FHR Interpretation in 20 (or so) Slides
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• Fetal heart rate monitoring = Fetal brain monitoring

• Brain monitors and responds to
  – Extrinsic influences
  – Intrinsic influences
  – Homeostatic interactions between the fetus and the environment

• Goal = maintain optimal blood flow (oxygenation) of the brain without compromising other organs
Questions to Ask Yourself

• Where did we start from?
  – Is there a clinical risk factor that suggests a predisposition to acidemia

• What is the pH now? And when was I last reassured?

• Is there evidence of impaired oxygen transfer?
  – If yes:
    • Can I improve oxygen transfer (interventions)?
    • Can I reasonably exclude metabolic acidosis?

• If I cannot exclude metabolic acidosis how long do I have before injury might occur?
Strip Review

• Essential characteristics for tracing interpretation
  – Clinical setting – provides the background risk
  – Baseline – Important to determine all other features
  – Variability – A marker of normal pH
  – Decelerations – A marker of ongoing O2 deprivation
  – Contractions – potential cause of O2 deprivation
  – Accelerations – A marker of normal pH
  – Change over time – evidence of an evolving process and marker of time course
... the subsequent fetal response if oxygen transfer is disrupted

POTENTIAL INJURY
Three Key Concepts

1. Significant FHR decelerations (variable, late, prolonged) represent interruptions in fetal oxygen transfer

2. Disrupted oxygen transfer does not cause injury unless there is progression to metabolic acidemia

3. The presence of FHR variability and/or accelerations predict the ABSENCE of metabolic acidosis*

* The converse is not always true...
Three Tier System

- **Category 1**
  - Baseline: 110-160 bpm
  - Variability: moderate (6-25 bpm)
  - Accelerations: present or absent
  - Decelerations: No late/variable/prolonged

This should be your “go to” definition of normal.
Three Tier System

- Category III
  - Absent variability with any one of the following
    - Recurrent late decelerations
    - Recurrent variable decelerations
    - Bradycardia
  - Sinusoidal pattern
    - Cycle frequency 3-5/min lasting at least 20’

If this persists, it is pretty good evidence that you are in deep doo doo.
Category II

- **Baseline**
  - Bradycardia (<110 bpm) with preserved variability
  - Tachycardia (>160 bpm)

- **Variability**
  - Minimal (≤ 5 bpm but detectable)
  - Absent (undetectable)
    - but *NOT* accompanied by recurrent decelerations
  - Marked (>25 bpm)

- **Accelerations**
  - Absence of acceleration with scalp stimulation

- **Decelerations**
  - Late
  - Variable
  - Recurrent
  - Prolonged
The Basics

- Category I: “Strongly predictive of normal fetal acid-base status”
- Category III: “Predictive of abnormal fetal acid-base status”
- Category II: “Indeterminate....[they] require evaluation and continued surveillance and reevaluation, taking into account the entire associated clinical circumstances”

Gee, thanks...
FHR Tracings and Acidemia

• Moderate variability predicts pH > 7.15
  – Negative predictive value 98%

• Minimal/absent variability AND decels associated with pH < 7.15
  – Though predictive value still poor (23%)

• Likelihood of acidemia increases with depth of recurrent decelerations
  – Especially late and with min/absent variability

Evolving Fetal Compromise

- Recurrent variable/late decelerations
- Progressively deeper decelerations
- Reflexive fetal tachycardia (+/-)
- Progressive reduction in variability moderate to minimal to absent
- Terminal bradycardia

Repetitive Cord Occlusion

• Near term fetal sheep – exposed to cord occlusion
  – Mild – 1 minute occlusion every 5 minutes
  – Moderate – 1 minute occlusion every 3 minutes
  – Severe – 1 minute of occlusion every 2 minutes

• Continuous measurement of base deficit (BD) as a marker of metabolic acidosis

Frasch, MG, et al. AJOG 2009;200:200
Deceleration

- Fetal sheep cord occlusion studies
- 1:5 occlusion series – 1 minutes occlusion every 5 minutes
  - Onset of each occlusion was accompanied by a variable FHR deceleration, with rapid return to baseline levels
  - Small fall in pH and a rise in BD and lactate occurred in the first 30 minutes of occlusions
    - (pH, 7.34 ± 0.07; BD, 1.3 ± 3.9 mmol/L; lactate, 4.5 ± 1.3 mmol/L)
  - Values remained stable, despite a further 3.5 hours of occlusions
Deceleration

• 1:2.5 occlusion series – 1 minutes occlusion every 2.5 minutes
  – Rapid occlusion frequency provided only a brief period of recovery between occlusions
  – After 1 hour
    • All animals had a severe metabolic acidosis, with pH 6.92 ± 0.03; BD, 19.2 ± 1.5 mmol/L, and lactate 14.6 ± 0.8 mmol/L by the end of the occlusions
Timecourse to Acidemia

- With minimal/absent variability and recurrent decelerations, acidemia evolves over ~60’
  - In the setting of a previously normal tracing
- Can occur more quickly with acute events
  - Abruption, uterine rupture, cord prolapse
  - Sudden and profound fetal bradycardia
  
Evidence is limited but general expert consensus is “about one hour”

Low JA Obstet Gynecol 1999;93:85-91
Williams KP Am J Obstet Gynecol 2003;188:820-3
Eilimian A Obstet Gynecol 1997;89:373-6
Clark S Am J Obstet Gynecol 1982
Glucose $\rightarrow$ H$_2$O and CO$_2$

Glycolysis

Energy

O$_2$

Lactic Acid

Anaerobic metabolism

Blood flow to placenta is compromised

Carbonic acid (H$_2$CO$_3$)

Diffusion across placenta to maternal circulation rapidly blown off by maternal respiration

H$_2$O + CO$_2$ $\rightleftharpoons$ H$_2$CO$_3$ $\rightleftharpoons$ H$^+$ + HCO$_3^-$

pH in blood maintained by Endogenous base which removes Free hydrogen ions

When base is no longer available to buffer pH **pH falls** rapidly producing a **metabolic acidemia** with increasing **base deficit**
Admit Delivery

Fetal BD
On admit
-1 to -2 mmol/L

-1 mmol/L every hour
In first stage

-1 mmol/L every 3-6 hours
In second stage

Variability and accels tell you where you are with respect to pH/BD

Permanent Fetal injury does not occur until BD < -12 mmol/L
Factors that determine risk of fetal injury

Permanent Fetal injury does not occur until BD < -12 mmol/L
BD on Admission

• Risk of lower starting BD
  – Post term (start 1-2 points lower)
  – Preeclampsia
  – IUGR
  – Oligohydramnios
  – Maternal IDDM
  – Long labor before admission
  – Abruptio
Factors that determine risk of fetal injury

Permanent Fetal injury does not occur until
BD < -12 mmol/L
Rate of BD Decline

• $O_2$ available to fetus
  – Depends on placental function, blood flow
• Frequency, depth and duration of decels
  – Oxygen debt, utilization of buffer
• Ability to remove $CO_2$
  – Placental blood flow

\[ H_2O + CO_2 \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \]
Rate of BD Decline

• “Normal” labor drops BD by ~3 mmol/L
  – First stage drop ~1 mmol/L every 3-6 hours
  – Second stage drop ~1 mmol/L every 1 hour

• Prolonged decelerations
  – BD drops ~1 mmol/L every 2 min of decel
    • So, a 15 minute deceleration drops BD by ~7.5 mmol/L
Rate of BD Recovery

• With corrective measures, BD can improve
  – But much more slowly than it fell
• Recovery of deficit ~0.1 mmol/L per min
  – BD falls 10x more rapidly than it recovers
• Five minutes of normal heart rate are required to recover from one minute of deceleration
Factors that determine risk of fetal injury

Permanent Fetal injury does not occur until BD < -12 mmol/L
Permanent Fetal injury does not occur until $BD < -12 \text{ mmol/L}$
ACOG Algorithm

Intrapartum Fetal Heart Rate Management Decision Model

Confirm FHR and uterine activity

FHR Category?

II or III

I

Is the patient low risk?

Yes

Routine Surveillance
- Every 30 min in the 1st stage of labor
- Every 15 min in the 2nd stage of labor

Heightened Surveillance
- Every 15 min in the 1st stage of labor
- Every 5 min in the 2nd stage of labor

Expedite Delivery

“ABCD”

“A” – Assess oxygen pathway
“B” – Begin corrective measures

FHR Category?

I

Yes

Moderate variability and/or accelerations and
No clinically significant decelerations

II

Yes

“C” – Clear obstacles to rapid delivery
“D” – Determine decision to delivery time

III

No

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

**Category I**
- **Surveillance**
  - "Low risk"
    - 1st stage q 30 min
    - 2nd stage q 15 min
  - "High risk"
    - 1st stage q 15 min
    - 2nd stage q 5 min

**Category II**
- **Conservative Measures “A & B”**
  - Assess Oxygen Pathway
    - Lungs
    - Heart
    - Vasculature
    - Uterus
    - Placenta
    - Cord
  - Begin Corrective Measures
    - Supplemental oxygen
    - Position change
    - Fluid bolus
    - Correct hypotension
    - Stop/reduce uterine stimulant
    - Consider uterine relaxant
    - Consider amnioinfusion

**Category II - III**
- **Prepare for Delivery “C & D”**
  - Clear obstacles to delivery
    - Facility
    - Staff
    - Mother
    - Fetus
    - Labor
  - Decision-delivery
    - Facility
    - Staff
    - Mother
    - Fetus
    - Labor

**Outcome**
- Is immediate delivery indicated?
  - No

Evolution of metabolic acidemia ~ 60 min
- Subtract 50% safety margin ~ 30 min
- Subtract “decision-delivery estimate” ~ X min
- Allow the remaining time for vaginal delivery or correction of the FHR tracing

If vaginal delivery does not occur in this time frame and the FHR abnormalities have not been corrected, it is reasonable to offer operative delivery

Algorithm for management of category II fetal heart rate tracings

Moderate variability or accelerations

Yes

Significant decelerations with ≥50% of contractions for 1 hour

Yes

Latent Phase

Normal labor progress

Cesarean

No

Active Phase

Normal progress

Observe

Yes

Second Stage

Normal progress

Cesarean or OVD

No

Observe

Yes

Observe for 1 hour

No

Persistent pattern

Manage per algorithm

**OVD**, operative vaginal delivery.

*That 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.

Conclusion

• Proposed algorithm is the result of Expert opinion
  – Not tested in prospective fashion (or retrospective fashion for that matter)
• “We do not believe it is possible to simultaneously eliminate preventable fetal neurologic injury and significantly reduce the cesarean delivery rate for abnormal FHR patterns”
  – This approach will increase the cesarean section rate in order to prevent HIE
Summary General Approach

• Recognize potential for fetal compromise
• Attempt to improve oxygen delivery
  – Begin corrective measures
• Anticipate time to delivery
  – “Do you think she can do it???”
  • Parity, labor progress, fetal size/station/position, etc
• Account for potential complicating factors
  – time to mobilize care teams (operative delivery)
  – maternal factors (BMI, prior surgery, willingness)
Crystal Clear, Right?

- It’s as simple as I, II, III
- Or maybe green, blue, yellow, orange, red?
- Questions???