 5-minute Apgar scores, NICU admission, HIE
- Measurement of **umbilical** artery lactate appears to be better than pH or base excess in predicting adverse outcomes
 - Direct product of anaerobic metabolism
 - Source of umbilical artery lactate is fetal not maternal or placental
- Direct measure of fetal hypoxia
 - Fetal brain is sensitive to hypoxic injury

Umbilical Lactate

- May be a more precise assessment tool
- Easy rapid measurement using test strip that requires a smaller amount of fetal blood
- Normal levels not precisely defined
 - 3.5 - 7 mM upper limit of normal range

Three Elements of EFM Standardization

Terminology

What do we call it?

Interpretation

What does it mean?

Management

What to do about it?



Baseline Fetal Heart Rate

- Approximate mean FHR rounded to nearest 5 bpm (e.g., 140 or 145)
- Assess over 10 minutes
 - Requires minimum 2 minutes but not contiguous
- Excludes
 - Accels, decels, marked variability, and any segments differing by ≥ 25 bpm
- Bradycardia: < 110 bpm
- Tachycardia: > 160 bpm

Differentials for Bradycardia

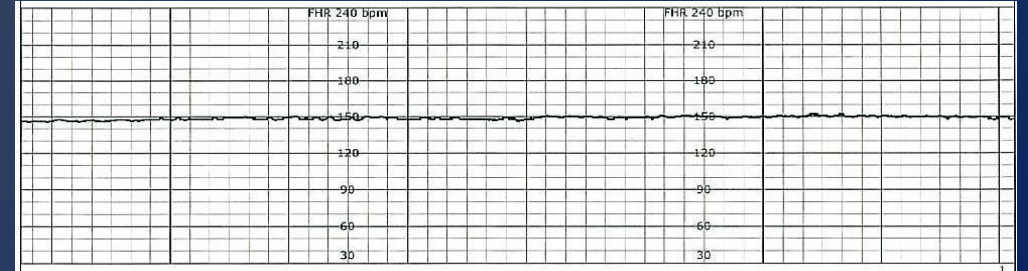
Maternal	Fetal
Sympatholytics <i>Beta-blockers (propranolol), clonidine</i>	Cardiac conduction abnormalities <i>Heart block</i>
Viral infection (CMV)	Fetal oxygenation pathway interruption
Autoimmune and connective tissue disease <i>Sjogren's Syndrome, SLE, APAS</i> <i>(Anti-Ro/SS-A or Anti-La/SS-B antibodies)</i>	Structural cardiac defects <i>Heterotaxy syndrome</i>
Hypoglycemia	Fetal heart failure
Hypothermia	
Hypothyroidism	

Differentials for Tachycardia

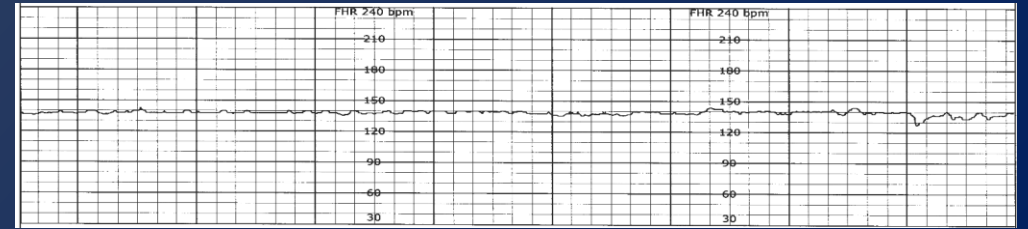
Maternal	Fetal
Beta-sympathomimetic drugs Terbutaline, epinephrine	Acute blood loss
Cocaine	Fetal Anemia
Dehydration	Heart Failure
Fever	Hyperthyroidism
Hyperthyroidism	Hypoxia / Hypoxemia
Infection (chorioamnionitis, pyelonephritis)	Increased metabolic rate
Parasympatholytic drugs Atropine, scopolamine, dicyclomine	Tachyarrhythmias WPW, SVT(paroxysmal or continuous)
	Infection and Fetal Sepsis

Baseline Variability

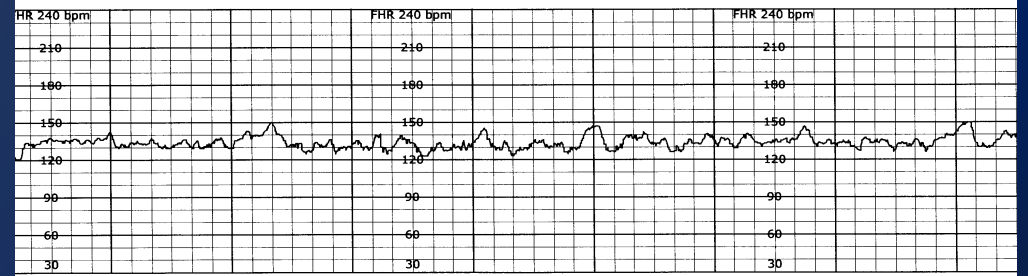
Undetectable from baseline
Absent



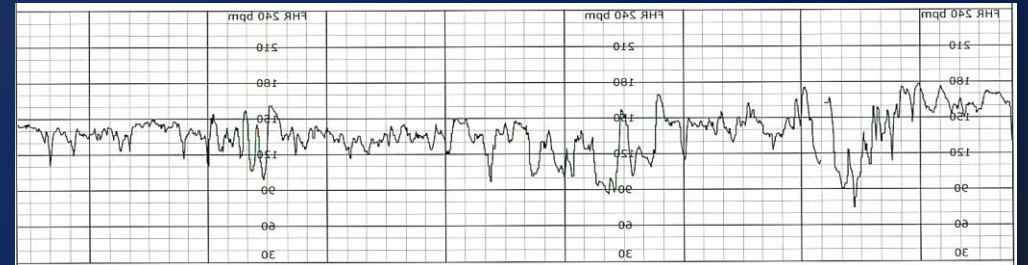
Visually detectable from FHR BL, but ≤ 5 bpm
Minimal



6 – 25 bpm
Moderate



>25 bpm
Marked



Minimal and Absent Variability

- Fetal sleep cycle
- Fetal tachycardia
- General anesthesia
- Prematurity
- Congenital anomalies
- Preexisting neurologic injury
- Medications
 - Narcotics, barbiturates, atropine, phenothiazines, tranquilizers
- Fetal anemia
- Fetal cardiac arrhythmia
- Infection
- Fetal metabolic acidosis

Moderate Variability

- Reliably predicts absence of fetal metabolic acidemia at time of observation
- Active and alert fetus
- Reflection of neuromodulation of an active CNS
 - Normal cardiac responsiveness
- Reflection of R-R interval changes

Marked Variability

- Etiology unclear
- Presumed to be result of increase alpha-adrenergic activity
 - Fetal activity or fetal stimulation
- In the absence of abnormal FHR changes
 - Not associated with acidemia based on fetal blood pH or Apgar scores
- Interpret in context of other FHR changes

Sinusoidal

- Excluded from definition of variability

Smooth, sine wave-like pattern with regular frequency and amplitude

- 3-5 cycles per minute, must be present for 20 minutes for diagnosis
- Severe fetal anemia, amnionitis, fetal sepsis, and narcotic analgesics

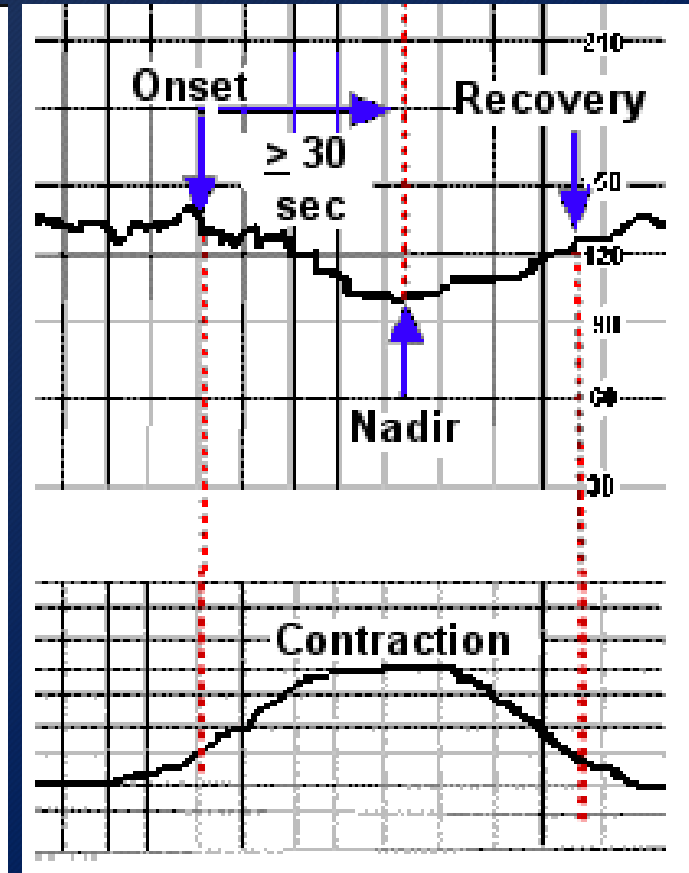
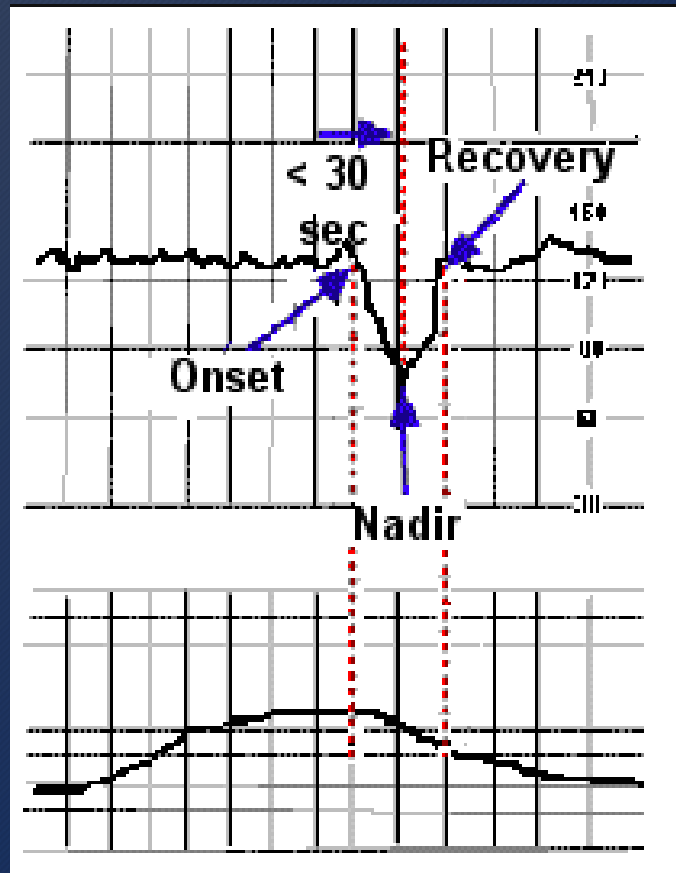


Accelerations

- Visually apparent abrupt increase from baseline
- Term fetus
 - Onset to peak <30 seconds; peak (acme) ≥ 15 bpm
 - Duration >15 seconds; < 2 minutes from onset to return to baseline
- Preterm fetus
 - Onset to peak < 30 seconds; peak (acme) ≥ 10 bpm
 - Duration >10 seconds
- Prolonged acceleration ≥ 2 minutes, < 10 minutes

Decelerations

- Nadir
 - Abrupt
 - Onset to nadir < 30 seconds
 - Gradual
 - Onset to nadir ≥ 30 seconds

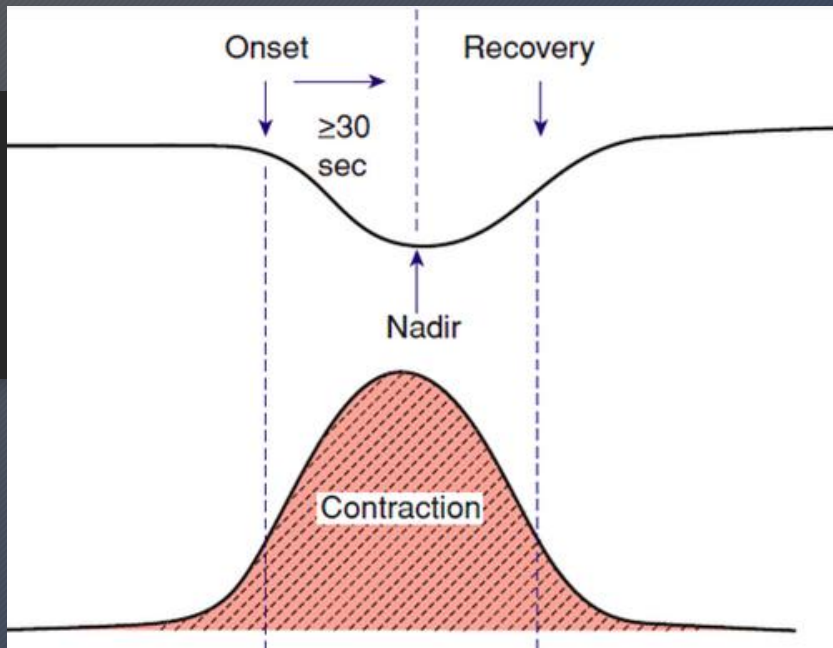


Early Deceleration

- **Gradual** decrease and return to baseline associated with a contraction
- Onset, nadir, and offset always occur coincidentally with the contraction, with the nadir at contraction peak
- Because of the importance in timing related to uterine contractions, be careful regarding the use of a toco versus palpation or IUPC

Early Decelerations

- Vagal response from head compression
 - Benign finding
- Associated with
 - Labor between 4-7 cm
 - Primigravida
 - Persistent occiput posterior
 - Cephalopelvic disproportion



Early Decelerations

Transient head compression

Altered intracranial pressure and/or cerebral blood flow

Reflex parasympathetic outflow

Gradual FHR slowing

Early deceleration

Contraction relaxes and autonomic reflexes subside

Late Deceleration

- **Gradual** decrease and return to baseline associated with a contraction
- Delayed onset, with nadir *always* occurring after contraction peak
- Because of the importance in timing related to uterine contractions, be careful regarding the use of a toco versus palpation or IUPC

Late Deceleration

- Transient alterations in O₂ transport
- Associated with
 - Decreased uteroplacental circulation
 - Postdates placenta, pre-eclampsia

Recurrent or sustained disruption of oxygenation

Tissue hypoxia

Anaerobic metabolism

Lactic acidosis

Metabolic acidemia

Direct myocardial depression



Variable Decelerations

- Abrupt decrease in FHR below the baseline of ≥ 15 bpm lasting ≥ 15 seconds but < 2 minutes
- When associated with contractions,
 - May vary in onset, depth, and duration from contraction to contraction

Variable Deceleration

- Cord compression: Most common deceleration in labor
- Associated with
 - Nuchal cord or short cord or body entanglement
 - Umbilical cord prolapse
 - Rapid fetal descent
 - Oligohydramnios
 - Cord abnormalities (knot, decreased Wharton's jelly)

Prolonged Decelerations

- Decrease of ≥ 15 bpm from baseline
 - Duration of ≥ 2 minutes but < 10 minutes
 - Change of baseline: duration of ≥ 10 minutes
- Gradual or abrupt onset

Prolonged Deceleration

- Associated with
 - Rapid fetal descent
 - Prolonged cord compression
 - Vagal stimulation after vaginal exam or FSE placement
 - Oligohydramnios
 - Decreased Wharton's Jelly
 - Maternal event: hypotension, seizure

Significant Decelerations

- “Significant metabolic acidemia cannot be excluded. Further, these deceleration patterns signify the presence of physiologic stresses that increase the risk of developing such acidemia. “
- Variable decelerations lasting >60 seconds reaching a nadir of > 60 bpm below the baseline
- Variable decelerations lasting >60 seconds reaching a nadir <60 bpm regardless of baseline
- Any late decelerations of any depth
- Any prolonged deceleration

REASSURING AND NONREASSURING NOT DEFINED BY NICHD!

- **Dictionary: Reassuring**
 - Say or do something: Remove doubts and fears of someone
 - To restore to assurance or confidence
 - To assure anew
- **Dictionary: Non-reassuring**
 - Not reassuring
 - Giving cause for concern
 - Chaldean and Pythagorean Numerology: value 3

FHR Characteristic	NE	No NE	aOR ^b (95% CI)	p
Tachycardia	18 (16.2)	31 (11.7)	1.40 (0.68-2.89)	0.36
Bradycardia	8 (7.2)	2 (0.8)	3.45 (0.52-22.65)	0.20
Minimal/absent variability	54 (48.7)	38 (14.3)	5.11 (2.74-9.54)	<0.01
Recurrent variable decelerations	56 (50.5)	133 (50.2)	0.77 (0.45-1.30)	0.32
Severe variable decelerations	35 (31.5)	49 (18.5)	1.82 (1.00-3.13)	0.05
Any late decelerations	59 (95.2)	88 (80.0)	2.66 (1.56-4.54)	<0.01
Recurrent late decelerations	29 (26.1)	31 (11.7)	1.86 (0.93-3.69)	0.08
Prolonged decelerations	45 (40.5)	57 (21.5)	2.14 (1.22-3.75)	<0.01

^aData presented as n (%)

^bModeled in separate regressions and adjusted for maternal age, weight, insurance status, and FHR category

I

Baseline: 110-160

Moderate Variability

Accelerations and/or Early Decelerations May Be Present

Absent Variable, Late, and Prolonged Deceleration

II

Everything else

III

Absent variability with either recurrent late or variable decelerations

Absent variability with bradycardia

Sinusal pattern

I

Normal

Strongly predictive of normal acid-base status at time of observation

II

Indeterminate

Not predictive of abnormal acid-base status but inadequate evidence to classify as Category I or III

III

Abnormal

Associated with abnormal acid-base status at time of observation

Uterine Activity Terminology

- Frequency: Beginning of contraction to beginning of next one
- Duration: Length of contraction from beginning to end
 - Measured in seconds
- Strength / Intensity: Assessed via palpation or mmHg
 - Montevideo units
- Resting Tone: Intrauterine pressure when uterus is not contracting
 - Assessed via palpation or mmHg
- Relaxation time: Time from end of contraction to beginning of next

Assessment of Uterine Activity

- Quantified as the number of contractions present in 10 minutes
 - Averaged over 30 minutes
- Frequency alone is a partial assessment
 - Duration, intensity, relaxation time, resting tone
- Terminology
 - Normal: 5 contractions or less in 10 minutes
 - Tachysystole (not hyperstimulation or hypercontractility)
 - > 5 contractions in 10 minutes

Resting Tone and Relaxation Time

- Resting tone
 - Normal: Maintains adequate fetal oxygenation
 - Normal: < 20-25 mg
 - Hypertonus
- Relaxation time to ensure adequate O_2 and CO_2 exchange
 - First stage: 60 seconds
 - Second stage: ~45 seconds

Tachysystole >5 contractions in 10 minutes
Averaged over 30 minutes

Constriction of spiral arterioles and ↓ blood
flow in intervillous space

Risk for fetal
hypoxemia

Metabolic acidemia

Tachysystole

- Known complication of induction/augmentation
- Spontaneous tachysystole
 - Intrauterine infection (bacterial “irritation” of myometrium)
 - Placental abruption (prostaglandins activated)
 - Cocaine
 - Norepinephrine/catecholamines related to maternal anxiety
 - Uterine leiomyoma

EFM Standardization

- What do I call it?
 - Standardized NICHD terminology & categories
- What does it mean?
 - Standardized principles of interpretation
- What do I do about it?
 - Standardized management using a simple questions designed to ↓ risk of error
 - Based on EFM's strength: NPV related to metabolic acidemia

Why Can't We Provide Care Right All The Time Every Time ?

- Distractions
 - Personal or Unit
- Stress
- Fatigue
- Memory lapses
- Brain “freeze”
- Inadequate training
- Inadequate experience



Environment

Lungs

Heart

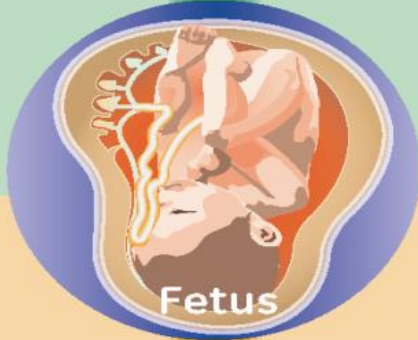
Vasculature

Uterus

Placenta

Cord

Oxygen
Pathway



Fetus

Hypoxemia

Hypoxia

Metabolic acidosis

Metabolic acidemia

Fetal
Response

Potential
Injury

Fetal oxygenation involves the transfer of oxygen from the environment to the fetus...

And the subsequent fetal physiologic response if oxygen transfer is interrupted...

PATHWAY	ETIOLOGY
Lungs	Airway and breathing Respiratory depression, asthma, cystic fibrosis
Heart	Heart rate and rhythm SVT, bradycardia after seizure
Vasculature	Blood pressure and volume status Severe pre-e, hypovolemia, dehydration
Uterus	Contraction strength, frequency, intensity resting tone Tachysystole
Placenta	Placental separation Abruptio, vasa previa
Umbilical Cord	Cord compression Cord prolapse, cord entanglement

Environment

Lungs

Heart

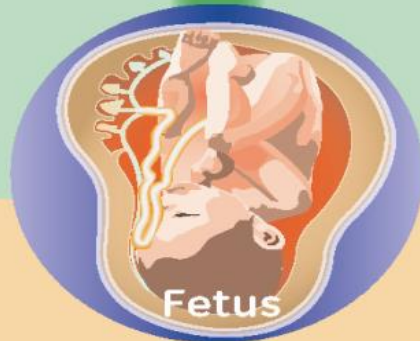
Vasculature

Uterus

Placenta

Cord

Oxygen
Pathway



Fetal
Response

Hypoxemia

Hypoxia

Metabolic acidosis

Metabolic acidemia

Potential
Injury

What information does the FHR tracing provide regarding oxygen transfer?

Head Compression

Cord Compression

Uteroplacental insufficiency

Environment

Lungs

Heart

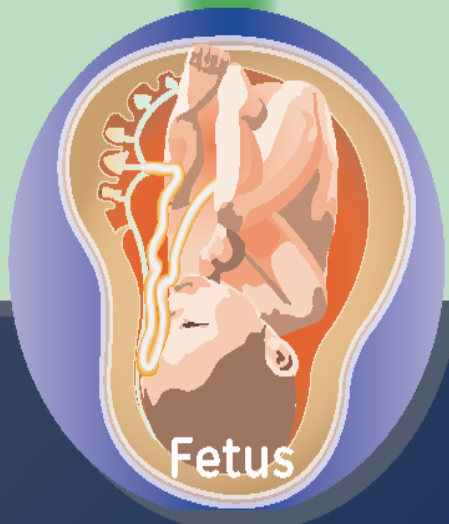
Vasculature

Uterus

Placenta

Cord

Oxygen
Pathway



All clinically significant FHR decelerations **HAVE EXACTLY THE SAME TRIGGER...**

Interruption of oxygen transfer from the environment to the fetus at one or more points along the oxygen pathway

So, when we see a late, variable, or prolonged deceleration, we can agree that the oxygen pathway has been interrupted at one or more points...

Environment

Lungs

Heart

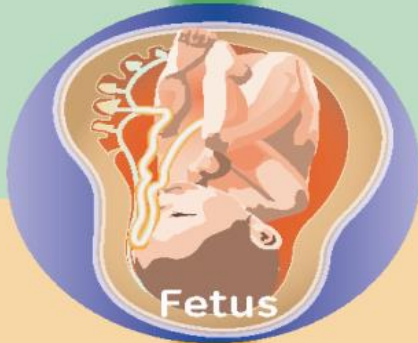
Vasculature

Uterus

Placenta

Cord

Oxygen
Pathway



Fetus

Fetal

Response

Hypoxemia

Hypoxia

Metabolic acidosis

Metabolic acidemia

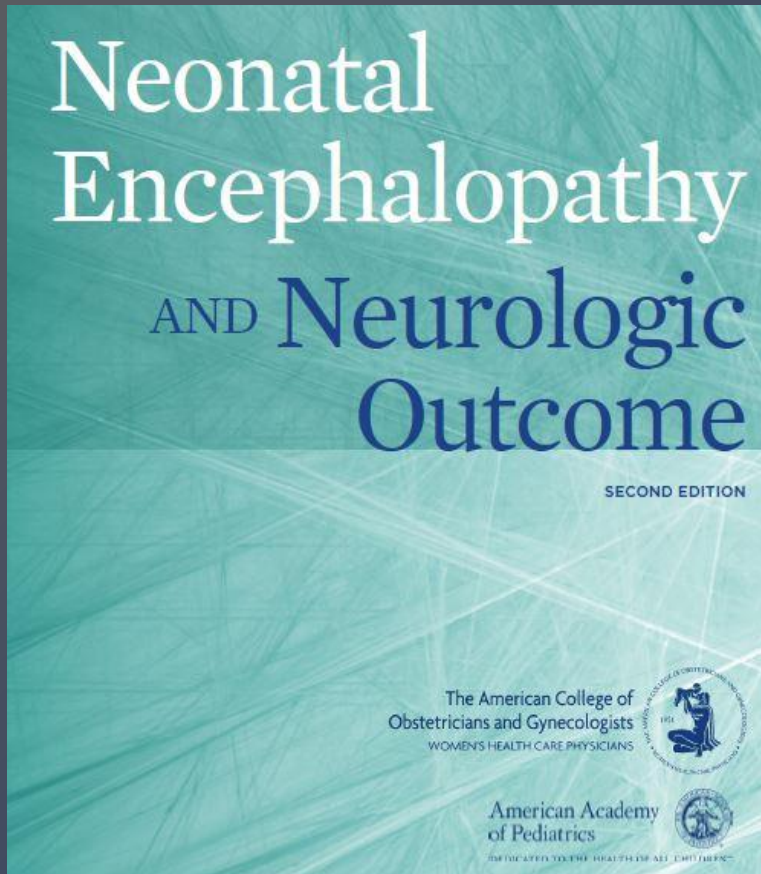
Potential
Injury

Principle #1

Variable, late or prolonged decelerations signal interruption of the oxygen pathway at one or more points

Principle #2

Moderate variability or accelerations exclude ongoing hypoxic injury



“In a fetus exhibiting either moderate variability or accelerations of the FHR, damaging degrees of hypoxia-induced metabolic acidemia can reliably be excluded”

EXCEPT : The converse is not true:

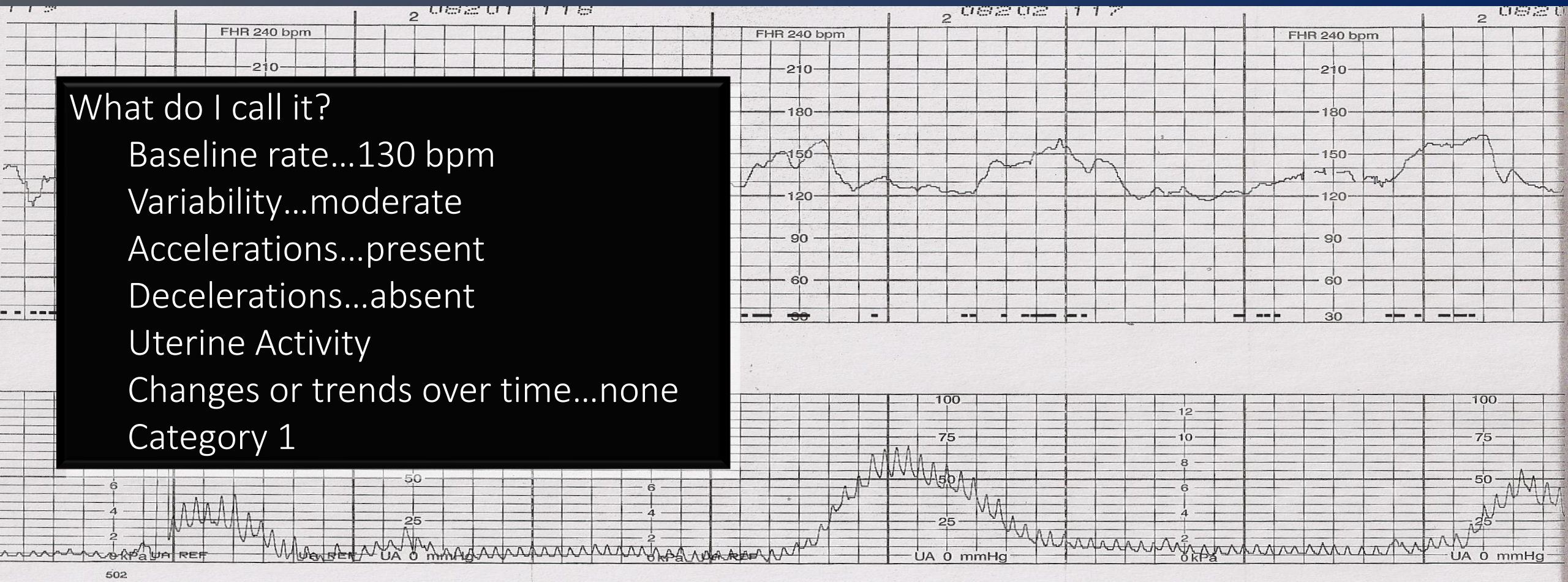
Minimal-absent variability **DOES NOT** reliably predict *the presence* of hypoxic injury

Absence of accelerations **DOES NOT** reliably predict *the presence* of hypoxic injury

One end of the FHR spectrum

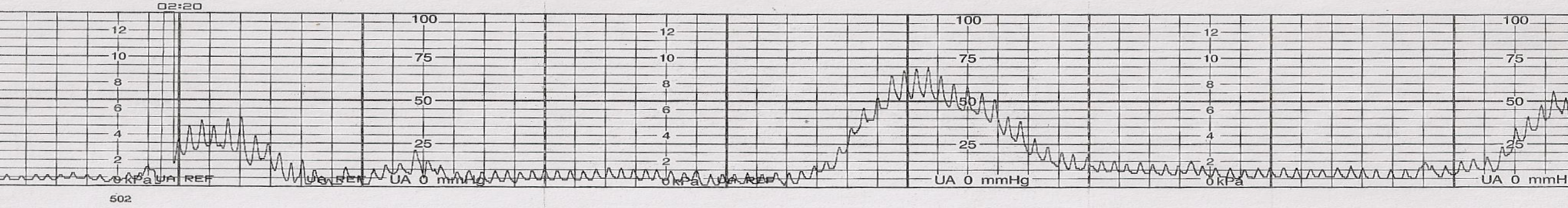
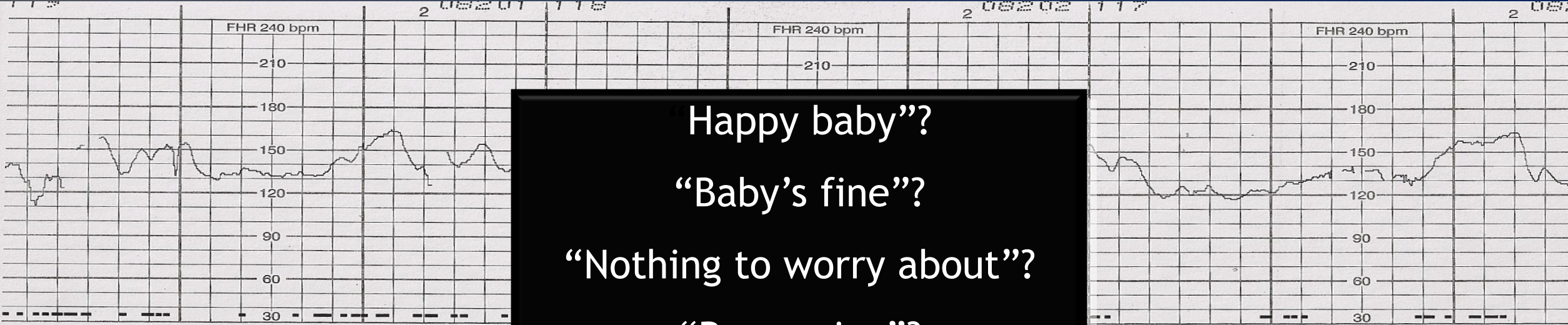
1. Definitions
2. Interpretation
3. Management

What do I call it?
Baseline rate...130 bpm
Variability...moderate
Accelerations...present
Decelerations...absent
Uterine Activity
Changes or trends over time...none
Category 1



What does it mean?

Happy baby”?
“Baby’s fine”?
“Nothing to worry about”?
“Reassuring”?



What does it mean?

Two Principles of Fetal Heart Rate interpretation

Environment

Lungs
Heart
Vasculature
Uterus
Placenta
Cord

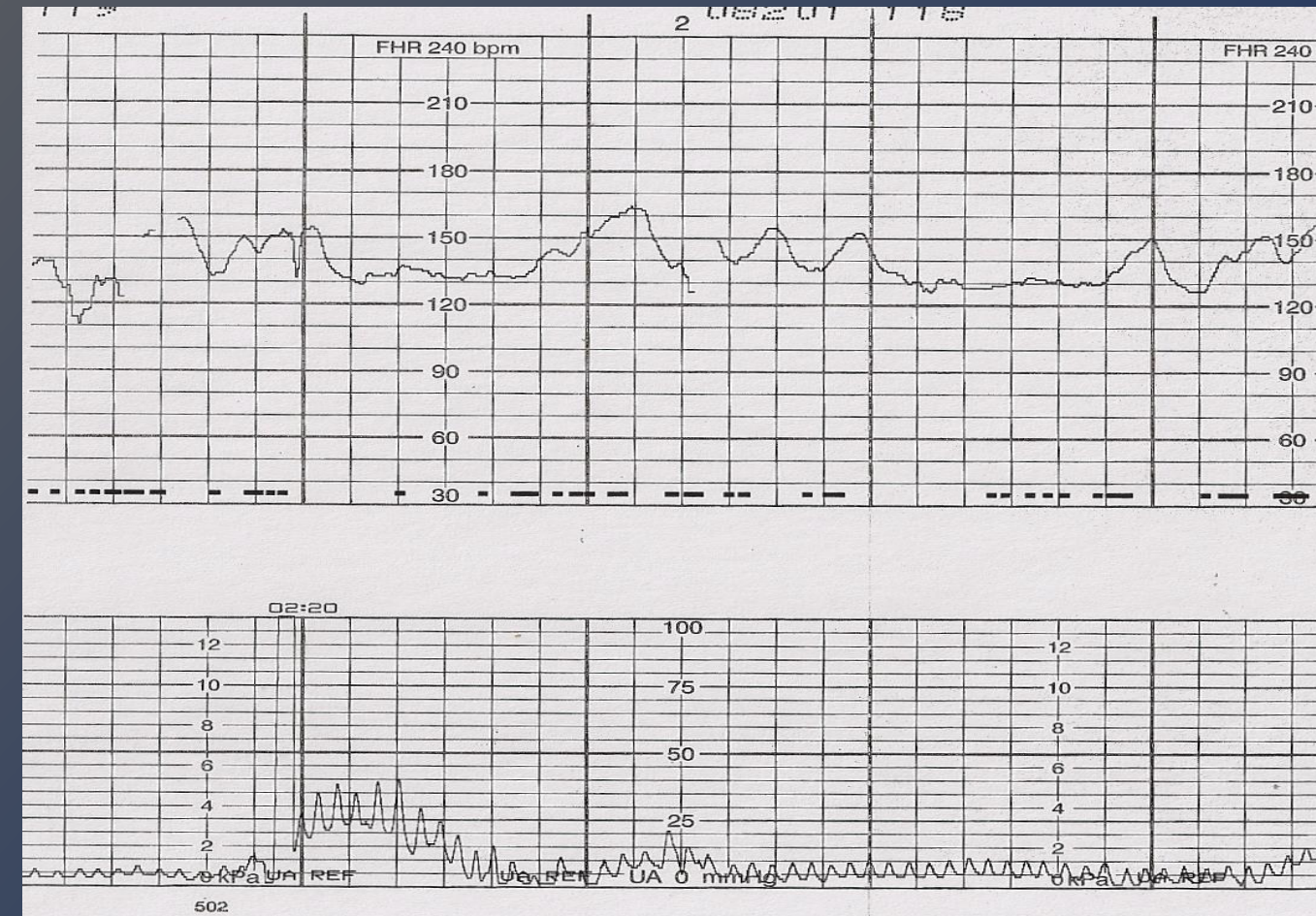
1. Decelerations (late, variable or prolonged) signal interruption of the oxygen pathway at one or more points

Fetus

Hypoxemia
Hypoxia
Metabolic acidosis
Metabolic acidemia

2. Moderate variability or accelerations exclude hypoxic neurologic injury

Potential Injury



FHR 240 bpm

FHR 240 bpm

The middle of the FHR spectrum

- 1. Definitions
- 2. Interpretation
- 3. Management

What do I call it?

Baseline rate...150 bpm

Variability...moderate

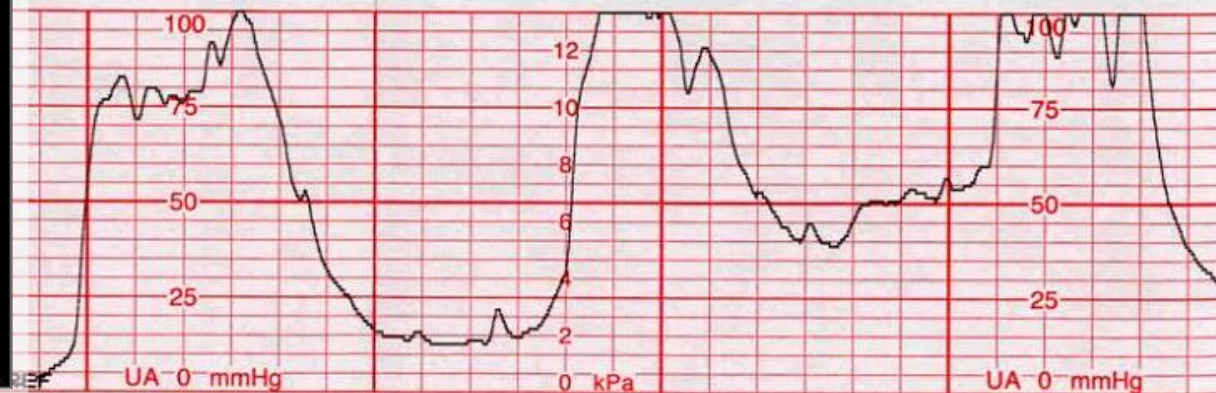
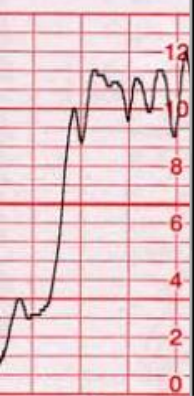
Accelerations...absent

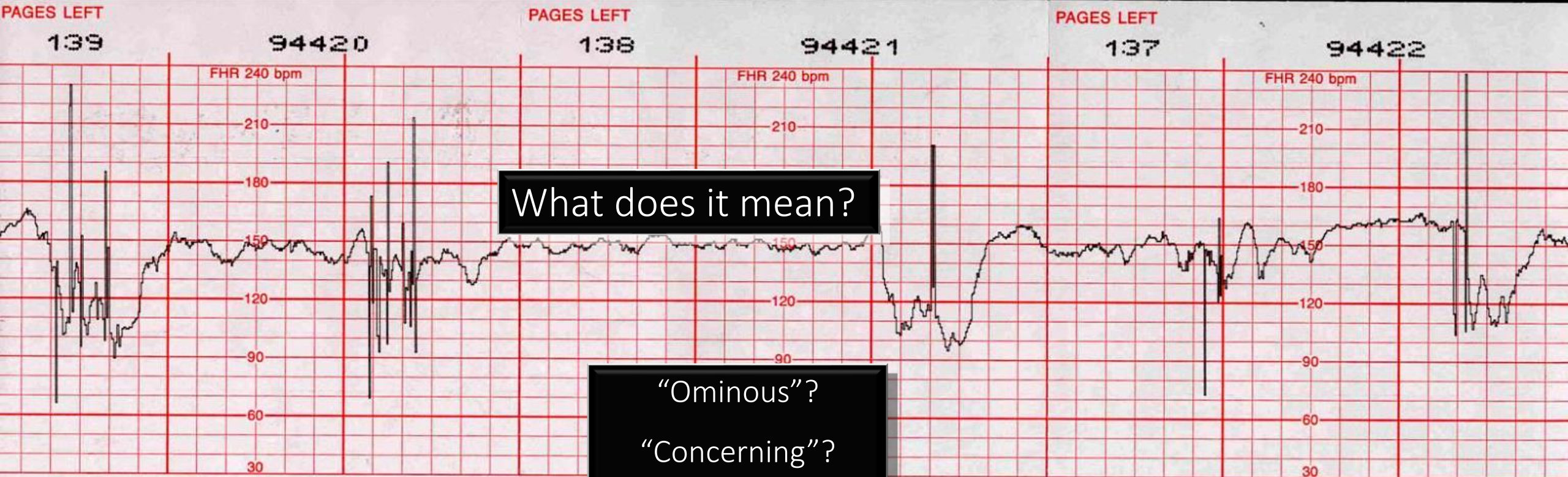
Decelerations...present

Uterine Activity

Changes or trends...yes

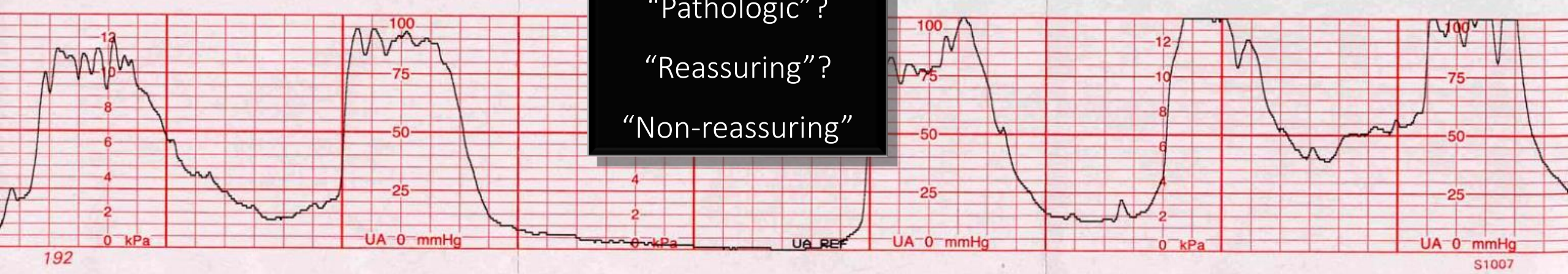
Category 2





What does it mean?

- “Ominous”?
- “Concerning”?
- “Problematic”?
- “Pathologic”?
- “Reassuring”?
- “Non-reassuring”

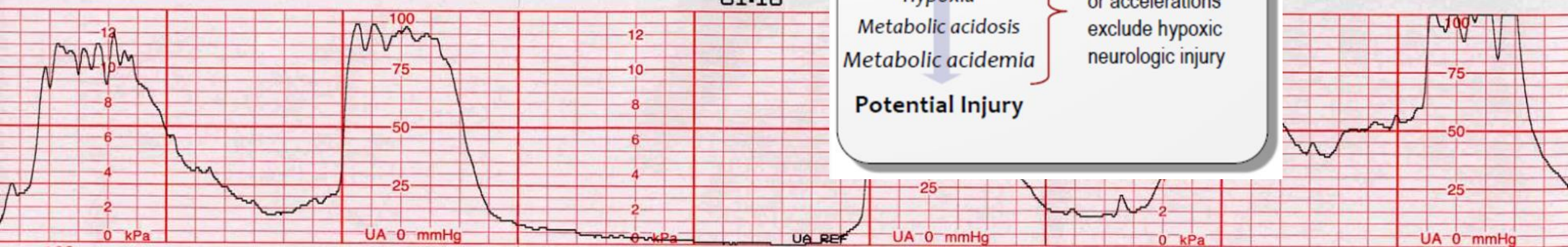
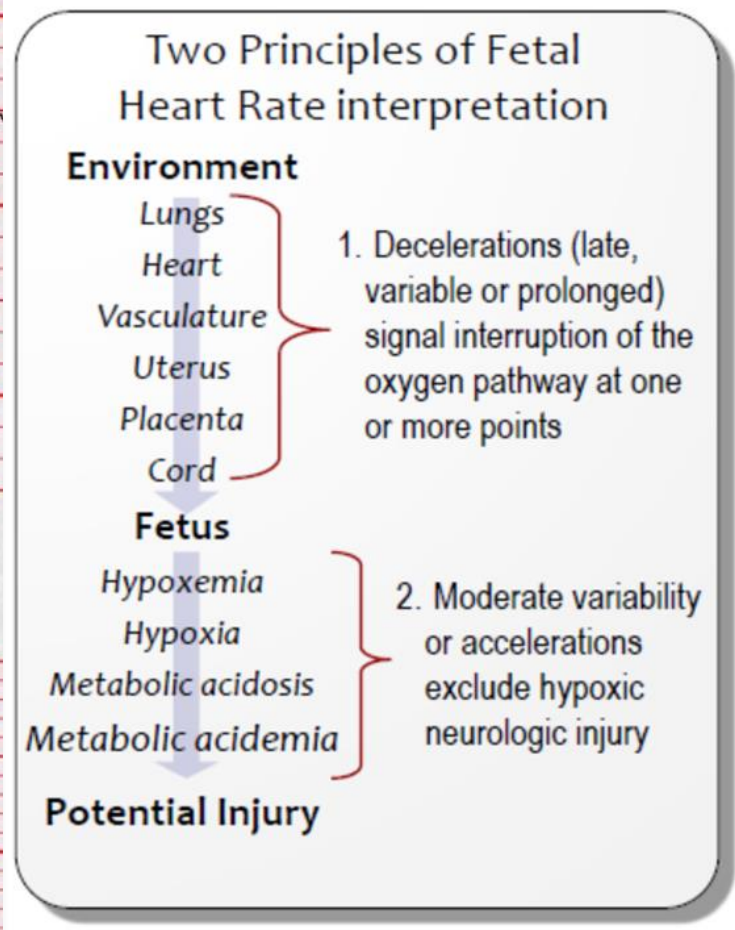


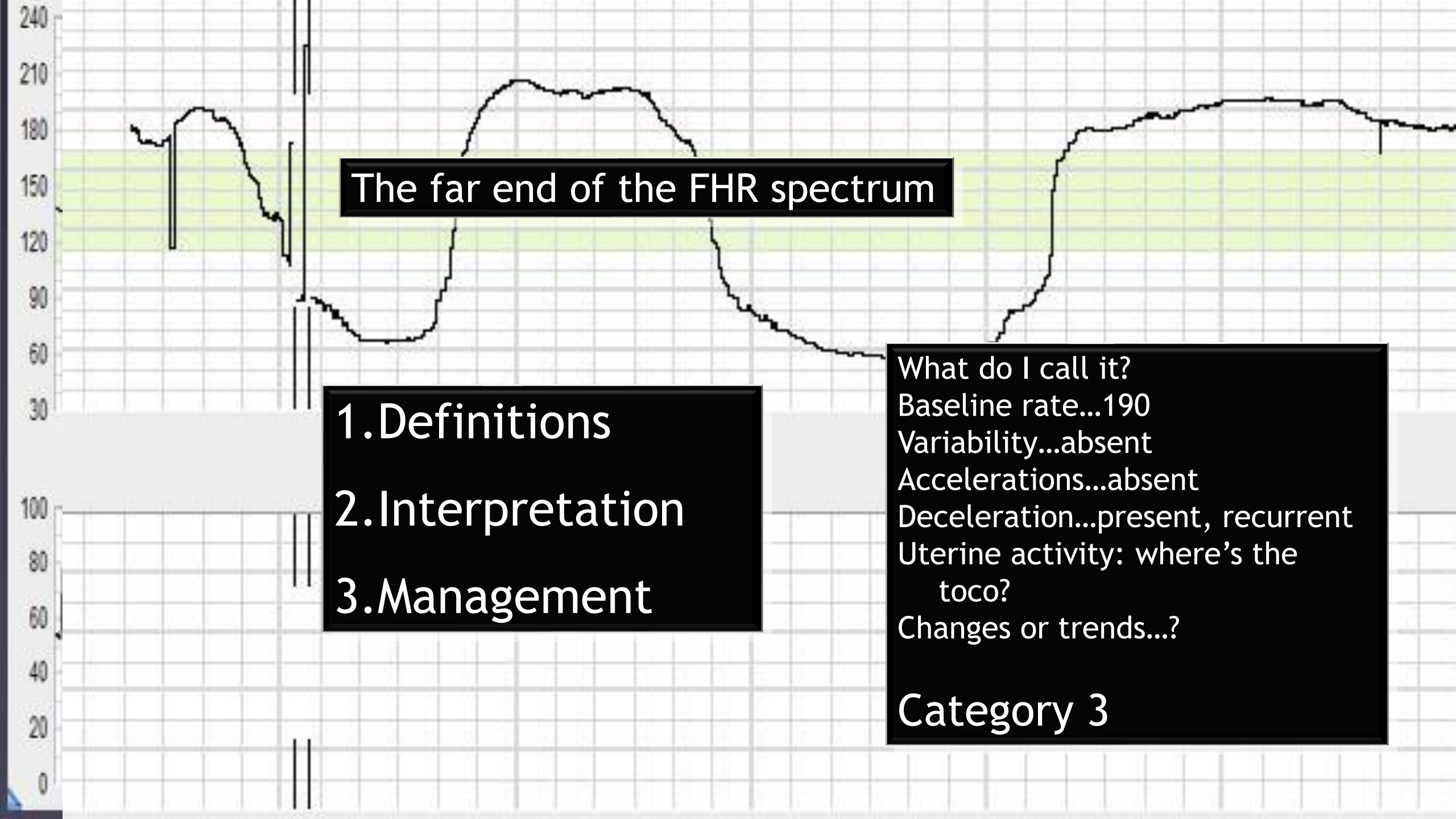
FHR 240 bpm

FHR 240 bpm

FHR 240 bpm

What does it mean?





The far end of the FHR spectrum

- 1. Definitions
- 2. Interpretation
- 3. Management

What do I call it?
Baseline rate...190
Variability...absent
Accelerations...absent
Deceleration...present, recurrent
Uterine activity: where's the toco?
Changes or trends...?

Category 3

What does it mean?



↑
C
↓

“Ominous”?

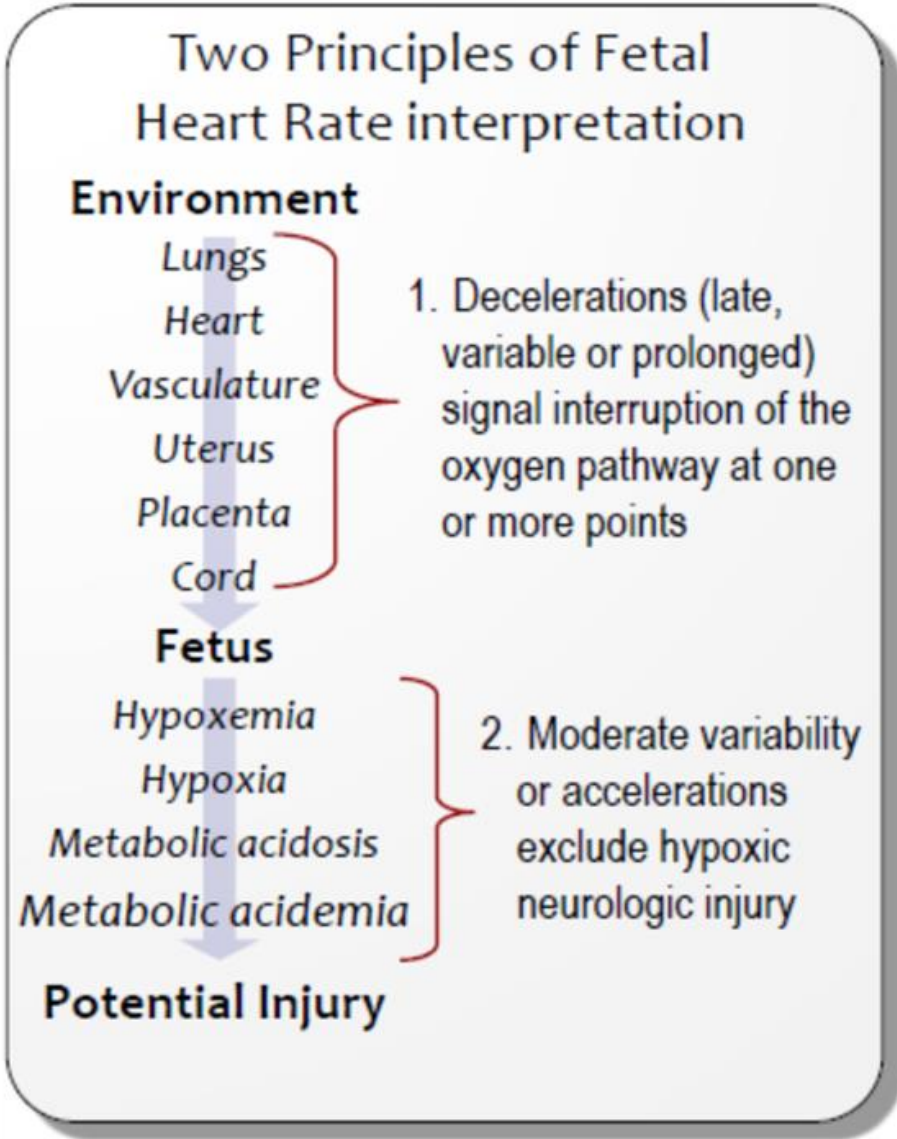
“It’s time to get a real doctor in here”

“Problematic”?

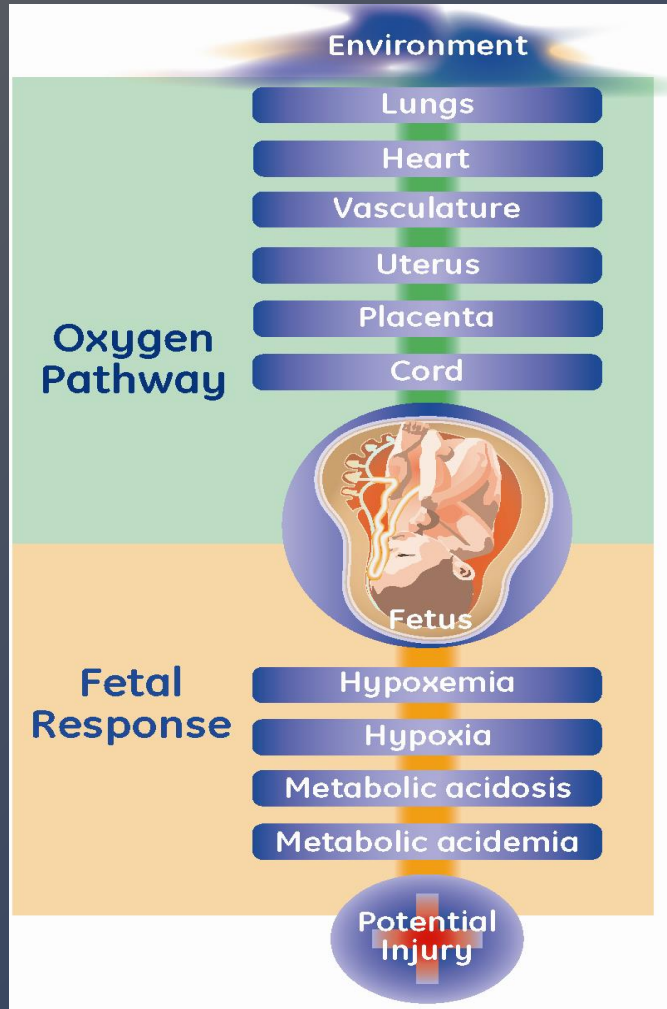
“The lights of the nursery are in your future”

“Non-reassuring”

What does it mean?



A Standardized Intrapartum FHR Management Model



Four Central Concepts: “ABCD”

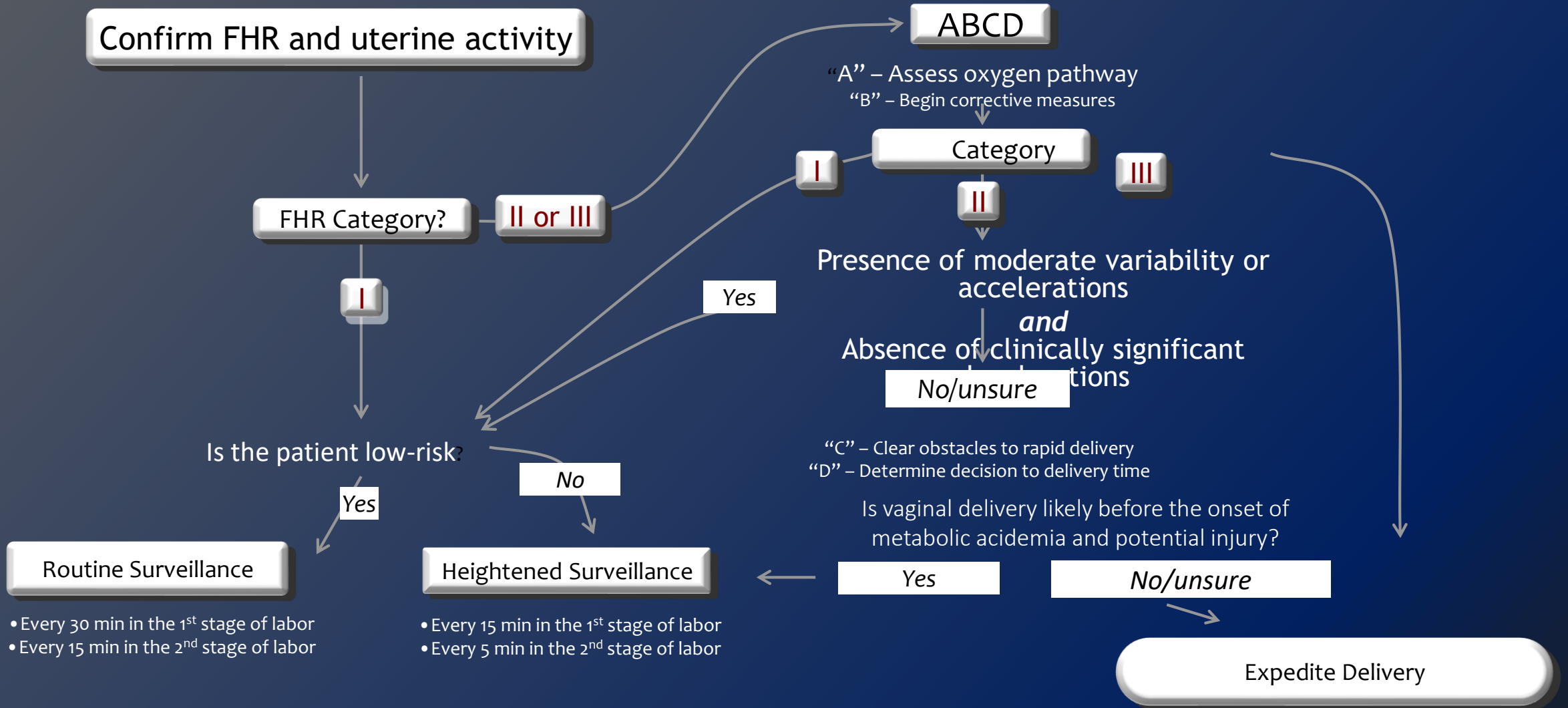
A - Assess the oxygen pathway and review differentials

B - Begin conservative corrective measures

C - Clear for delivery

D - Decision to delivery time

Intrapartum Fetal Heart Rate Management Decision Model



Confirm Fetal Heart Rate and Uterine Activity



“B” Begin Corrective Measures

- ✓ Maternal repositioning
- ✓ IV fluid bolus
- ✓ Oxygen administration
- ✓ Correct hypotension
- ✓ Decrease uterine activity
- ✓ Amnioinfusion
- ✓ Tocolytic administration
- ✓ Alteration in 2nd stage pushing technique



AWHONN Physiologic Goals

- Support maternal coping and labor progress
- Maximize uterine blood flow
- Maximize umbilical circulation
- Maximize oxygenation
- Maintain appropriate uterine activity



“Now what do you do with all this information?”

- “Standardized management” : minimize the opportunities for preventable error
- Even the best scenarios for practice cannot prevent all poor outcomes
 - Obstetric TEAM must be able to articulate action’s rationale in order to defend clinical practice



If a tracing remains in Category II after conservative corrective measures, how do you decide whether it is safe to continue labor?

Why not exclude metabolic acidemia?
(moderate variability and/or accelerations)

And exclude significant interruption of oxygenation?
(no significant decelerations)



If you have *any question*...the safest approach is to proceed to the next step...

In an alphabetical management plan, the next immediate step after “B” is

Clear Obstacles to Rapid Delivery

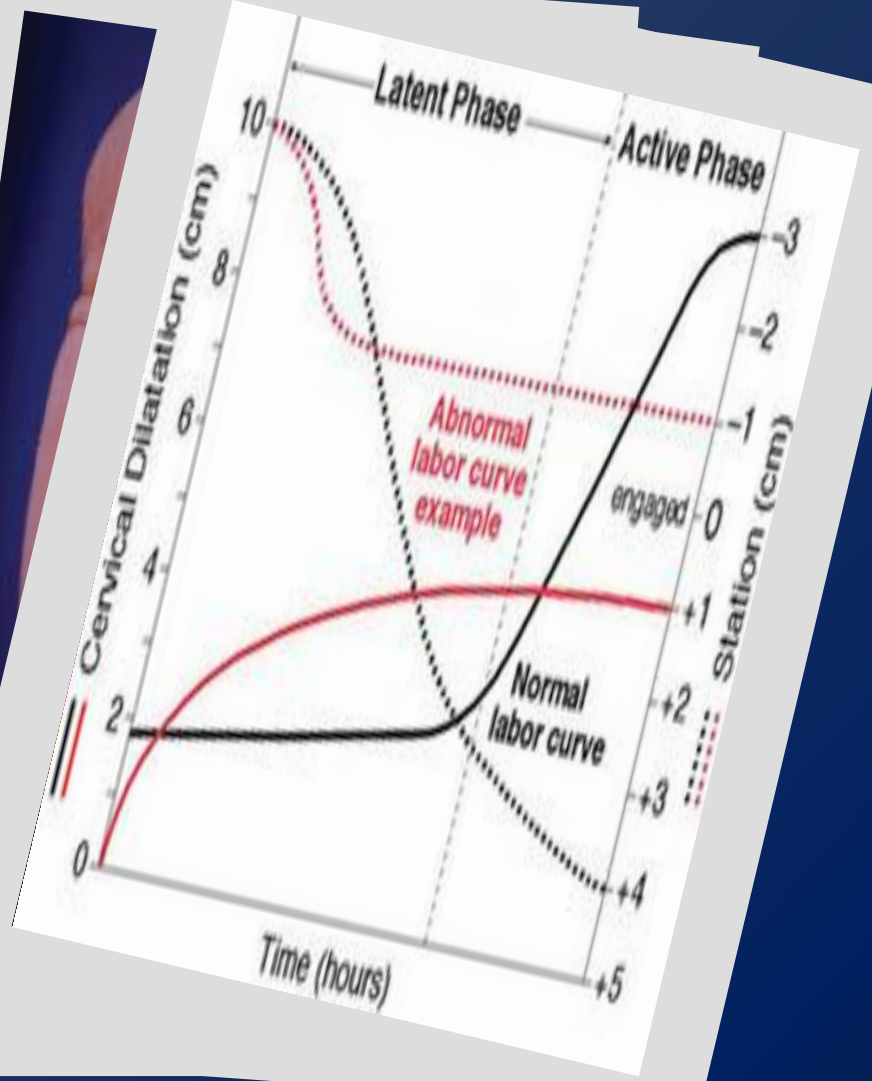
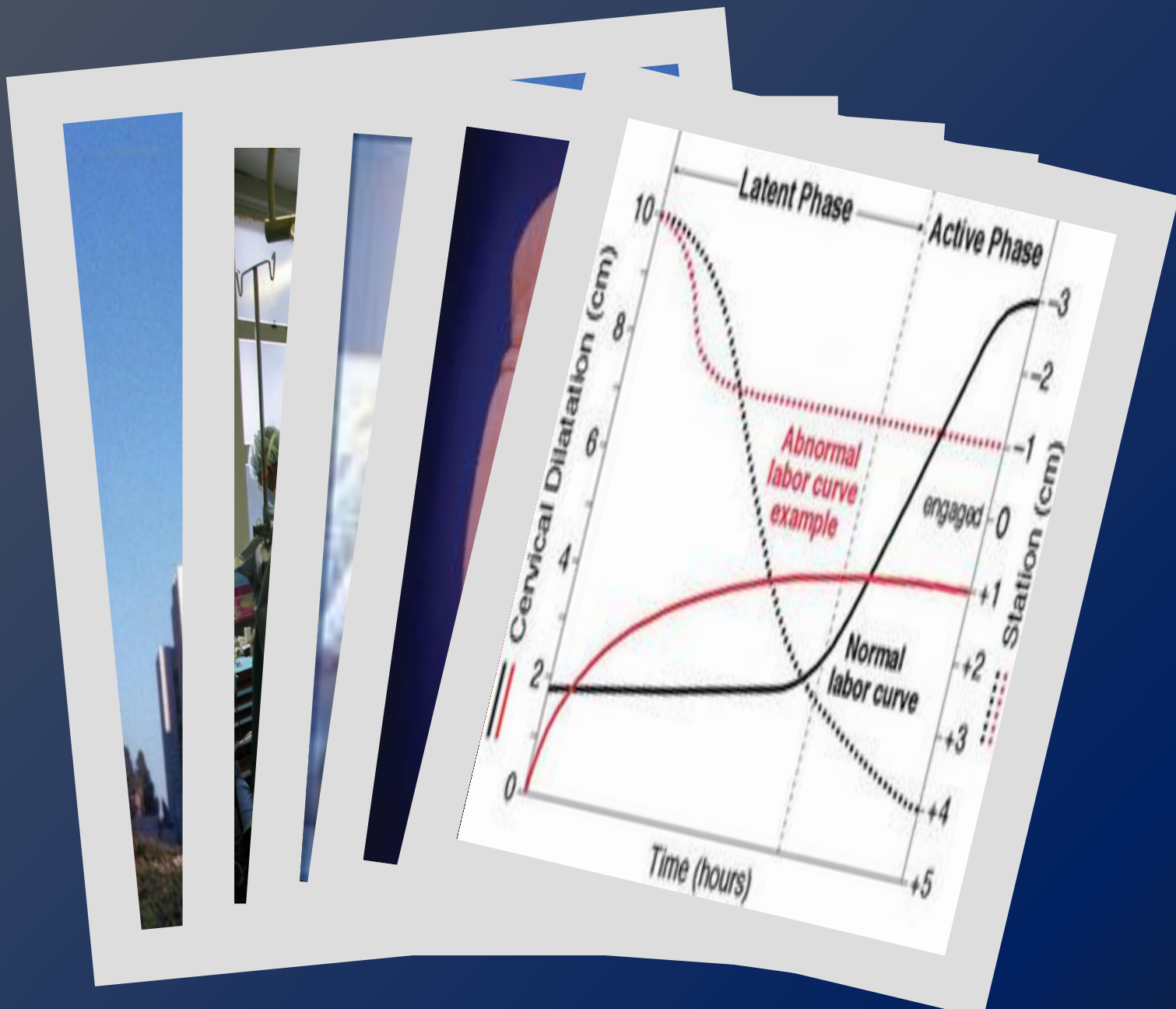
If conservative measures do not correct FHR tracing, it's prudent to plan ahead for a possible need for rapid delivery

*This does **NOT** commit the patient to delivery*

It simply identifies common sources of unnecessary delay in a systematic way so they can be addressed in timely fashion

By doing this, it demonstrates reasonableness and prudence...two elements that define the standard of care

Facility
Staff
Mother
Fetus
Labor





“D”- Determine decision to delivery time



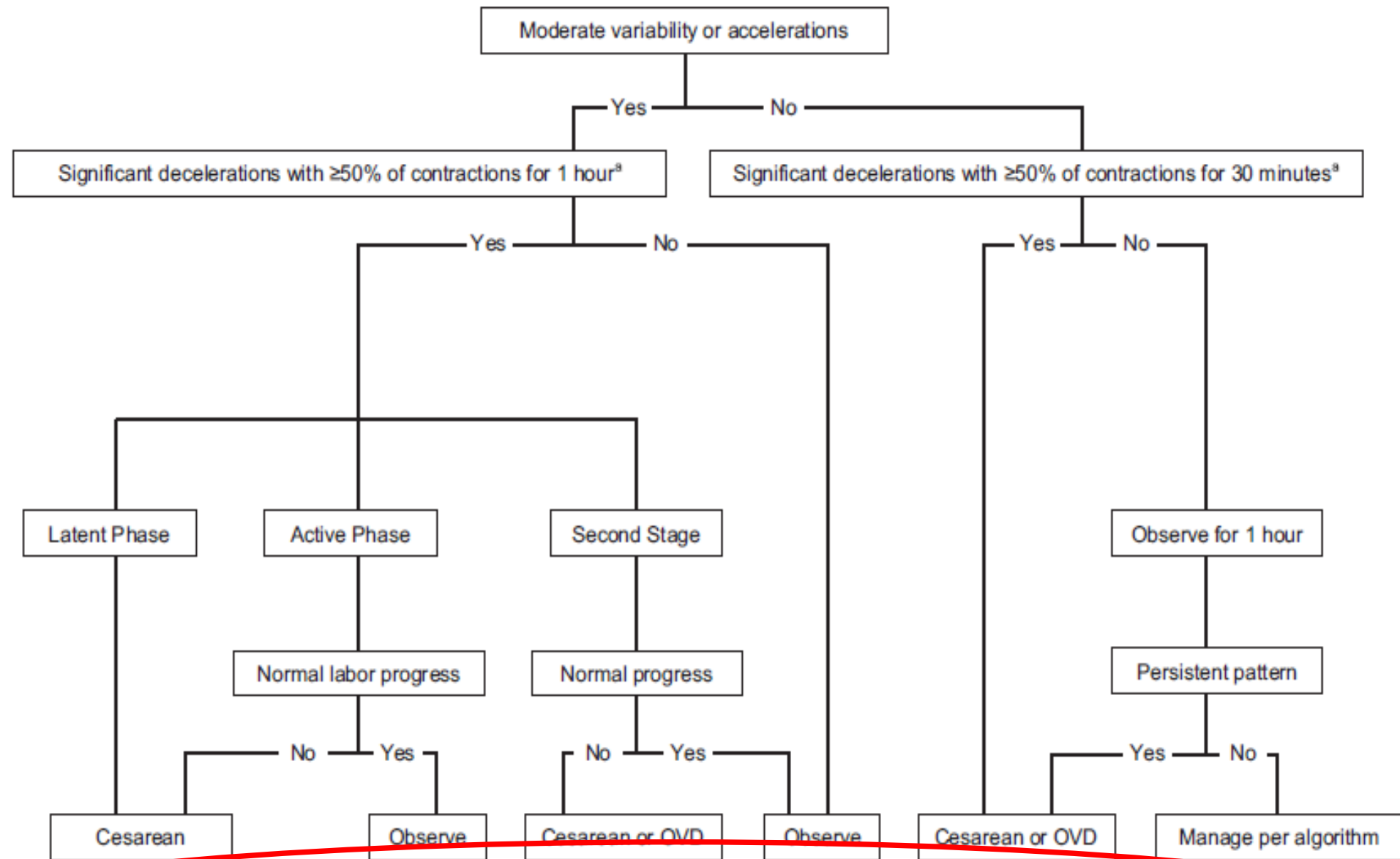
Is vaginal delivery likely before the onset of metabolic acidemia and potential injury?

USE INDIVIDUAL CLINICAL JUDGMENT TO ESTIMATE Time until the onset of metabolic acidemia

What is too long?



Algorithm for management of category II fetal heart rate tracings

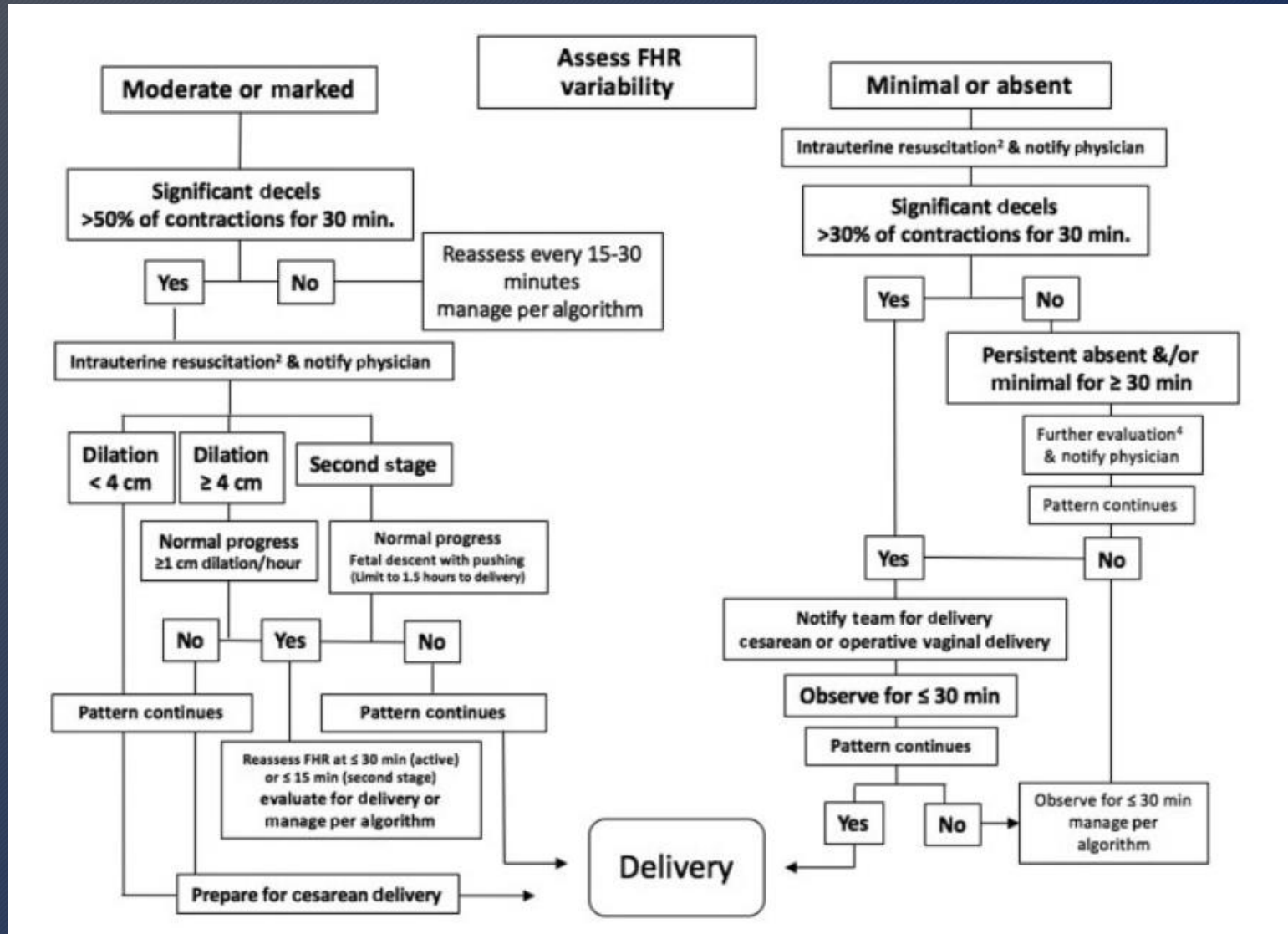


OVD, operative vaginal delivery.

^aThat have not resolved with appropriate conservative corrective measures, which may include supplemental oxygen, maternal position changes, intravenous fluid administration, correction of hypotension, reduction or discontinuation of uterine stimulation, administration of uterine relaxant, amnioinfusion, and/or changes in second stage breathing and pushing techniques.

Clark. Category II FHR. Am J Obstet Gynecol 2013.

Significant Decelerations



Trial Hospital (6)	Pre Oct 2015-March 2016	Post April 2016-Feb 2017	Non-Trial Hospital (23)	Pre	Post
Total Births	5,208	9,974	Total Births	19,363	46,839
Repeat CD	737	1,459	Repeat CD	2,885	6,933
Eligible	4,471	8,515	Eligible	16,478	39,906
Primary CD -1.5% <i>p</i> < 0.05	884/4,471 19.8%	1,562/8,515 18.3%	Primary CD -0.8% <i>P</i> = 0.02	3,136/16,478 19%	7,259/39,906 18.2%
VD 1.2% <i>P</i> = 0.13	3,334/4,471 74.6%	6,451/8,515 75.8%	VD 1.3% <i>P</i> = 0.02	12,296/16,478 74.6%	30,305/39,906 75.9%
Operative VD 0.2% <i>P</i> = 0.6	253/4,471 5.7%	502/8,515 5.9%	Operative VD -0.4% <i>P</i> = .02	1,045/16,478 6.3%	2,342/39,906 5.9%

Trial Hospital (6)	Pre	Post	Non-Trial (23)	Pre	Post
5-min Apgar <7 -24.6% P <0.05	102/4,471 1 2.2%	146/8,515 1.7%	5-min Apgar <7 +5.8% P = 0.08	2,554/16,478 8 1.55%	6,545/39,906 1.6%
5-min Apgar <5 -26.4% P = 0.11	474/4,471 1 1.1%	66/8,515 0.78%	5-min Apgar <5 +12.0% P = 0.01	1,236/16,478 8 0.53%	227/39,906 0.57%
5-min Apgar <3 0% P = 0.9	25/4,471 0.57%	49/8,515 0.57%	5-min Apgar <3 +7.5% P = 0.6	87/16,478 0.53%	227/39,906 0.57%
<i>Severe UNC</i> UNC: Unexplained Newborn Complications (severe respiratory complications, sepsis, birth trauma, neonatal shock, neuro injury) -27.2% P <0.04	71/4,471 1.6%	98/8,515 1.2%	<i>Severe UNC</i> -6.7% P = 0.4	247/16,478 1.5%	559/39,906 1.4%

Even with algorithms and expert consensus, delivery decisions can may be challenging for the entire OB team

No matter what the decision, nothing will guarantee a good outcome

But having a less than perfect outcome despite a well-thought out plan is not necessarily unreasonable

It is much more difficult to convince someone that our actions were reasonable *if we neglect to make a plan*, meaning if we fail to make a decision at a critical point

	“A” Assess Oxygen Pathway	“B” Begin Corrective Measures <i>if Indicated</i>		“C” Clear Obstacles to Rapid Delivery	“D” Determine Decision to Delivery Time
Lungs	Airway and breathing	Supplemental oxygen	Facility	OR availability Equipment	Facility response time
Heart	Heart rate and rhythm	Position changes Fluid bolus Correct hypotension	Staff	Notify <i>Obstetrician</i> <i>Surgical assistant</i> <i>Anesthesiologist</i> <i>Neonatologist</i> <i>Pediatrician</i> <i>Nursing staff</i>	Consider staff: Availability Training Experience
Vasculature	Blood pressure Volume status		Mother	Informed consent Anesthesia options Laboratory tests Blood products Intravenous access Urinary catheter Abdominal prep Transfer to OR	Surgical considerations (<i>prior abdominal or uterine surgery</i>) Medical considerations (<i>obesity, hypertension, diabetes, SLE</i>) Obstetric considerations (<i>parity, pelvimetry, placental location</i>)
Uterus	Contraction strength Contraction frequency Baseline uterine tone Exclude uterine rupture	Stop or reduce stimulant Consider uterine relaxant	Fetus	Confirm <i>Estimated fetal weight</i> <i>Gestational age</i> <i>Presentation</i> <i>Position</i>	Consider factors such as: <i>Estimated fetal weight</i> <i>Gestational age</i> <i>Presentation</i> <i>Position</i>
Placenta	Placental separation Bleeding vasa previa				
Cord	Vaginal exam Exclude cord prolapse	Consider amnioinfusion	Labor	Consider IUPC	Consider factors such as: <i>Arrest disorder</i> <i>Protracted labor</i> <i>Remote from delivery</i> <i>Poor expulsive efforts</i>

Lateral Positioning

- Right or left lateral
 - Changes relationship of umbilical cord, fetus and uterine wall
 - Supine associated with more changes in FHR characteristics
- Improves maternal cardiac return and cardiac output
 - Uterus positioned off vena cava or aorta
 - ↓ Risk of maternal hypotension
 - Maximizes blood flow to uterus
 - Improves fetal oxygenation
 - Improves cardiac return and output

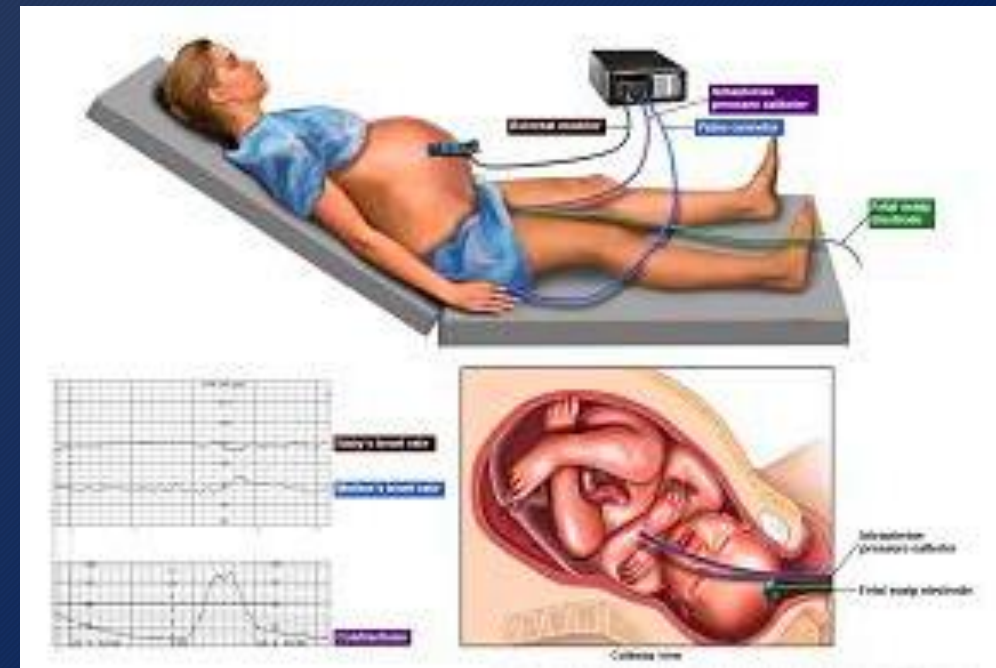
Lateral Positioning



Fetal Pulse Oximetry

- Critical threshold : 30%
- Hypoxia likely to cause metabolic acidosis

- Improves fetal oxygenation
 - Mean FSpO₂:
 - LL = 53.2%, RL - 50.5%, Supine = 46.7%



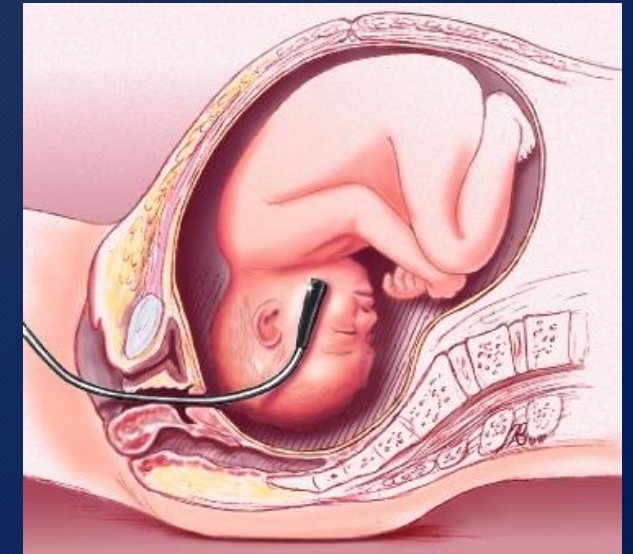
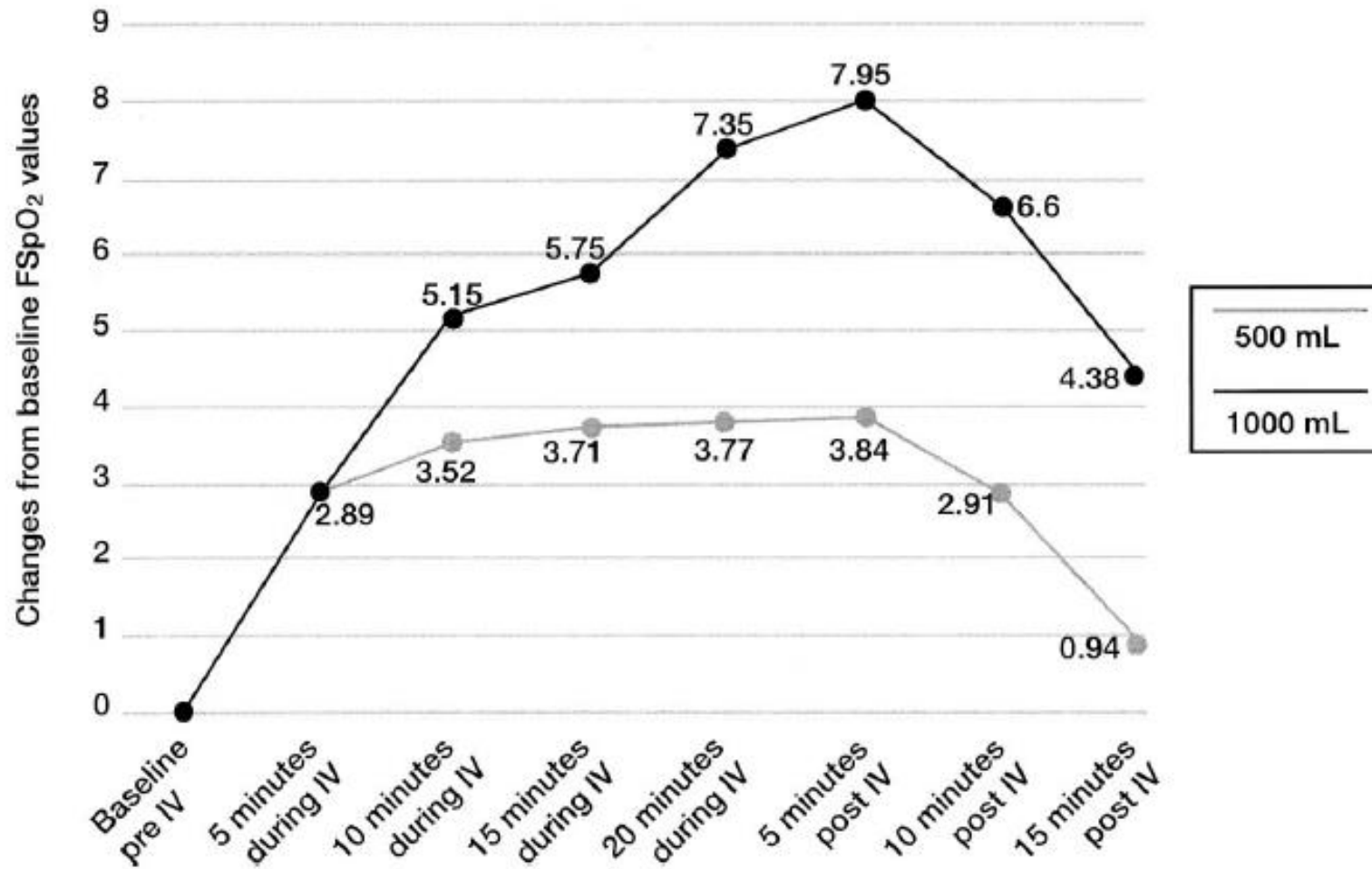


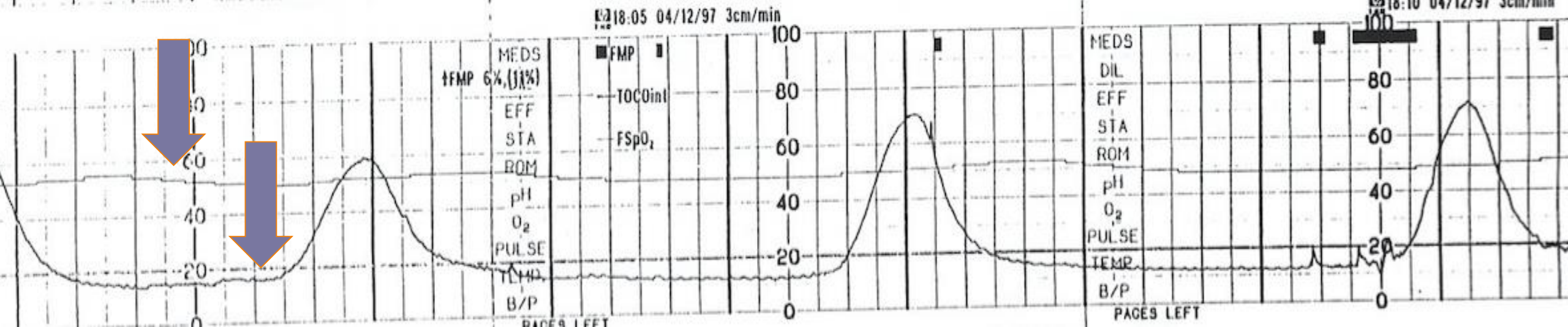
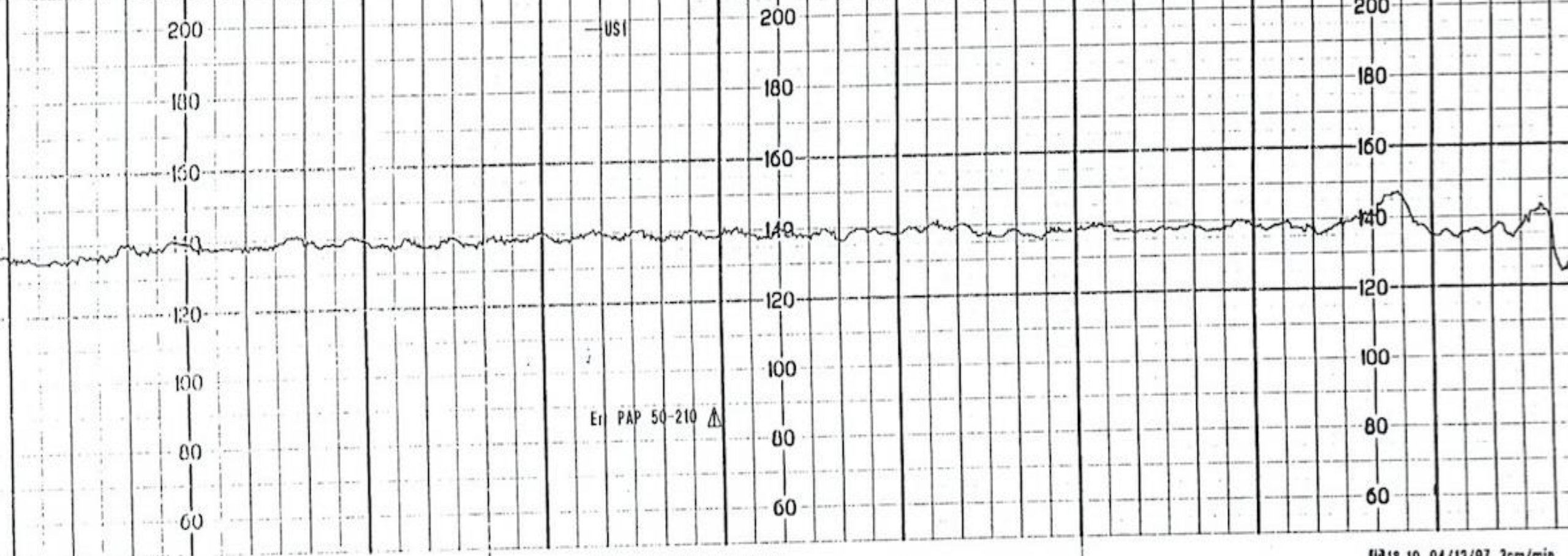
IV Fluids

- What do we give
- How much do we give
- Does it make a difference

Intravenous Fluids

- Maximizes intravascular volume which may improve uteroplacental perfusion
 - Hypotension or hypovolemia
 - 500 -1000 cc bolus LR increases FSpO₂
 - Greatest ↑ with 1000 cc bolus
 - Change continues for more than 30 minutes
- Caution with high risk patients = Pulmonary edema





Maternal pulse pressure at admission is a risk factor for fetal heart rate changes after initial dosing of a labor epidural: a retrospective cohort study

Nathaniel R. Miller, MD; Rebecca L. Cypher, MSN; Peter E. Nielsen, MD; Lisa M. Foglia, MD

OBJECTIVE: To examine low maternal admission pulse pressure (PP) as a risk factor for new onset postepidural fetal heart rate (FHR) abnormalities.

STUDY DESIGN: Retrospective cohort study of nulliparous, singleton, vertex-presenting women admitted to labor and delivery after 37 0/7 weeks that received an epidural during labor. Women with a low admission PP were compared with those with a normal admission PP. The primary outcome was new onset FHR abnormalities defined as recurrent late or prolonged FHR decelerations in the first hour after initial dosing of a labor epidural.

RESULTS: New onset FHR abnormalities, defined as recurrent late decelerations and/or prolonged decelerations, occurred in 6% of


subjects in the normal PP cohort compared with 27% in the low PP cohort (odds ratio, 5.6; 95% confidence interval, 2.1–14.3; $P < .001$). A multivariate logistic regression analysis generated an adjusted odds ratio of 28.9 (95% confidence interval, 3.7–221.4; $P < .001$).

CONCLUSION: New onset FHR abnormalities after initial labor epidural dosing occur more frequently in women with a low admission PP than those with a normal admission pulse. Admission PP appears to be a novel predictor of new onset postepidural FHR abnormalities.

Keywords: intrapartum fetal heart monitoring, obstetric anesthesia, pregnancy hemodynamics

Pulse Pressure Study Objective

- Hemodynamic parameter estimating intravascular volume
- Calculated by subtracting DBP from SBP
 - BP = 134/72: Pulse pressure = 62 mmHg
- Examine ↓ maternal pulse pressure (PP) as a risk factor for new onset post-epidural FHR abnormalities
 - ↓ PP = <45 mmHg
 - FHR abnormalities in first 60 minutes after dosing
 - Recurrent late decelerations and/or prolonged decelerations



Variable	Admission PP >45 mm Hg (n = 95)	Admission PP <45 mm Hg (n = 95)	OR (95% CI)	P value	Adjusted ^a OR	P value
Fetal heart rate abnormalities	6 (6)	26 (27)	5.6 (2.1–14.3)	< .001	28.9 (3.8–221.4)	< .001

New onset FHR abnormalities after initial labor epidural dosing occur more frequently in women with low admission PP compared to those with normal admission PP

The “So What” Factor

- Why is there a low pulse pressure?
 - Evaluate for intravascular volume reduction
 - Bleeding or dehydration
- Increase IV fluid maintenance rate
 - 125 cc/hr designed to replace loss in resting patient
 - Labor = active metabolically and physiologically
 - Consider 200-250 cc/hr in healthy patient
- Pretreat with vasoconstricting agent

Original Research

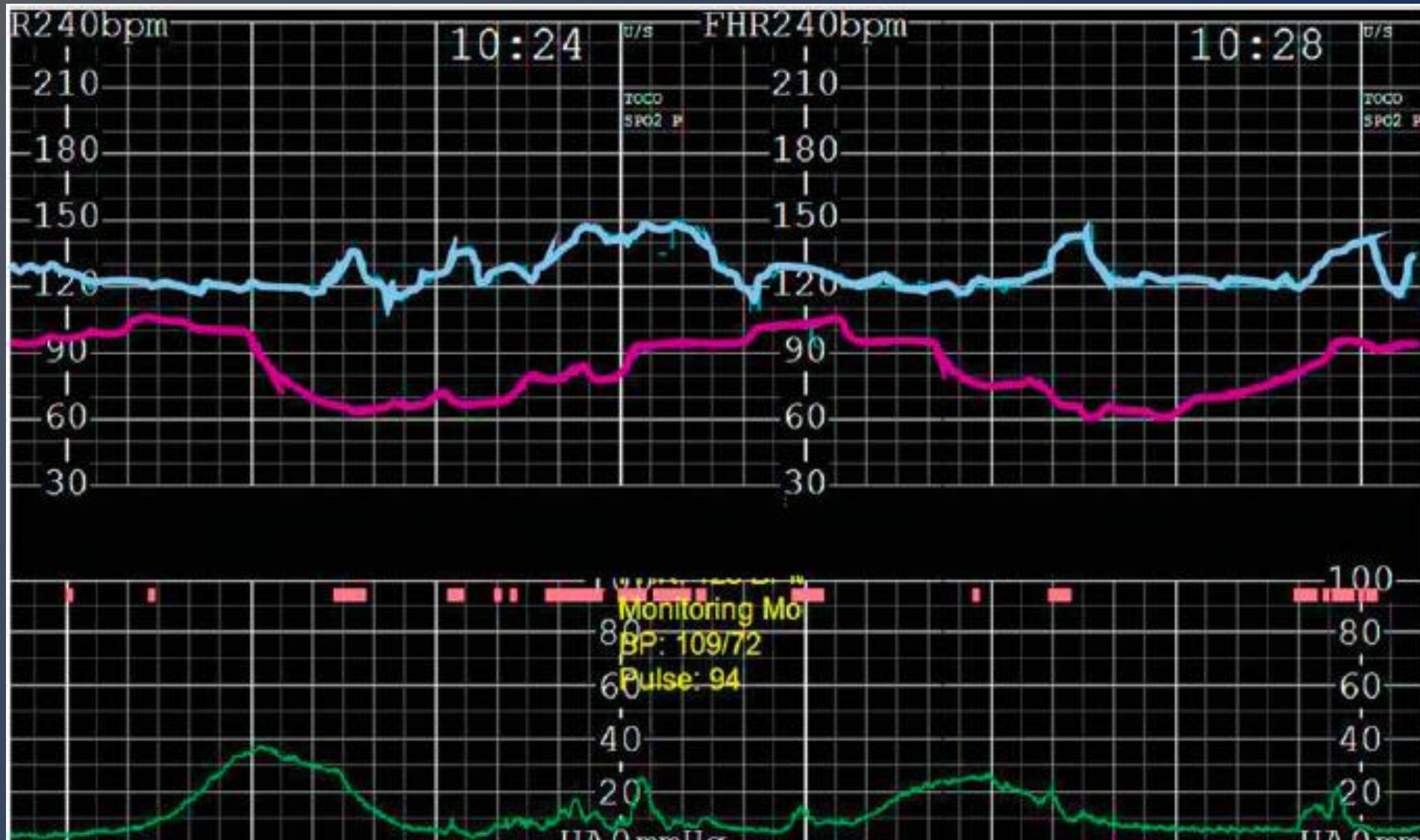
Contraction-Associated Maternal Heart Rate Decelerations

A Pragmatic Marker of Intrapartum Volume Status

Justin R. Lappen, MD, Edward K. Chien, MD, MBA, and Brian M. Mercer, MD

Hypovolemic (<45 mmHg)

Euvolemic (\geq 50 mmHg)



Lappen, Justin R., Edward K. Chien, and Brian M. Mercer. "Contraction-Associated Maternal Heart Rate Decelerations: A Pragmatic Marker of Intrapartum Volume Status." *Obstetrics & Gynecology* 132.4 (2018): 1011-1017.

Contraction Associated Decelerations

- Hypovolemic vs euvolemic = 41.1% vs 13.6%
- CAHRD
 - ↑ Post-epidural FHR abnormalities (43.5% vs 31.1%)
 - ↑ Diastolic hypotension (63.7% vs 50.0%)
 - ↑ Need for resuscitative interventions (33.9% vs 23.1%)
- Your goal: Intrapartum maternal heart rate assessment
Intrapartum fluid management



American Journal of Obstetrics and Gynecology

Volume 183, Issue 6, December 2000, Pages 1544–1548



Obstetrics

A randomized controlled trial of the effect of increased intravenous hydration on the course of labor in nulliparous women ☆

Thomas J. Garite, MD, Jonathan Weeks, MD, Kimberly Peters-Phair, RN, MN, Carol Pattillo, RN, Wendy R. Brewster, MD, PhD

Sports medicine literature indicates that adequate hydration is useful for peak athletic performance

125 cc/hr versus 250 cc/hr in nullips with spontaneous labor between 2 - 5 cm

"... novel finding that increasing fluid administration...is associated with a lower frequency of prolonged labor and possibly less need for oxytocin. Thus inadequate hydration in labor may be a factor contributing to dysfunctional labor and possibly cesarean delivery

Effect Of Increased Intravenous Hydration On The Course Of Labor In Nulliparous Women

- Objective: Determine whether increased IVF affect labor progress
- RCT: 195 women in labor
 - 125 or 250 mL/hr LR or isotonic sodium chloride
 - Uncomplicated nulliparous women with singleton term gestations
 - Spontaneous active labor with dilatation between 2 and 5 cm
- Mean volume
 - 250 ml group = 2487 ml 125 ml group=2008 mL

	125 cc/hr = 94	250 cc/hr = 101	P
Mean duration: 1 st stage	483 minutes	413 minutes	.060
Mean duration: 2 nd stage	69 minutes	71 minutes	NS
Mean total labor duration	552 minutes	484 minutes	.060
Frequency of labor > 12 hours	20/78 = 26%	12/91 = 13%	.047
Oxytocin Augmentation	61 (65%)	51 (49%)	.062
Cesarean Section	16 FTP =15	10 FTP=10	.22

Normal Saline With OR Without Dextrose

- Objective: compare intravenous NS with and without dextrose on the course of labor in nulliparas
- Double blind RCT: 289 women in active labor; 125 cc/hr
 - NS
 - NS with 5% dextrose (D5NS)
 - NS with 10% dextrose (D10NS)

	NS = 84	D5NS = 76	D10NS = 72	p
Time from IVF start to 10 cm	360 minutes (95-1203)	299 minutes (82-1091)	328 minutes (61-672)	.10
2 nd stage	106 minutes (24-266)	69 minutes (17-227)	62 minutes (14-191)	.01
Time from IVF start to delivery	464 minutes (185 -1336)	392 minutes (100-1157)	393 minutes (97 -827)	.02
Labor >12hrs	18 (22%)	7 (9.3%)	5 (5.8%)	.01

32: Reduction of total labour length through the addition of parenteral dextrose solution in induction of labor in nulliparous: Results of DEXTRONS prospective randomized controlled trial

[Josianne Paré](#), [Jean-Charles Pasquier](#), [Antoine Lewin](#), [William Fraser](#), [Yves-André Bureau](#)
University of Sherbrooke, Sherbrooke, QC, Canada

- Study goal: Provide evidence whether IV glucose supplementation during induction in nullips can reduce duration of active labor.
- Random: 250 mL/hour IV D5NS or 250 mL/hour NS for whole L&D duration
- 1st and 2nd stage: D5NS vs NS: (441 versus 505 minutes)
- Delivery by 200 minutes: 19% versus 8%
- Delivered by 450 minutes: 75% versus 61%
- No difference in the rate of cesarean section and APGAR score.

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Let's Talk About Oxygen

Although the classic triad of intrauterine resuscitation has been position changes, IV fluids, and oxygen, there is little evidence on potential adverse effects (both hypoxia and hyperoxia can cause free radical production & oxidative stress)

More research is needed on the risks of oxygen, both short- & long-term, on the duration of use, the types of FHR tracings where it is indicated, and algorithms for intrauterine resuscitation

Oxygen for intrauterine resuscitation: of unproved benefit and potentially harmful

Maureen S. Hamel, MD; Brenna L. Anderson, MD, MSc; Dwight J. Rouse, MD, MSPH

Maternal oxygen is often given to laboring women to improve fetal metabolic status or in an attempt to alleviate nonreassuring fetal heart rate patterns. However, the only 2 randomized trials investigating the use of maternal oxygen supplementation in laboring women do not support that such supplementation is likely to be of benefit to the fetus. And by increasing free radical activity, maternal oxygen supplementation may even be harmful. Based on a review of the available literature, we conclude that until it is studied properly in a randomized clinical trial, maternal oxygen supplementation in labor should be reserved for maternal hypoxia, and should not be considered an indicated intervention for nonreassuring fetal status.

Key words: fetal resuscitation, labor, maternal oxygen

to hemoglobin) in maternal arterial blood is around 100 mm Hg, while the umbilical venous PO_2 in the near term fetus is estimated to be approximately 28 mm Hg.⁴ Despite lower partial pressures within the umbilical vein, the fetus is able to adequately oxygenate its tissues. Oxygen saturation is the percentage of oxygen-binding sites on hemoglobin that are bound by oxygen. Normal oxygen saturation in healthy women is 99-100% while in the near term fetus it is usually 60-70%.⁴

Study	Population	N	Groups	Findings
Lawes et al, 1988 RCT	Elective CD	35	O ₂ 50% vs 33%	ND: Cord gases Apgars
Perreault et al, 1992 RCT	Elective CD	20	O ₂ 50% vs 100%	ND: Cord gases 5 minute Apgars
Thorp et al, 1995 RCT	2 nd stage labor	86	O ₂ 10L face mask vs no O ₂	↑ abnormal cord gases prolonged O ₂
Sirimai et al, 1997 RCT	2 nd stage labor	80	O ₂ vs no O ₂	ND: cord gases
Jozwik et al, 2000 Prospective Cohort	Elective CD	41	O ₂ 60% at 15L x15 min vs O ₂ face mask	ND: Fetal acid base status
Qian et al, 2017 RCT	2 nd stage labor No EFM changes	443	O ₂ 2L/min nasal cannula vs placebo	ND: Cord gases FHR changes
Raghuraman et al, 2018 Retrospective Cohort	1 st and 2 nd stage	7,789	O ₂ vs no O ₂	O ₂ : ↑ neo morbidity in acidemic neonates

Oxygen for Category II Intrauterine Fetal Resuscitation
A Randomized, Noninferiority Trial
Society of Maternal-Fetal Medicine
Pregnancy Meeting: 2018

<http://www.smfmstreamingvideos.com/Player/08/08.html>

JAMA Pediatrics | Original Investigation

Effect of Oxygen vs Room Air on Intrauterine Fetal Resuscitation

A Randomized Noninferiority Clinical Trial

Nandini Raghuraman, MD, MS; Leping Wan, MPH; Lorene A. Temming, MD, MSCI; Candice Woolfolk, PhD, MPH; George A. Macones, MD, MSCE; Methodius G. Tuuli, MD, MPH; Alison G. Cahill, MD, MSCI

Among patients with category II fetal heart tracings, intrauterine resuscitation with room air is noninferior to oxygen in improving umbilical artery lactate. The results of this trial challenge the efficacy of a ubiquitous obstetric practice and suggest that room air may be an acceptable alternative.

Take Home Points on Oxygen

- Try other corrective measures initially
- Do you really need oxygen for moderate variability
- **DISCUSS** simultaneous oxytocin - oxygen use
 - What's causing Category II changes?
- Discontinue as soon as fetal response warrants

Correct Hypotension

- Systolic BP < 100 mmHg or 20% decrease in BP
 - From pre-anesthesia levels
- Neuraxial anesthesia
 - Risk for ↓ uteroplacental blood flow R/T sympathetic blockade
- Position change and IV fluid bolus
- Ephedrine
 - Increases vascular tone to improve BP
- Phenylephrine

Ephedrine: Dosage 5-10mg IV push

Maternal effects

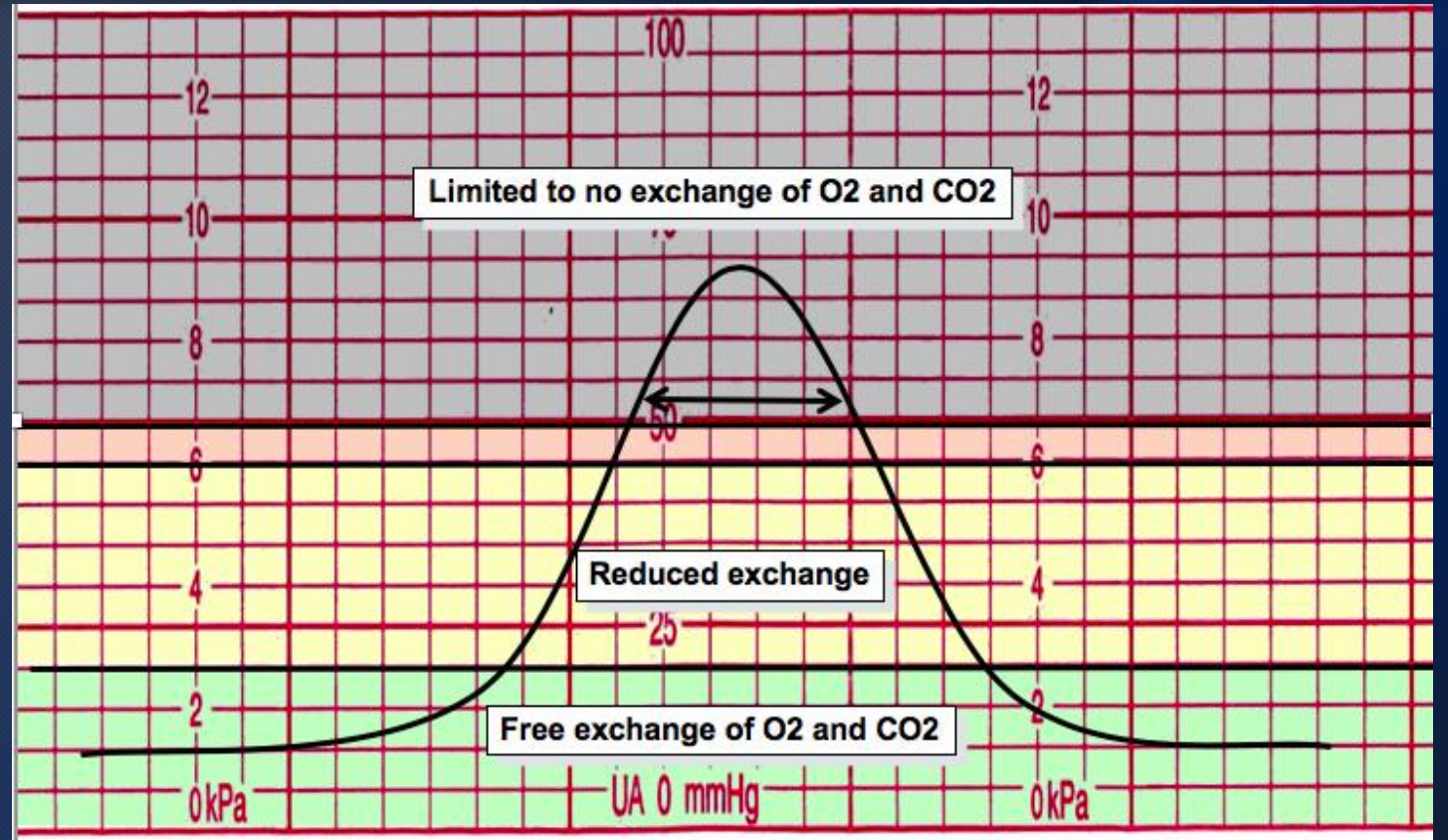
Alpha and beta receptor stimulation → vasoconstriction

- ❖ ↑ heart rate
- ❖ ↑ cardiac output
- ❖ ↑ blood pressure

Fetal effects

- ❖ ↑ FHR
- ❖ Tachycardia
- ❖ ↑ FHR variability

Reduction of Uterine Activity



Reduction of Uterine Activity

Endogenous Oxytocin

- First stage of Labor:
- Maternal circulating concentrations ~2-4 mu/min
- Fetal contribution ~ 3 mu/min
- Combined: 5-7 mu/min

Exogenous Oxytocin

- Half life is 10-12 minutes
 - 3-4 ½ lifes to reach steady state
- Uterine response within 30-60 min
 - Full effect of oxytocin dose
- Physiologic dosing
 - Initial dose: 1-2 mu/min
 - Increase 1-2 mu/min q 30-60

Reduce Uterine Activity

- Corrective Measures
 - ↓ or discontinue oxytocin or cervical ripening agent
 - Lateral positioning
 - IV fluid bolus
- Simultaneous interventions
 - Oxytocin dc'd = resolution **14.2 minutes**
 - Oxytocin dc'd and IVF bolus 500 cc = resolution **9.8 minutes**
 - Oxytocin dc'd, IVF bolus 500 cc, lateral position = resolution **6.1 minutes**

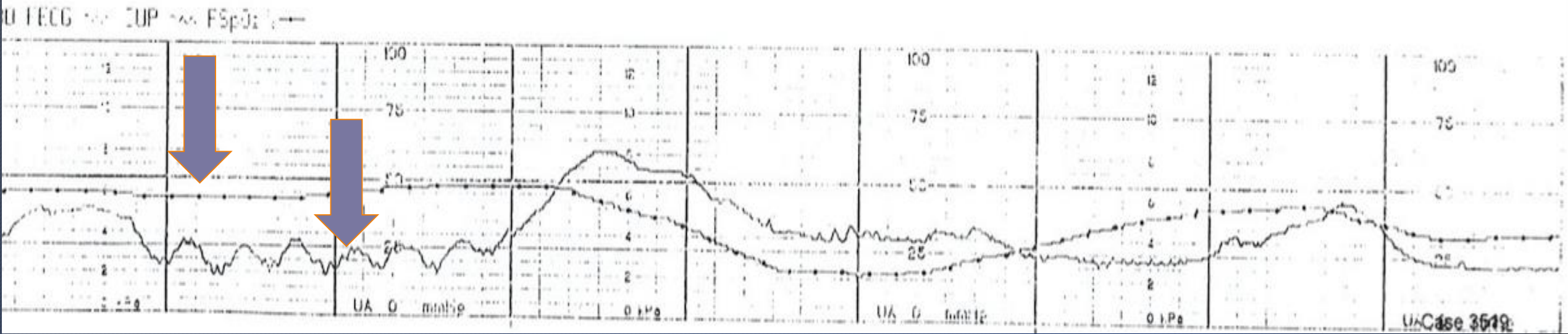
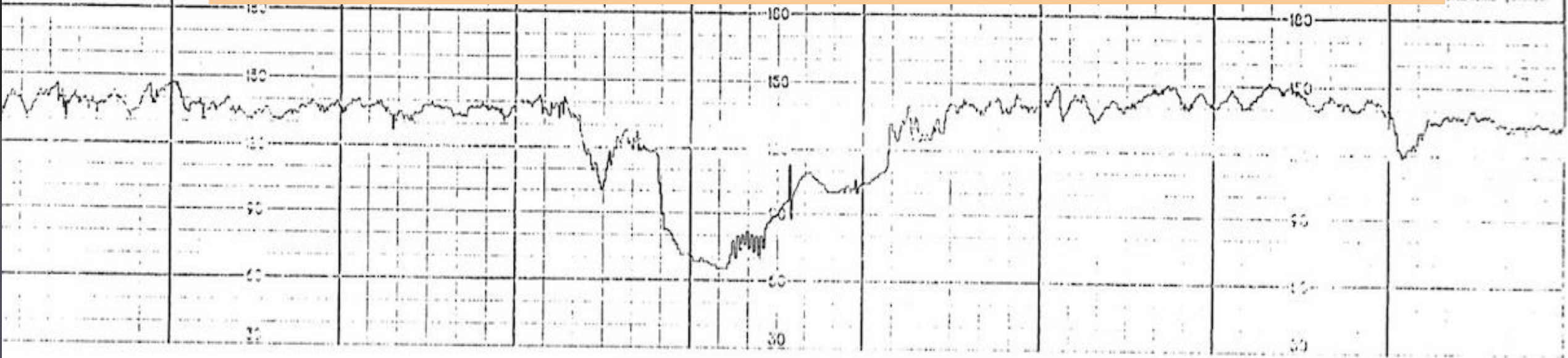
30-40 minutes:

FHR "resolution", normal uc pattern, restart oxytocin by half

Reduction of Uterine Activity

- 56 nullips elective induction
- 30 minutes of oxytocin induced “hyperstimulation”
 - Associated with a ↓ in FspO₂
 - ≥ 5 contractions / 10 minutes
 - ↓ 20% FSpO₂
 - ≥ 6 contractions / 10 minutes
 - ↓ 29% FSpO₂

>30 mmHg decreases flow to intervillous space
>50 mmHg blood flow ceases



Amnioinfusion

- Transcervical placement of IV fluid
- Corrects umbilical cord compression
- Impacts variable decelerations
 - Not LATE decelerations or minimal/absent variability
- Suggested procedure
 - Bolus 250-500 cc over 30 minutes via infusion pump
 - Consider continuous infusion 2-3 cc/min (120-180 cc/min)
 - What goes in must come out



Cochrane
Library

Cochrane Database of Systematic Reviews

Amnioinfusion for potential or suspected umbilical cord compression in labour (Review)

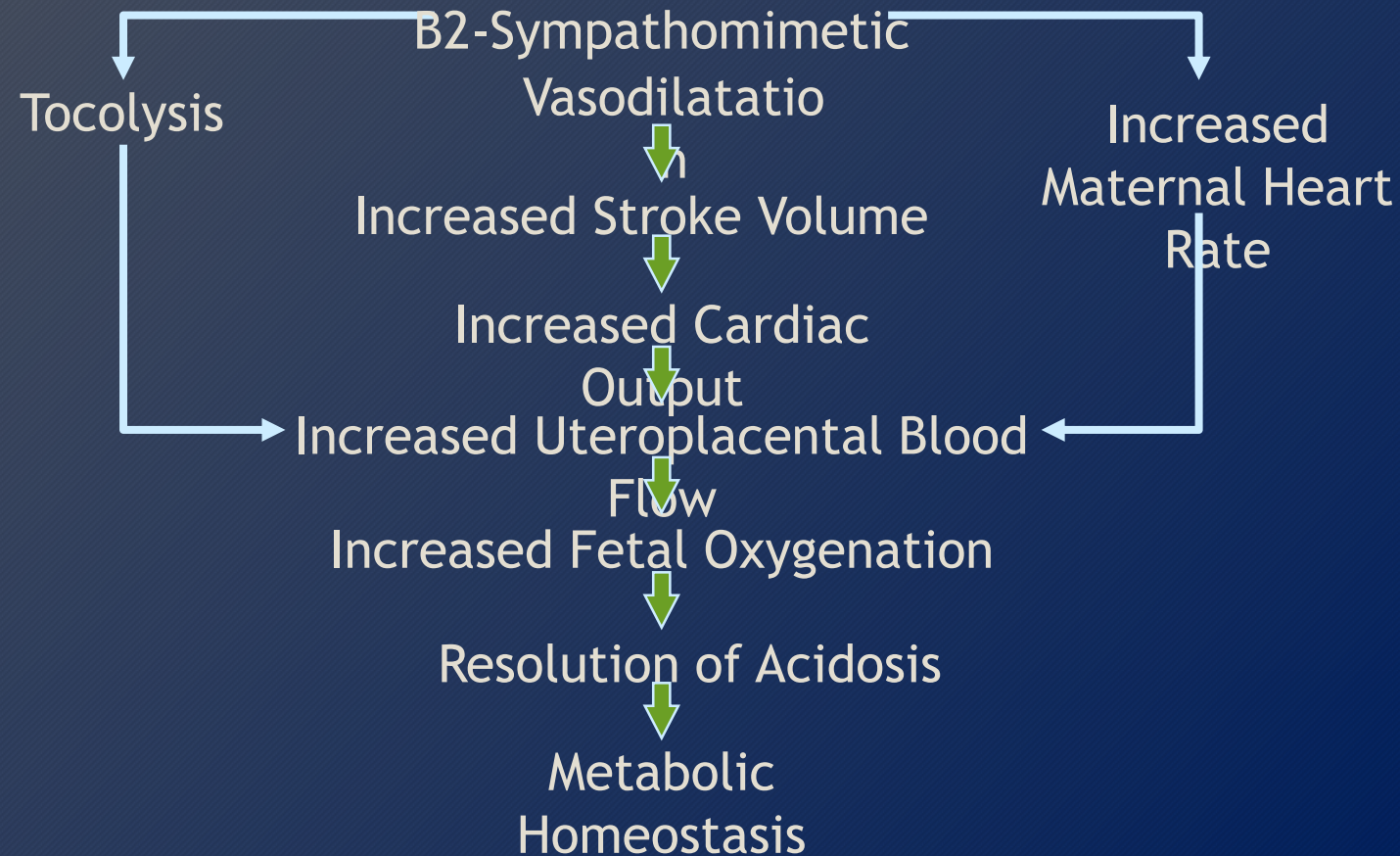
Hofmeyr GJ, Lawrie TA

Main results

We have included 19 studies, with all but two studies having fewer than 200 participants. Transcervical amnioinfusion for potential or suspected umbilical cord compression was associated with the following reductions: caesarean section overall (13 trials, 1493 participants; average risk ratio (RR) 0.62, 95% confidence interval (CI) 0.46 to 0.83); fetal heart rate (FHR) decelerations (seven trials, 1006 participants; average RR 0.53, 95% CI 0.38 to 0.74); Apgar score less than seven at five minutes (12 trials, 1804 participants; average RR 0.47, 95% CI 0.30 to 0.72); meconium below the vocal cords (three trials, 674 participants, RR 0.53, 95% CI 0.31 to 0.92); postpartum endometritis (six trials, 767 participants; RR 0.45, 95% CI 0.25 to 0.81) and maternal hospital stay greater than three days (four trials, 1051 participants; average RR 0.45, 95% CI 0.25 to 0.78). Transabdominal amnioinfusion showed similar trends, though numbers studied were small.

Tocolytic Administration For Uterine Contractions

Beta -2 Sympathomimetic (Terbutaline): 0.25 mg



Alterations in 2nd Stage Pushing Efforts

- Involuntary
 - Spontaneous pushing against a closed glottis
 - In response to descent of presenting part on perineum
- Valsalva
 - Directed strenuous bearing down effort against a closed glottis for at least 10 seconds
 - “Take a deep breath and hold it for as long as you can” (usually 10 seconds) using the entire contraction 2-3 pushes of 10 seconds each

Directed and Non-directed Pushing

- Directed
 - Similar to closed glottis
 - Also includes instructions on positioning
 - Often supine or Semi-Fowlers
- Non-directed
 - Clinicians encourage women to choose methods she feels is effective
 - Choosing her position
 - Deciding whether to hold her breath during pushing efforts
 - Determining duration of each push

Open Glottis

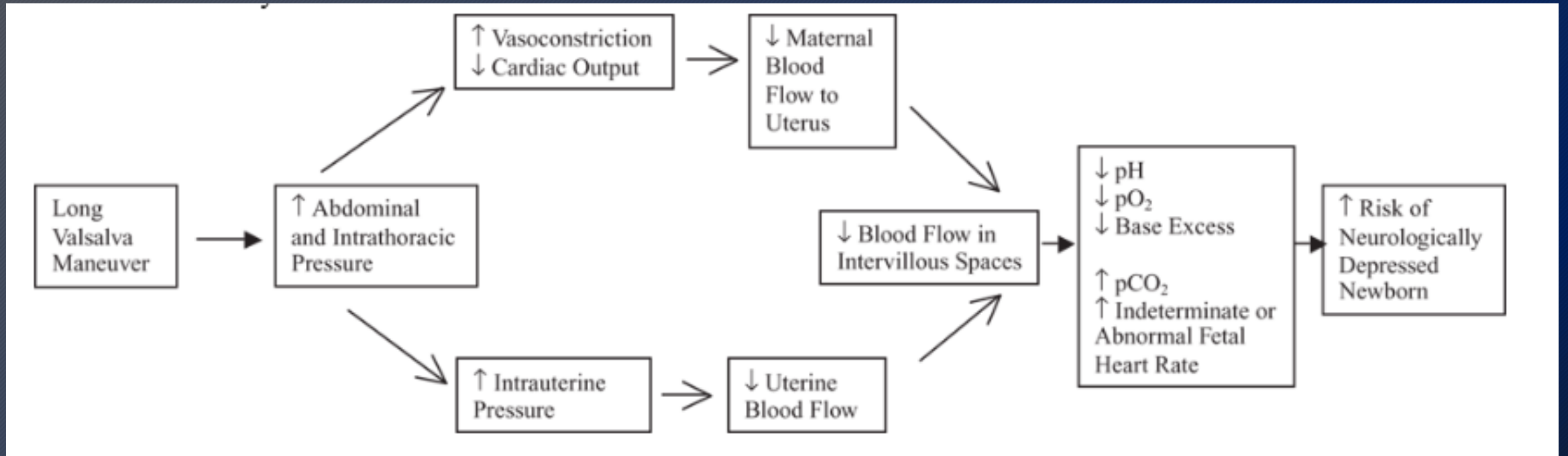
- Spontaneous involuntary bearing down accompanying uterine contractions
- Expiratory grunting or vocalization
- 3-4 pushes of 6-8 seconds with each contraction



Closed Glottis

- Potential ↑ risk for pelvic floor and perineal injuries
 - Structural and neurogenic injury to pelvic floor and perineum
 - Vaginal wall, bladder, and support structures are forced in front of fetal head
 - Obstructs fetal descent
 - Increased risk of urinary incontinence

Alteration in Second Stage Pushing Technique



Alterations in 2nd Stage Pushing Efforts

- Discourage prolonged breath-holding (“purple pushing”)
 - Consider open glottis pushing, allow patient to choose
- Discourage >3 pushing efforts with each contraction
- Discourage > 6-8 seconds of each pushing effort
- Don't forget about FHR
 - Pushing efforts may need to be modified based on pattern
 - Push every other or 3rd contraction to avoid recurrent decels
- Reposition as necessary for FHR decelerations/fetal descent
- Consider delayed pushing



The American College of
Obstetricians and Gynecologists
WOMEN'S HEALTH CARE PHYSICIANS

COMMITTEE OPINION

Number 687 • February 2017

Committee on Obstetric Practice

The American College of Nurse–Midwives and the Association of Women’s Health, Obstetric and Neonatal Nurses endorse this document. This Committee Opinion was developed by the American College of Obstetricians and Gynecologists’ Committee on Obstetric Practice, in collaboration with American College of Nurse–Midwives’ liaison member Tekoa L. King, CNM, MPH, and College committee members Kurt R. Wharton, MD, Jeffrey L. Ecker, MD, and Joseph R. Wax, MD.

This document reflects emerging clinical and scientific advances as of the date issued and is subject to change. The information should not be construed as dictating an exclusive course of treatment or procedure to be followed.

Approaches to Limit Intervention During Labor and Birth

When not coached to breathe in a specific way, women push with an open glottis. In consideration of the limited data regarding outcomes of spontaneous versus Valsalva pushing, each woman should be encouraged to use the technique that she prefers and is most effective for her.

Cochrane Review

- Seven RCT's comparing spontaneous to Valsalva
 - No differences in duration of 2nd stage, rates of operative vaginal delivery, cesarean episiotomy, perineal lacerations, 5 minute Apgar <7, NICU admissions
 - Valsalva technique: shorter duration of pushing
 - Mean difference: 5.2 minutes vs 7.78 minutes

Effect of spontaneous pushing versus Valsalva pushing in the second stage of labour on mother and fetus: a systematic review of randomised trials

M Prins,^a J Boxem,^a C Lucas,^b E Hutton^{a,c}

^a Department of Midwifery Science, AVAG and the EMGO Institute for Health and Care Research, VU University Medical Centre, Amsterdam


^b Department of Clinical Epidemiology, Biostatistics and Bioinformatics, Academic Medical Centre, University of Amsterdam, Amsterdam, the Netherlands ^c Department of Obstetrics and Gynaecology, McMaster University, Hamilton, ON, Canada

Correspondence: M. Prins, Midwifery Academy of Amsterdam and Groningen (AVAG), Louwesweg 6, 1066 EC Amsterdam, the Netherlands.
Email marianne.prins@inholland.nl

- Meta-analysis (3 RCT's): low risk nullips ≥ 36 weeks without epidural
 - No difference in operative vaginal delivery, cesarean, episiotomy or perineal lacerations
 - Shorter 2nd stage with Valsalva (18.59 minutes) except confidence intervals were wide:
 - Sample size was too SMALL

Purpose of Documentation

- Facilitate communication among & between caregivers
- Promote improved quality of care by encouraging assessment and reevaluation of progress and clinical plans
- Meet professional and legal standards



"In spite of the apparent importance of charting, it is probably one of the greatest 'hates' of nurses. Many nurses complain that the time spent in charting might be more profitably used in actual patient care."

A very wise nurse

Intrapartum FHR Monitoring Challenges

- Failure to recognize Category II / III FHR and underlying physiology
- Lack of current FHM education and competency training
- Maternal-FHR Signal Ambiguity
- Failure to follow protocols
- **Poor documentation**
- Inadequate EFM tracing
- Communication failure at all care levels
- Lack of clinical context for current obstetric situation
- Lack of situational awareness
- Failure to address physician/nursing concerns
- Chain of command problems

Assessment of EFM tracings infers that there is **BEDSIDE** visual review of a paper tracing or labor room computer screen.



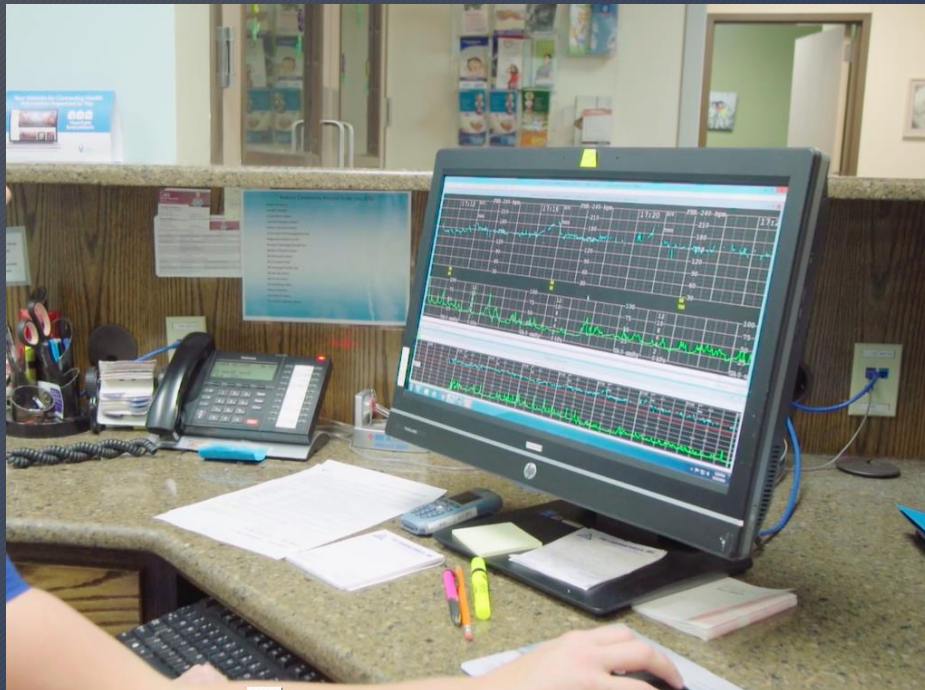
On occasion

- Tracing analysis from a remote location necessary

Staffing ratios do not allow for a bedside evaluation

Remote tracing review from an operating room during critical situation (i.e. emergent cesarean)

The Obstetric Record



- Critical Thinking
 - Assessment:** Encompasses everything
 - Communication:** What I tell others
 - Documentation:** What is recorded
- Must accurately reflect occurrence and sequence of events
- Will be subject to keen scrutiny by experts

The Three “D”s

- **Disclosure**

A family’s story will be affected by disclosure conversations following an unexpected outcome,

Do not underestimate the impact

- **Documentation**

Records will become a sword for the plaintiffs or a shield for the defense

- **Deposition**

Closely related to documentation, what is testified to at deposition will be the basis of trial testimony and may impact settlement

Bedside Evaluation

```
graph TD; A[Bedside Evaluation] --> B[Corrective Measures]; B --> C[Continued Surveillance]; C --> D[Re-Evaluation]; D --> E[DOCUMENT];
```

Corrective Measures

Continued Surveillance

Re-Evaluation

DOCUMENT

Documentation must be “CLEAR”

- Contemporaneous
- Logical
- Explicit
- Accurate
- Readable

Contemporaneous

- Written around or near time of occurrence or intervention
- No legal standard
- Use common sense
- Records must be transparent
- No harm in a proper “late” entry

Do Not Be Afraid Of The Narrative Note!

Gradual FHR baseline increase from 120 to 155 bpm over an hour. Irregular contractions with Montevideo units <130 mm Hg. Normal vital signs. Dr Navarre notified of baseline change/vital signs; will review tracing remotely from clinic.

Logical

- Plain and unambiguous
- Show a clear plan related to patient assessment/status
- SOAP concept provides a logical format
 - S: Feeling more pelvic pressure
 - O: FHR 130 bpm, mod var, (-) accel, (-) decel, 3 cm, 90%/-0
 - A: 1. 38 y/o G4 P3 at 40 2/7 wks
 - 2. Latent labor
 - P: Continue expectant management, anticipate NSVD

Explicit

- Avoid vague or ambiguous terms
- FHR and uterine activity,
 - Use components rather than categories
- 10 years from now
 - If you know components you can apply the summary terms, but the reverse is not!

Fetal Heart Monitoring

some clinicians elect to include further interpretation by noting the FHR category: normal (category I), indeterminate (category II), or abnormal (category III), and only if using EFM. Documentation of FHR category is optional; however, clinicians should follow institutional policies for documentation of fetal status during labor.

My point: Hospitals have mandated categories be documented at the same intervals as FHR / UA components. This is redundant and consumes nursing time not to mention people are wrong in category interpretation at times

Table 1. Principles of effective obstetric documentation and communication^a

Documentation quality	<ul style="list-style-type: none"> • Permanently accessible, retrievable, and available for audits • Thorough, accurate, relevant, and consistent • Clear, concise, timely, and complete • Legible regardless if paper or electronic format • Entered contemporaneously and sequentially • Reflective of nursing process and critical thinking • Apply standardized EFM nomenclature to entries • Avoid nonspecific terms such as “reassuring, good” • Provide evidence of patient handoffs
Staff education and training	<ul style="list-style-type: none"> • Comprehensive documentation education and training plan for new employees incorporating technical elements of charting with organization or unit documentation policies • Ongoing follow-up education for all employees to reinforce information and documentation trend updates • Conduct team training
Documentation and communication policies	<ul style="list-style-type: none"> • Familiarization with organization and work location documentation and communication policies that include chain of command, consultation and on-call policies, transfer policies, and conflict resolution • Consider annual review of key policy by bedside clinicians and leadership
Medical record security system	<ul style="list-style-type: none"> • Integrated into documentation systems that abide by recommended industry standards, governmental mandates, accrediting agencies, and organizational policies • To include: <ul style="list-style-type: none"> • Data security • Protection of patient identification • Confidentiality of patient information, clinical professionals’ information, and organizational information
Documentation entries	<p>Medical record entries must be:</p> <ul style="list-style-type: none"> • Accurate, valid, and complete • Authenticated demonstrating entries are truthful, the clinician is readily identified, and information has not been added or inserted • Dated and time-stamped by the clinician • Legible/readable • Completed using standardized terminology and abbreviations
Standardized terminology	<p>Standardized terminologies and The Joint Commission–approved abbreviations that are used to describe plan, deliver, and evaluate nursing care based on professional organizational guidelines and position statements</p>

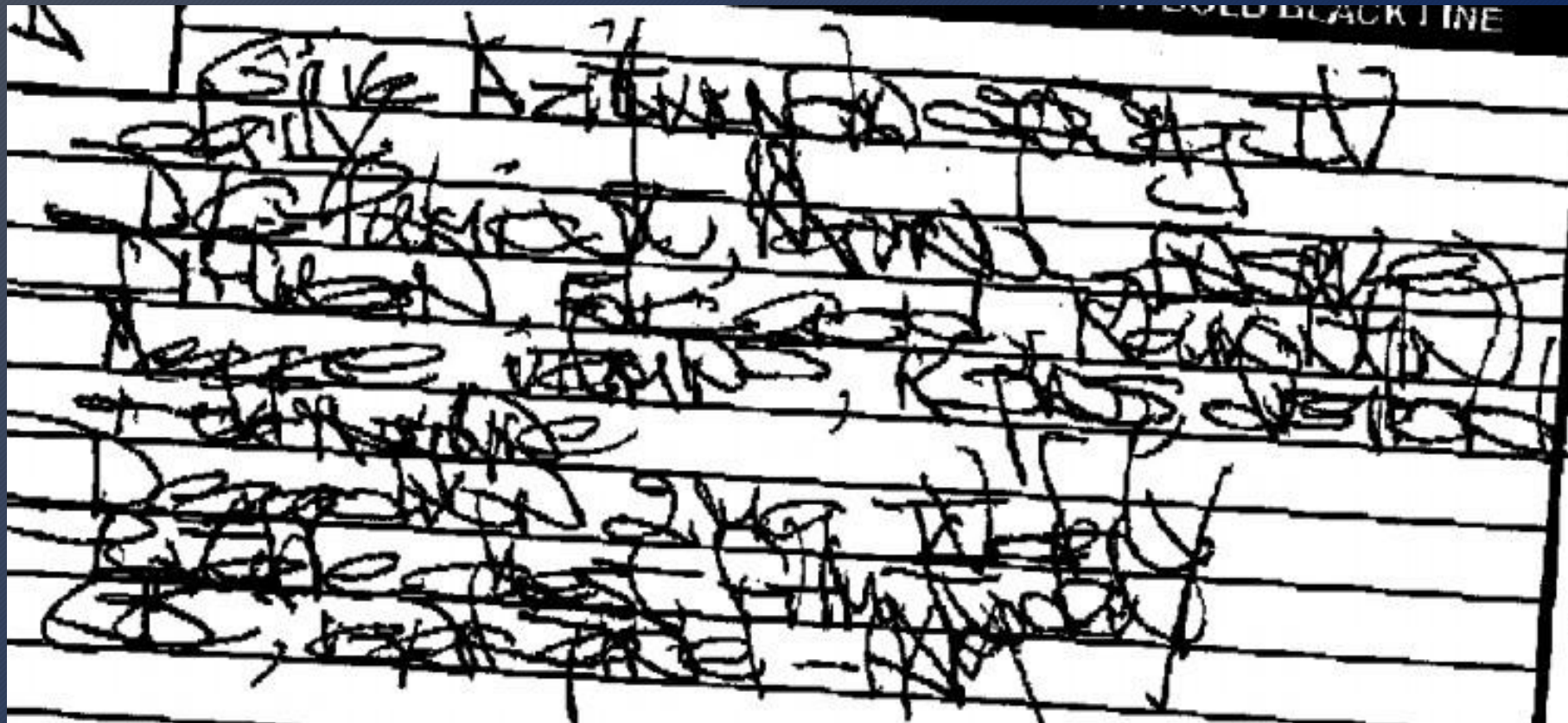
Accurate

- Timing of notes, interventions, occurrences
- Use correct terminology
- Notes must provide a truthful representation of what happened
- Avoid allegations of spoliation

Is This A Truthful Representation?

Display Time	User	Description
		Cervical consistency: medium
		Cervical position: midposition
		Contraction frequency: 7 / 10 min in last 15 minutes
		Average contraction duration: 71 seconds in last 15 minutes
		Contraction intensity: 37 in last 15 minutes
		FHR 1: Baseline: 128 bpm in last 15 minutes
		Maternal heart rate (SpO2): 80 BPM
		Maternal SpO2: 97%
		Maternal heart rate (SpO2): 87 BPM

Readable



Late Entry

“When there is a delay in entering chart information, write the phrase late entry at beginning of the note. ...Use the current date and time. Explain the delay in recording the information...”

Late entry due to urgency of patient care situation. At 22:10 patient had increasing pelvic pressure and bloody show. Fetal heart rate baseline 145 bpm, moderate variability, intermittent variable decelerations. Firm contractions every 2-4 minutes lasting 70-90 seconds. Vaginal examination by CNM Zemmer: 6/100%/-1. Approximately 10 minutes later, involuntary pushing noted, followed by a 5-minute prolonged deceleration to 90 beats per minute. Patient turned to right side. Repeat examination by this nurse 10/100%/+4. CNM Zemmer called to room for delivery. Head out at 22:32, followed by shoulder dystocia. Time of birth 22:38.

Which Of These Notes Is Better?

Nurse at bedside; fetal heart rate appears sketchy; toco not picking up contractions; patient requests pain medication; midwife Duncan called for orders.

Nurse at bedside; unable to interpret fetal heart rate data due to noncontiguous tracing related to maternal body habitus; firm contractions palpable every 2-3 minutes; monitors readjusted patient requests pain medication; pain scale 7 of 10; midwife Duncan called for pain medication orders and fetal spiral electrode/intrauterine pressure catheter placement.

The background of the slide is a white ECG strip on a dark blue background. The strip shows three leads with a grid. Each lead has a label 'FHR 240 bpm' and a numerical value '210'. The top of the strip has three columns of data: '2 50356 043', '2 50357 042', and '2 50358 04'.

Of questionable authenticity or trustworthiness: *a sketchy accent; a sketchy character.*

Of dubious safety; potentially harmful or dangerous: *a sketchy neighborhood.*

Frequency of Assessments and Documentation

- No published peer-reviewed data related to perinatal outcomes
- Concept of simultaneous assessment and documentation with EFM is not supported in the literature
- We mistakenly use IA assessment and documentation guidelines for EFM

TABLE 2 ASSESSMENT OF FETAL STATUS USING ELECTRONIC FETAL MONITORING^{a,b}

	Latent phase (<4 cm)	Latent phase (4–5 cm)	Active phase (≥ 6 cm)	Second stage (passive fetal descent)	Second stage (active pushing)
Low-risk without oxytocin	Insufficient evidence to make a recommendation Frequency at the discretion of the midwife or physician	Every 30 minutes	Every 30 minutes	Every 30 minutes	Every 15 minutes
With oxytocin or risk factors	Every 15 minutes with oxytocin; every 30 minutes without	Every 15 minutes	Every 15 minutes	Every 15 minutes	Every 5 minutes

^aFrequency of assessment should always be determined based on the status of the mother and fetus and at times will need to occur more often based on their clinical needs, e.g., in response to a temporary or on-going change.

^bSummary documentation is acceptable, and individual hospital policy should be followed.

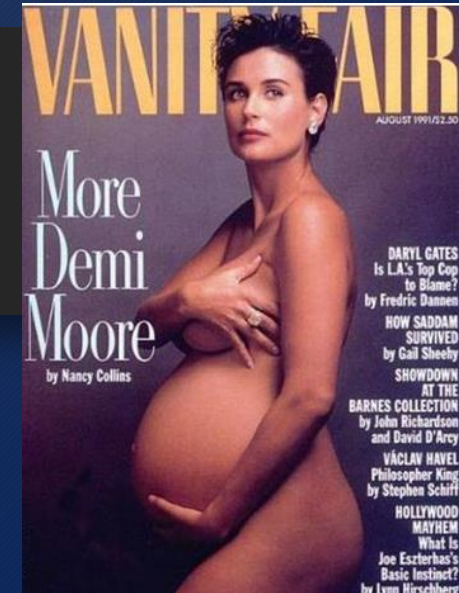
Documentation does not necessarily need to occur at the same intervals as assessment when using continuous EFM because FHM data are recorded in the tracing. For example, while evaluation of the FHR may occur every 15 minutes with EFM, a summary of findings of fetal status may be documented in the medical record less frequently. However, it is important that the documentation reflect the frequency of assessment and the interpretation of FHM findings.

Consider Performing Audits

- Based on unit's needs
 - Frequency of late entries
- Heightened awareness of documentation
 - Full systematic assessment
- Ensure policies are consistent with standard of care
 - MD, CNM, RN
- Ensure policies are up to date
 - Reflective of what unit is REALLY doing

Literature

- Scientific, peer reviewed journals
- “Authoritative” textbooks
- “You can prove anything you really want to prove”



I Regret Eating My Placenta

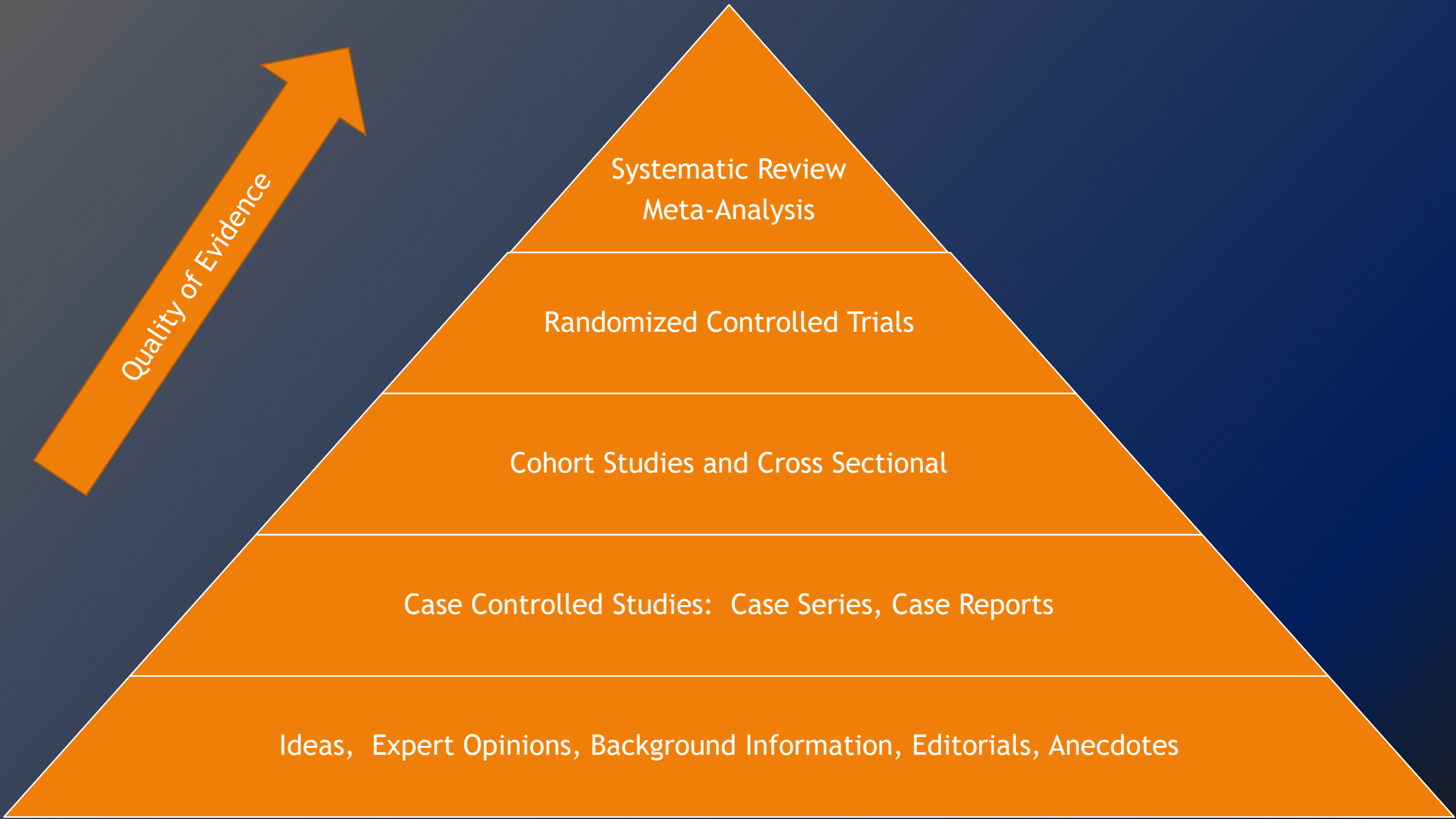
By NANCY REDD MARCH 25, 2012 9:13 PM 185 Comments

VBAC homebirth after 4 c/sections

November 25th, 2012

MotherBloom

Personalized Midwifery & Home Birth Care
Holistic Health Services



Quality of Evidence

Systematic Review
Meta-Analysis

Randomized Controlled Trials

Cohort Studies and Cross Sectional

Case Controlled Studies: Case Series, Case Reports

Ideas, Expert Opinions, Background Information, Editorials, Anecdotes