Electronic Fetal Monitoring and High Risk Patients Are They Really Any Different?

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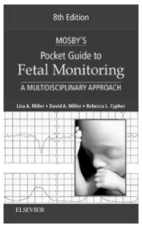
Disclosures

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

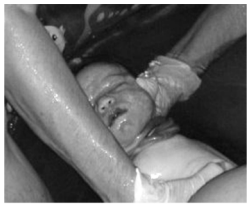
I may discuss off label medications or products



Objectives

Review principles of FHR interpretation using a standardized approach
Discuss optimal management strategies for intrapartum FHR tracings
Analyze FHR patterns and uterine activity through selected case studies

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



EFM and High-Risk Conditions

PTL	Diabetes
Hypertension	Placenta Previa
Postdates	Abruption
Obesity	Uterine Rupture
Multiples	Infection

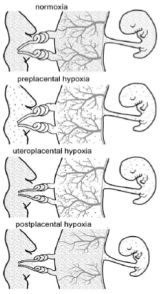
Not to mention low risk patients that turn into high risk patients…..

Origins of Fetal Hypoxia

Pre-placental: oxygen content in maternal blood
- Hypoxic placenta and fetus
- High altitudes, cyanotic cardiac disease
- Average 102 gm per 1000 m elevation gain

Utero-placental: Normal oxygen content
- Restricted flow into uteroplacental tissue
- Contractions, preeclampsia, occlusions

Post-placental: Normal oxygen content
- Villi fail to transfer oxygen to fetus
- Abnormal placentation



Kingdom JC, Kaufmann P. Oxygen and placental villous development: origins of fetal hypoxia. Placenta. 1997 Nov;18(8):613.

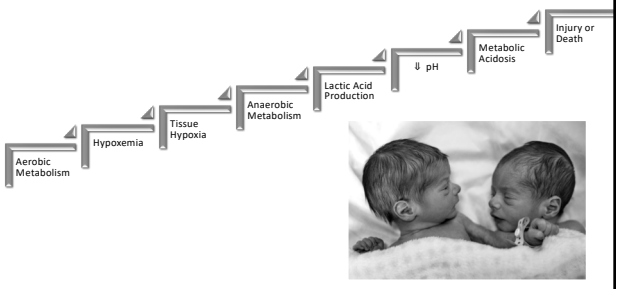
Hypoxia: Fetal Defense Mechanisms

Sustain metabolic requirements

Redistribution of blood to vital organs

Decreased oxygen consumption
- Myocardium uses less O_2
- FHR changes

If no improvement in oxygenation
- Convert to anaerobic metabolism



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, 4th ventricle	20-21 weeks
Fetal Heart Rate	Posterior Hypothalamus Medulla	28-32 weeks

Manning, F.A., 1995. Dynamic ultrasound-based fetal assessment: the fetal biophysical profile score. *Clinical obstetrics and gynecology*, *38*(1), pp.26-44.
Vintzileos, A.M. and Knuppel, R.A., 1994. Multiple parameter biophysical testing in the prediction of fetal acid-base status. *Clinics in perinatology*, *21*(4), pp.823-848.

Transporting Oxygen To The Fetus

Circulated to uterus via
- Pulmonary arteries
- Left atrium and left ventricles
- Aorta
- Uterine arteries

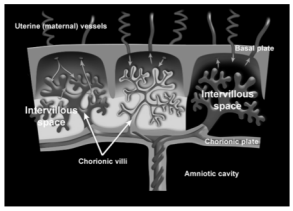
Oxygen Transport
- Oxygen Content
- Oxygen Affinity
- Oxygen Delivery
- Oxygen Consumption

Placental Intervillous Space

Uterine perfusion
- 700-800 cc/min at term
- 10-15% of maternal cardiac output

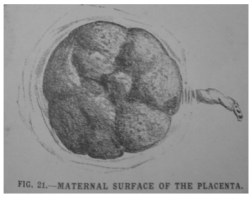
Fetal tissue protrusions
- Exposed to maternal blood
- Bathes chorionic villi

Factors impacting volume
- Contractions, abruption

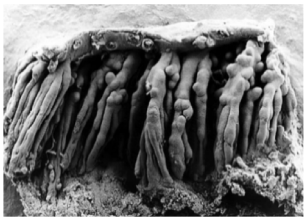


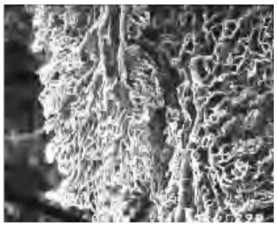
https://sonoworld.com/fetus/page.aspx?id=3315

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



Maternal-Fetal Placental Circulation





Physiology: Extrinsic and Intrinsic Factors

EXTRINSIC: "OUTSIDE" INFLUENCE

Maternal and 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

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
  - ⇑ tone and FHR baseline with advancing gestational age
- Sympathetic Nervous System: "Speedy"
  - Stimulation ⇑ FHR and may be promoted by hypoxemia
  - FHR baseline ⇓ 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

Intrinsic Influence

Chemoreceptors
- Respond to changes in fetal O2, CO2 and pH levels
- ⇑ CO2 or ⇓ 02 ⇒ 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

Intrinsic Influence

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

Physiologic Extrinsic Influence

Maternal influences
- Positioning: compression on inferior vena cava leads to ⇓ 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 02 exchange
- Damaged cotyledons, smoking, vessel constriction from medications

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

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

Three-Tier Fetal Heart Rate Interpretation System

Category I

Category I fetal heart rate (FHR) tracings include all of the following:

- Baseline rate: 110–160 beats per minute (bpm)
- Baseline FHR variability: moderate
- Late or variable decelerations: absent
- Early decelerations: present or absent
- Accelerations: present or absent

Category II

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

Baseline rate

- Bradycardia not accompanied by absent baseline variability
- Tachycardia

Baseline FHR variability

- Minimal baseline variability
- Absent baseline variability not accompanied by recurrent decelerations
- Marked baseline variability

Accelerations

- Absence of induced accelerations after fetal stimulation

Periodic or episodic decelerations

- Recurrent variable decelerations accompanied by minimal or moderate baseline variability
- Prolonged deceleration ≥2 minutes but <10 minutes
- Recurrent late decelerations with moderate baseline variability
- Variable decelerations with other characteristics, such as slow return to baseline, "overshoots," or "shoulders"

Category III

Category III FHR tracings include either:

- Absent baseline FHR variability and any of the following:
  - Recurrent late decelerations
  - Recurrent variable decelerations
  - Bradycardia
- Sinusoidal pattern

Obstet Gynecol. 2008 Sep;112(3):661-6. doi: 10.1097/AOG.0b013e3181841395.

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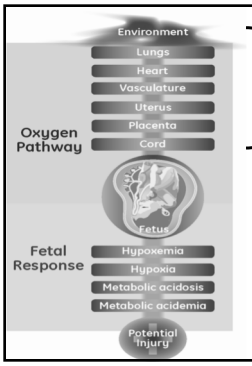
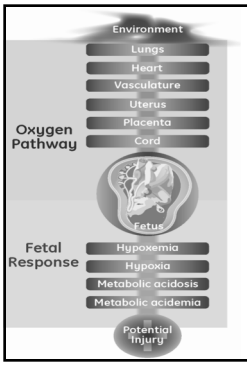


Fetal oxygenation involves the transfer of oxygen from the environment to the fetus…

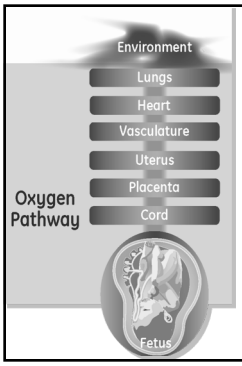
And the subsequent fetal physiologic response if oxygen transfer is interrupted…



What does each tracing reveal about this pathway and what information does the tracing provide regarding oxygen transfer?

Start at the top!

Head Compression
Cord Compression
Uteroplacental insufficiency



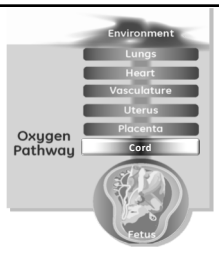
All clinically significant FHR decelerations HAVE EXACTLY THE SAME TRIGGER…

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

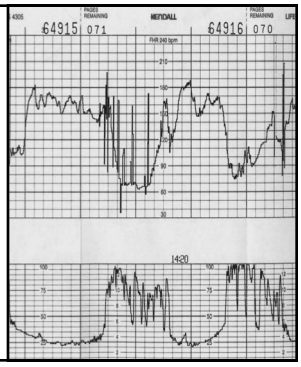
So, when we see a late, variable, or prolonged deceleration, we can agree

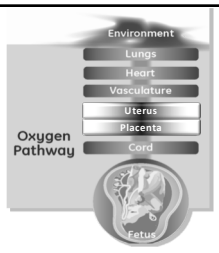
Principle #1

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

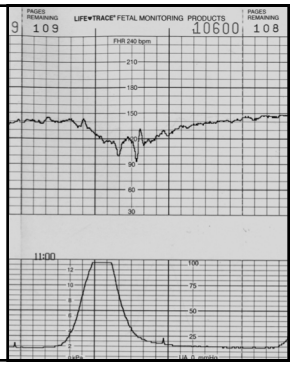


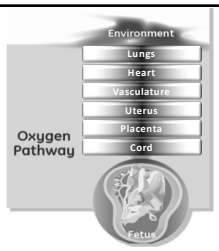
Interruption of the oxygen pathway by compression of the umbilical cord can result in a variable deceleration



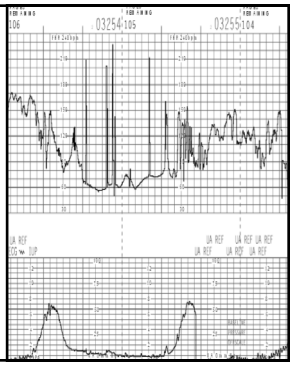


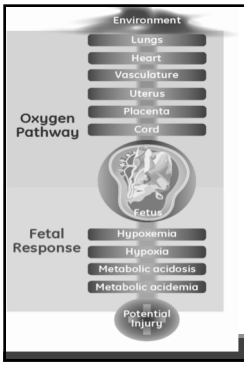
Interruption of the oxygen pathway at the level of the uterus or placenta can result in a late deceleration





Interruption of the oxygen pathway at any point can result in a prolonged deceleration



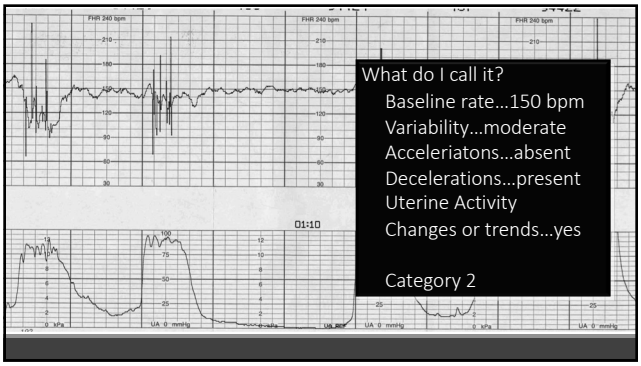


The second half of the pathway

What information can the FHR tracing provide regarding the fetal response to interruption of the oxygen pathway?

<u>Principle #2</u>

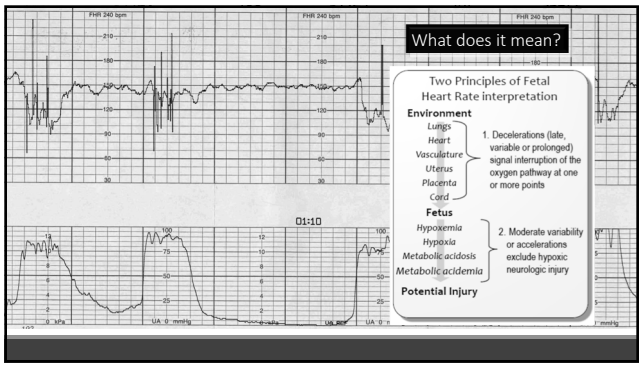
Moderate variability or accelerations exclude ongoing hypoxic injury



What do I call it?

- Baseline rate…150 bpm
- Variability…moderate
- Acceleriatons…absent
- Decelerations…present
- Uterine Activity
- Changes or trends…yes

Category 2



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What Do We Do About It?

Objective of a "standardized management" protocol is to minimize opportunities for preventable error

Risk factors for error include relying on random recall, lack of a checklist, unnecessary complexity, and lack of a shared mental model among team members

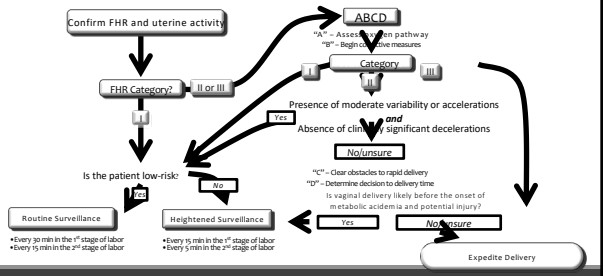
Additionally, even the best scenarios for practice cannot prevent all poor outcomes - in those cases, the team must be able to articulate the rationale for actions in order to defend their practice.

Why Can't We Do the Right Thing All The Time and Every Time ?

Distractions: Personal or Unit
Stress
Fatigue
Memory lapses
Brain "freeze"
Inadequate training
Inadequate experience

Belfort, M. A. (2004). Shoulder dystocia and flying airplanes!. *Obstetrics & Gynecology*, *104*(4), 658-660.

Intrapartum Fetal Heart Rate Management Decision Model



Miller, Miller & Cypher, 2017

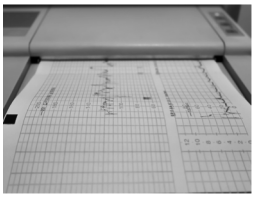
A Standardized Intrapartum FHR Management Model

Four Central Concepts:
"ABCD"

A – Assess the oxygen pathway/review differentials
B – Begin conservative corrective measures
C – Clear for delivery
D – Decision to delivery time

Miller LA, Miller DA, Cypher RL. Mosby's Pocket Guide to Fetal Monitoring E-Book: A Multidisciplinary Approach. Elsevier Health Sciences; 2017 Apr 5.

Confirm Fetal Heart Rate and Uterine Activity



Avoiding Intrapartum Misidentification

Confirm/compare maternal HR with FHR via palpation or pulse ox
- Repeat periodically during labor

Abrupt FHR changes may indicate maternal HR

Maternal tachycardia CAN and WILL trace as FHR

Be knowledgeable about FHR physiology

Know FHM equipment, alarm signals and tracing symbols

Other clinical situations for ambiguity
- Contractions, maternal movement , inaccurate transducer placement, maternal weight/size, fetal position, number of fetuses, and placental location.

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"B" Begin Corrective Measures

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

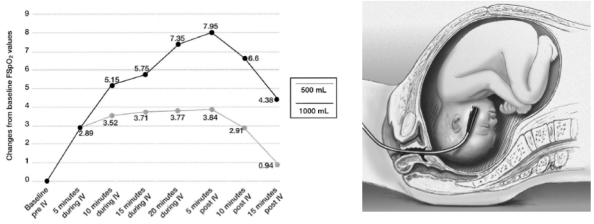
AWHONN's Physiologic Goals

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

AWHONN
PROMOTING THE HEALTH OF WOMEN AND NEWBORNS

AWHONN Fetal Heart Monitoring PROGRAM

Intravascular Volume Improves Uteroplacental Perfusion Hypotension and Hypovolemia



Simpson, K.R. and James, D.C. 2005. Efficacy of intrauterine resuscitation techniques in improving fetal oxygen status during labor. Obstetrics & Gynecology, 105(6), pp.1362-1368.

SMFM Papers

www.AJOG.org

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

Miller NR, Cypher RL, Nielsen PE, Foglia LM. 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. AJOG. 2013;209(4):382.e1.

Objective

Is decreased maternal pulse pressure a risk factor for new onset post-epidural FHR abnormalities

- <45 mmHg
- FHR abnormalities in first 60 minutes after dosing
  - Recurrent late decelerations and/or prolonged decelerations

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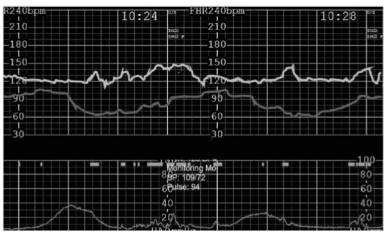
	Admission PP ≥45 mmHg N=95	Admission PP <45 mmHg N=95	OR (95% CI	P value
FHR Abnormalities	6 (6)	26 (27)	5.6 (2.1 -14.3)	< .001

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

Contraction Associated Maternal Heart Rate Decelerations



Lappen, J.R., Chen, E.K. and Mercer, B.M., 2018. Contraction-associated maternal heart rate decelerations: a pragmatic marker of intrapartum volume status. Obstetrics & Gynecology, 131(4), pp.1011-1017.

Contraction Associated Decelerations

Hypovolemic (<45 mmHg) vs euvolemic (≥ 50 mmgHg)
- 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%)

- Our goal: Intrapartum maternal heart rate assessment
  Intrapartum fluid management

Lappen, J R., Chien, E.K. and Mercer, B.M., 2018. Contraction-associated maternal heart rate decelerations: a pragmatic marker of intrapartum volume status. *Obstetrics & Gynecology*, *132*(4), pp.1013-1017.

"Now what do you do with all this information?"

"Standardized management" is to 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 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 a FHR tracing, prudent to plan ahead for a possible rapid delivery

This does NOT commit the patient to delivery

- Identifies common sources of unnecessary delay in a systematic way so they are addressed in timely fashion

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

Clear Obstacles to Rapid Delivery

Simple precautions are not often emphasized in a systematic way

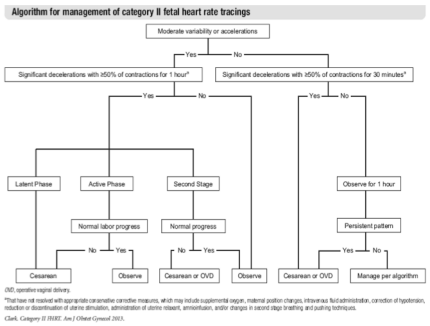
But failing to address them can be a major source of criticism in the event of an untoward outcome

"Common sense is not that common"

"D"- Determine decision to delivery time

↓

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



Clark, Steven L., et al. "Intrapartum management of category II fetal heart rate tracings: towards standardization of care." *American journal of obstetrics and gynecology* 209.2 (2013): 89-97.

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

What is too long?

Even with algorithms and expert consensus, delivery decisions can sometimes be very challenging for the physician, in fact for the entire OB team

No matter what our decision is, we'll never be able to 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 *if Indicated*
Lungs	Airway and breathing	Supplemental oxygen
Heart	Heart rate and rhythm	Position changes Fluid bolus Correct hypotension
Vasculature	Blood pressure Volume status	
Uterus	Contraction strength Contraction frequency Baseline uterine tone Exclude uterine rupture	Stop or reduce stimulant Consider uterine relaxant
Placenta	Placental separation Bleeding vasa previa	
Cord	Vaginal exam Exclude cord prolapse	Consider amnioinfusion

	"C" Clear Obstacles to Rapid Delivery	"D" Determine Decision to Delivery Time
Facility	OR availability Equipment	Facility response time
Staff	Notify *Obstetrician* *Surgical assistant* *Anesthesiologist* *Neonatologist* *Pediatrician* *Nursing staff*	Consider staff: Availability Training Experience
Mother	Informed consent Anesthesia options Laboratory tests Blood products Intravenous access Urinary catheter Abdominal prep Transfer to OR	Surgical considerations *(prior abdominal or uterine surgery)* Medical considerations *(obesity, hypertension, diabetes, SLE)* Obstetric considerations *(parity, pelvimetry, placental location)*
Fetus	Confirm *Estimated fetal weight* *Gestational age* *Presentation* *Position*	Consider factors such as: *Estimated fetal weight* *Gestational age* *Presentation* *Position*
Labor	Consider IUPC	Consider factors such as: *Arrest disorder* *Protracted labor* *Remote from delivery* *Poor expulsive efforts*