FHR Interpretation in 20 (or so) Slides

Intermountain Healthcare
University of Utah
M. Sean Esplin MD
Maternal Fetal Medicine

Pathophysiology

- 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

Environment

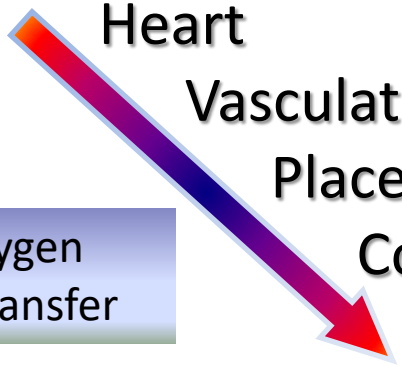
Lungs

Heart

Vasculature

Placenta

Cord



Oxygen Transfer

FETUS

… the subsequent fetal response if oxygen transfer is disrupted

Hypoxemia

Hypoxia

Fetal Response

Metabolic acidosis

Metabolic acidemia

Hypotension

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

Parer JT Matern Fetal Neonatal Med 2006; 19:289-94
Parer and Ikeda Am J Obstet Gynecol 2007;197(26):26e.1-26.e6.

Evolving Fetal Compromise

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

Parer JT Matern Fetal Neonatal Med 2006; 19:289-94

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 $\pm$ 0.07; BD, 1.3 $\pm$ 3.9 mmol/L; lactate, 4.5 $\pm$ 1.3 mmol/L)
  - Values remained stable, despite a further 3.5 hours of occlusions

Deceleration

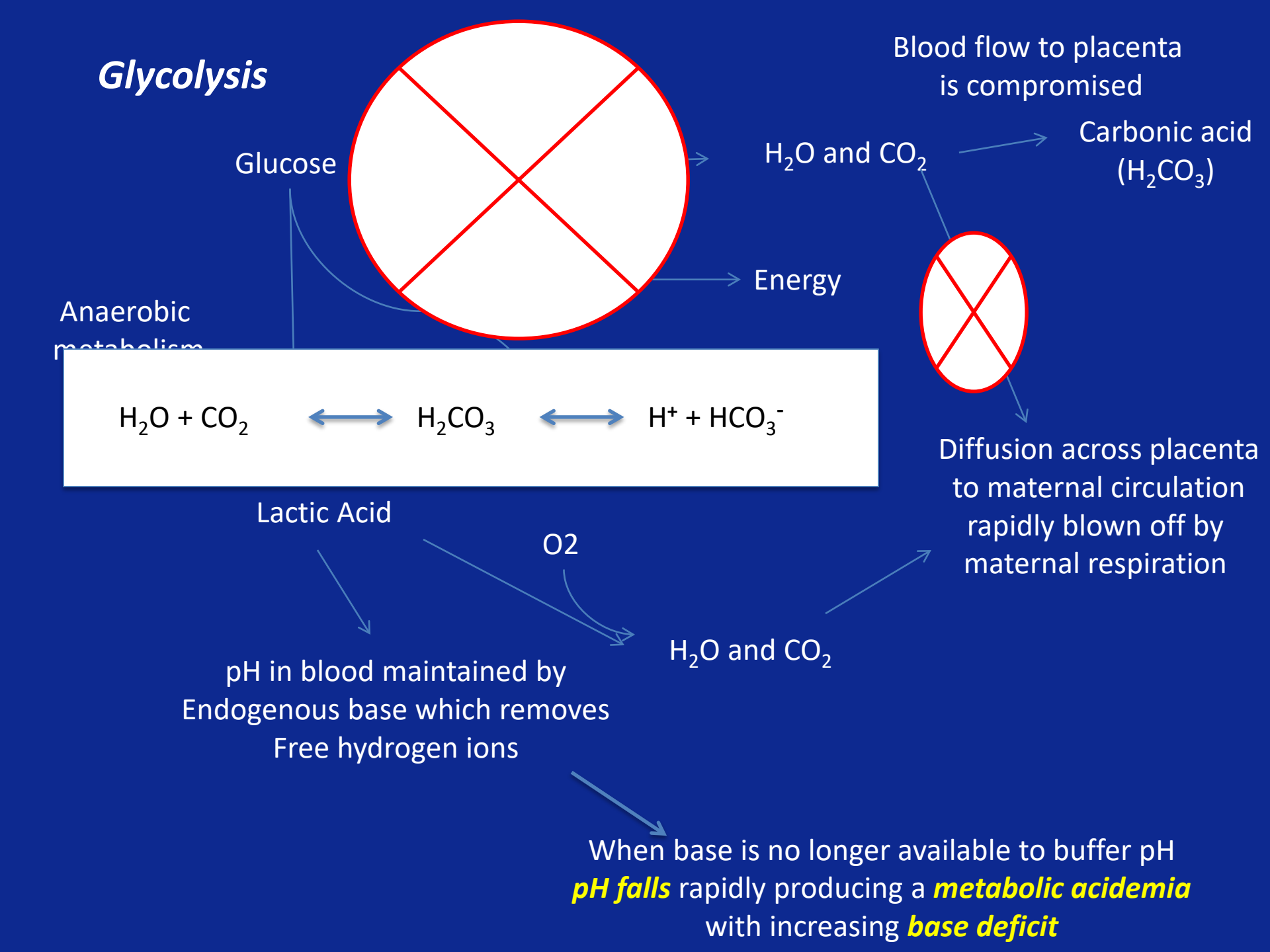
- 1:2.5 occlusion series – 1 minutes occlusion every 2.5 minutes
  - Rapid occlusion frequency provided only a brief period of recovery between occlusions
  - After 1 hour
    - All animals had a severe metabolic acidosis, with pH 6.92 $\pm$ 0.03; BD, 19.2 $\pm$ 1.5 mmol/L, and lactate 14.6 $\pm$ 0.8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

Timecourse to Acidemia

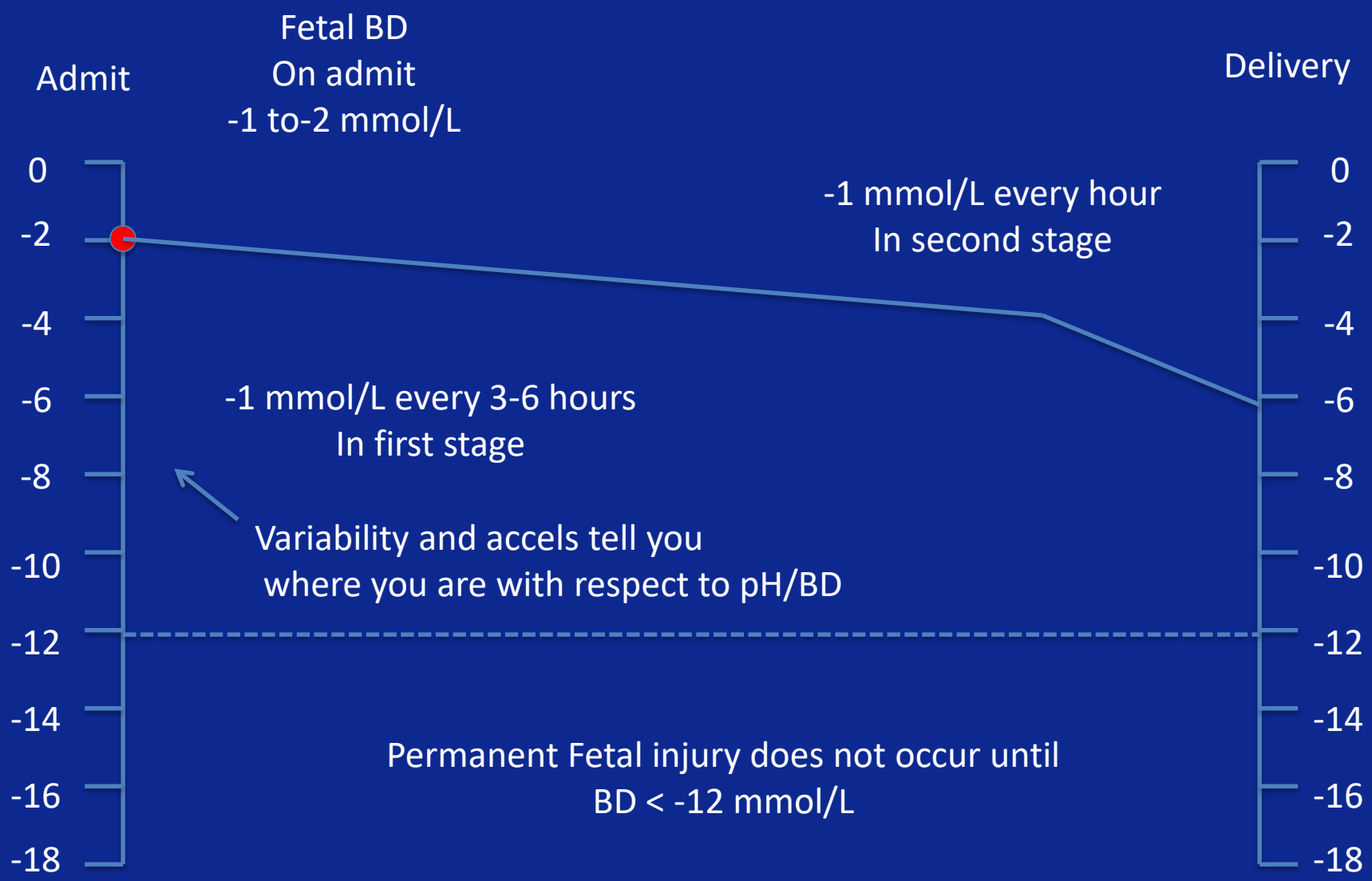
- With minimal/absent variabil
  decelerations, acidem
  - In the setti
- Ca
  rupture, cord prolapse
  and profound fetal bradycardia

Evidence is limited but general expert consensus is "about one hour"

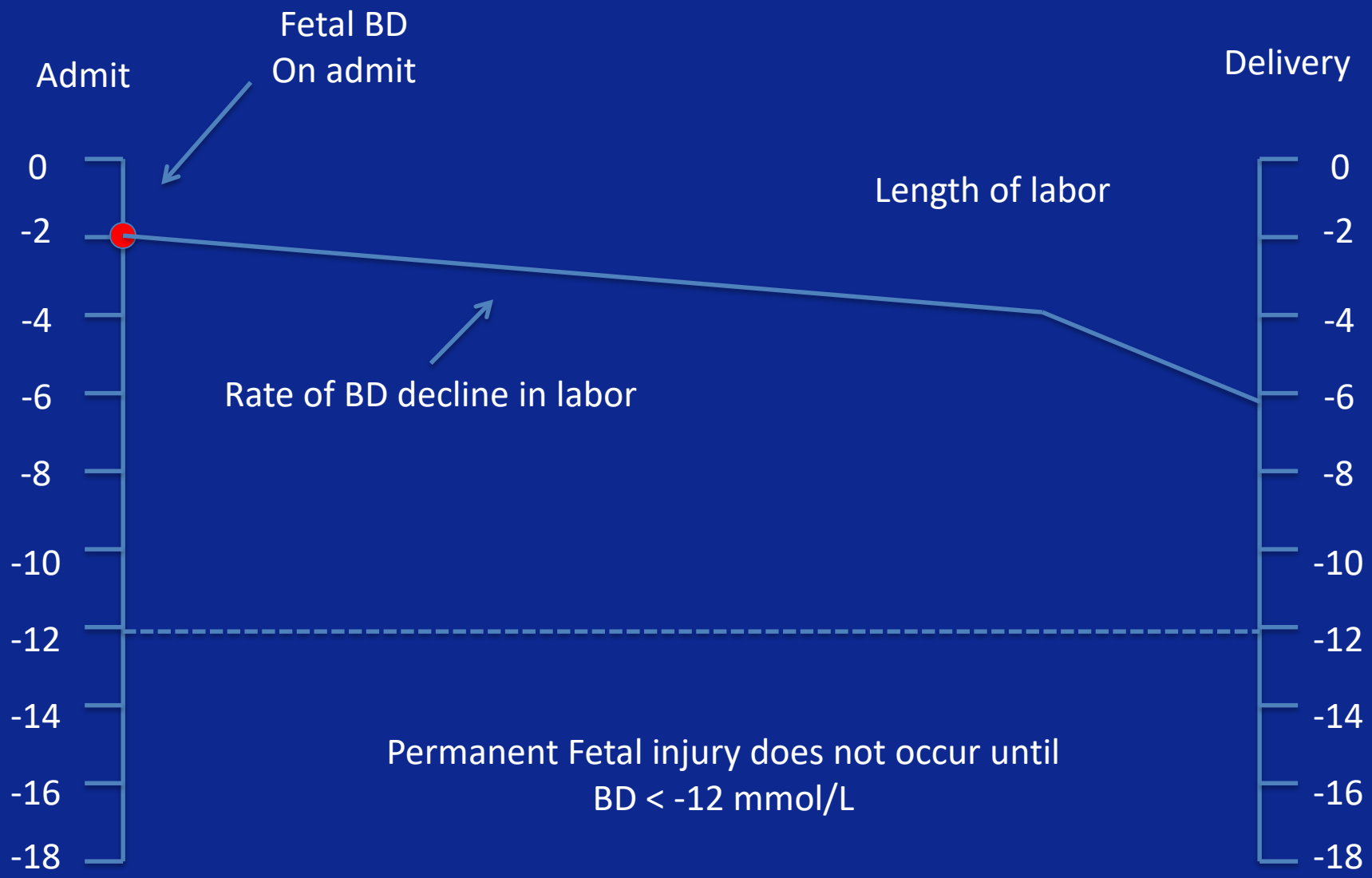
Parer JT Matern Fetal Neonatal Med 2006; 19:289-94
Low JA Obstet Gynecol 1999;93:85-91
Williams KP Am J Obstet Gynecol 2003;188:820-3
Eilimian A Obstet Gynecol 1997;89:373-6
Clark S Am J Obstet Gynecol 1982


Glycolysis
Blood flow to placenta is compromised
Glucose
H_2O and CO_2
Carbonic acid (H_2CO_3)
Energy
Anaerobic metabolism
$H_2O + CO_2 \longleftrightarrow H_2CO_3 \longleftrightarrow H^+ + HCO_3^-$
Diffusion across placenta to maternal circulation rapidly blown off by maternal respiration
Lactic Acid
O2
H_2O and CO_2
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

The Big Picture



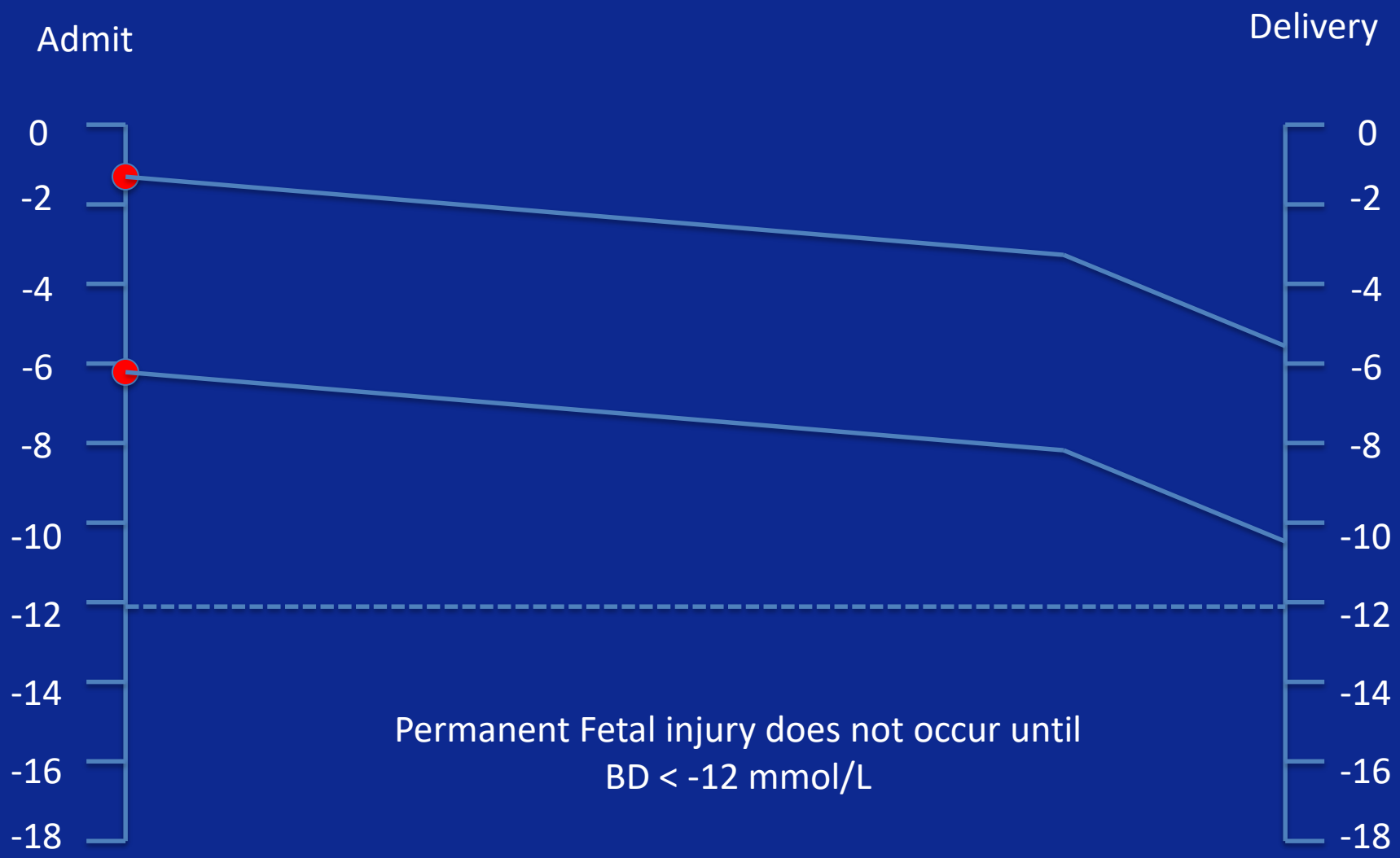
Factors that determine risk of fetal injury



BD on Admission

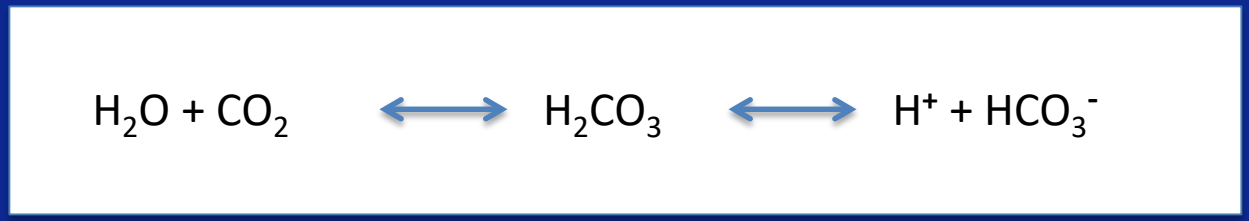
- Risk of lower starting BD
  - Post term (start 1-2 points lower)
  - Preeclampsia
  - IUGR
  - Oligohydramnios
  - Maternal IDDM
  - Long labor before admission
  - Abruption

Factors that determine risk of fetal injury



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



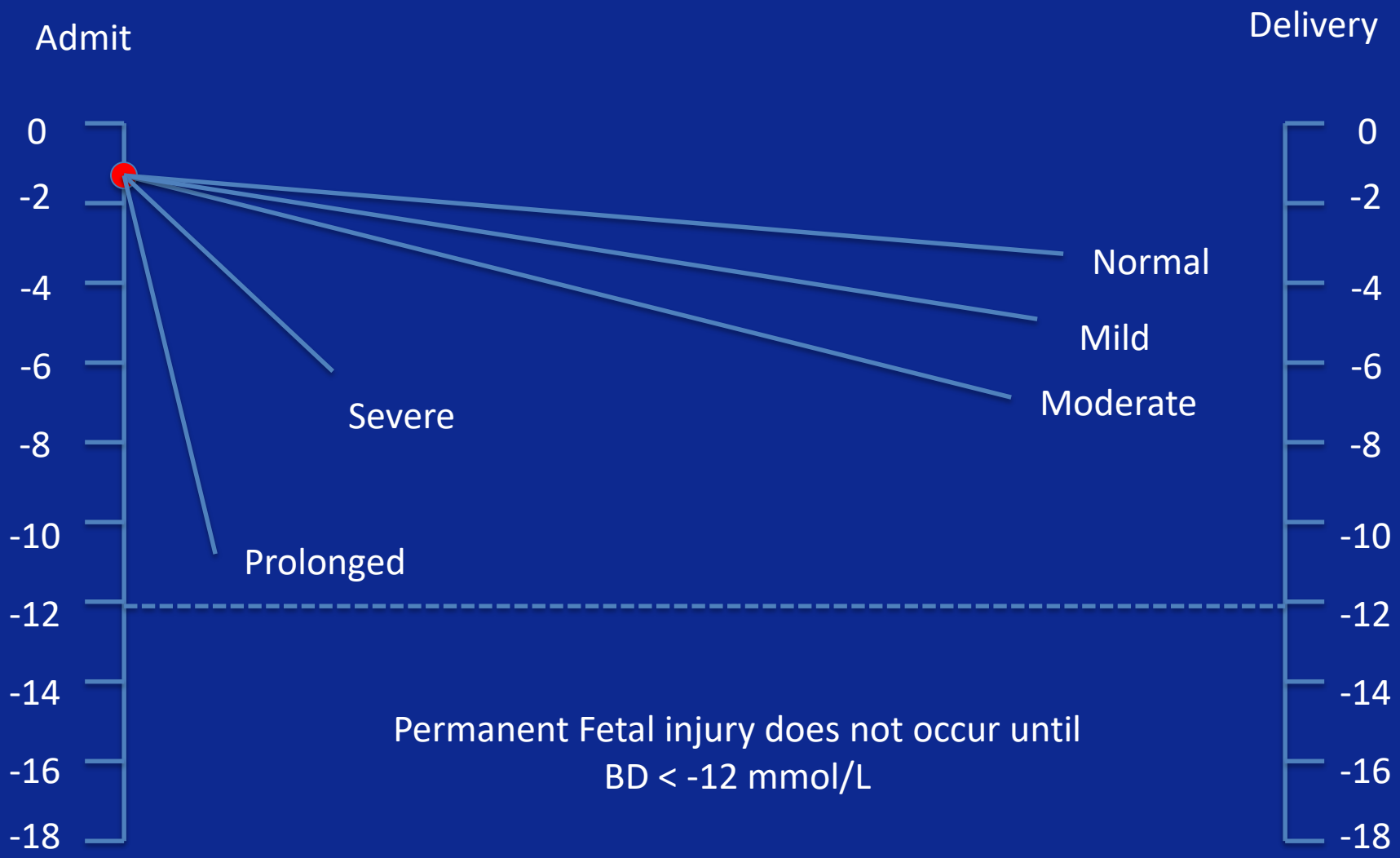
Rate of BD Decline

- "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

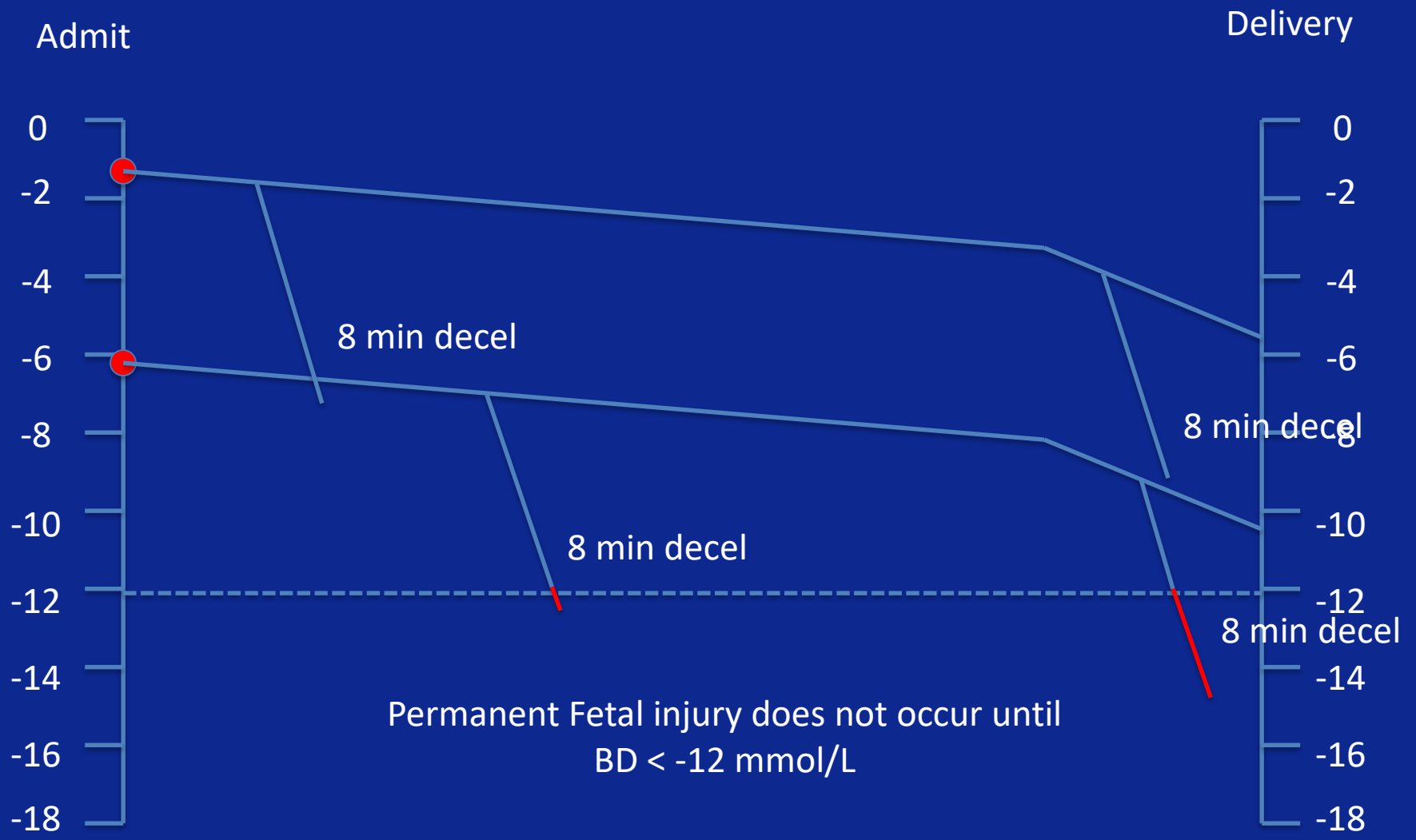
Rate of BD Recovery

- 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

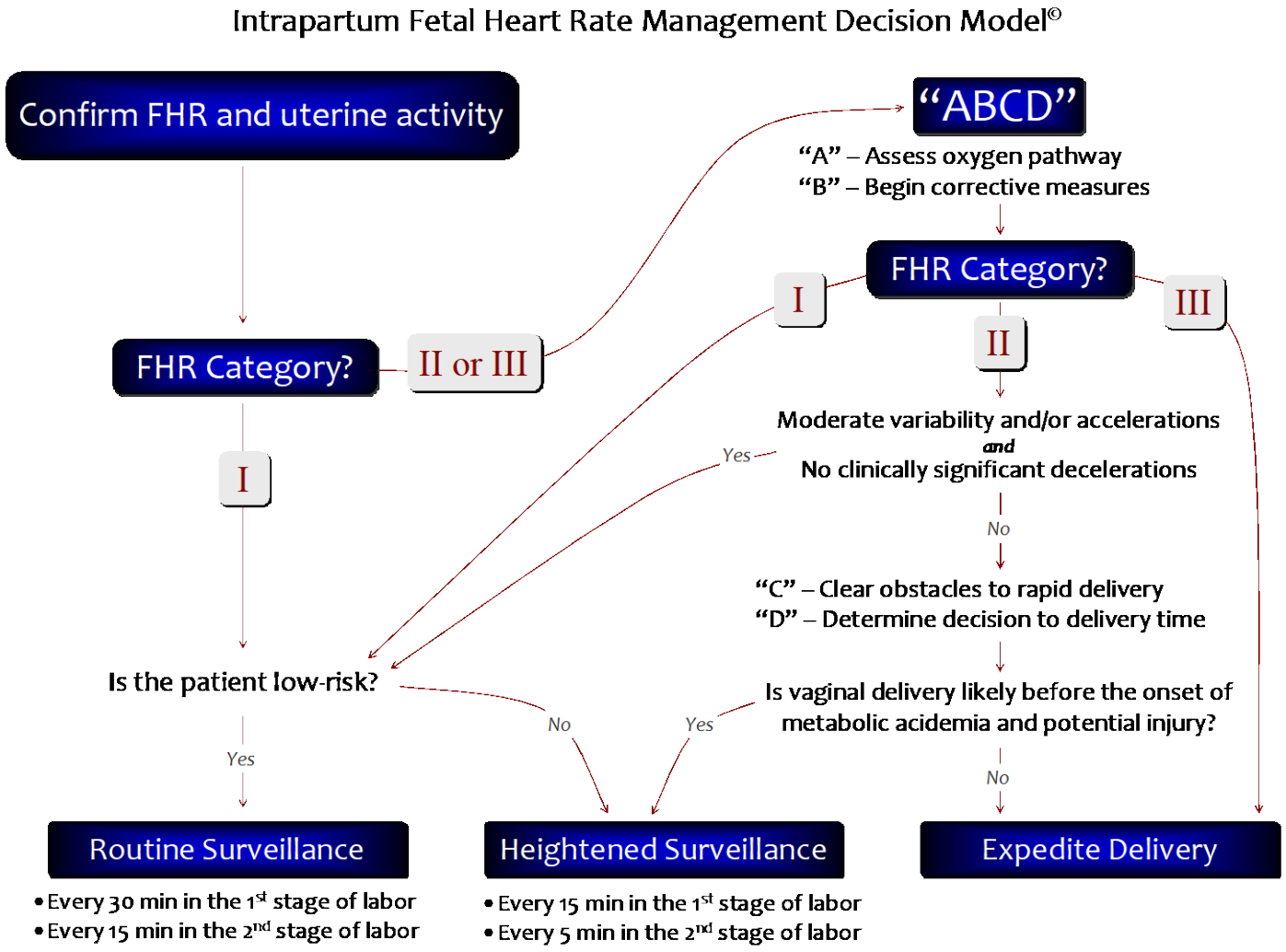
Factors that determine risk of fetal injury



Factors that determine risk of fetal injury

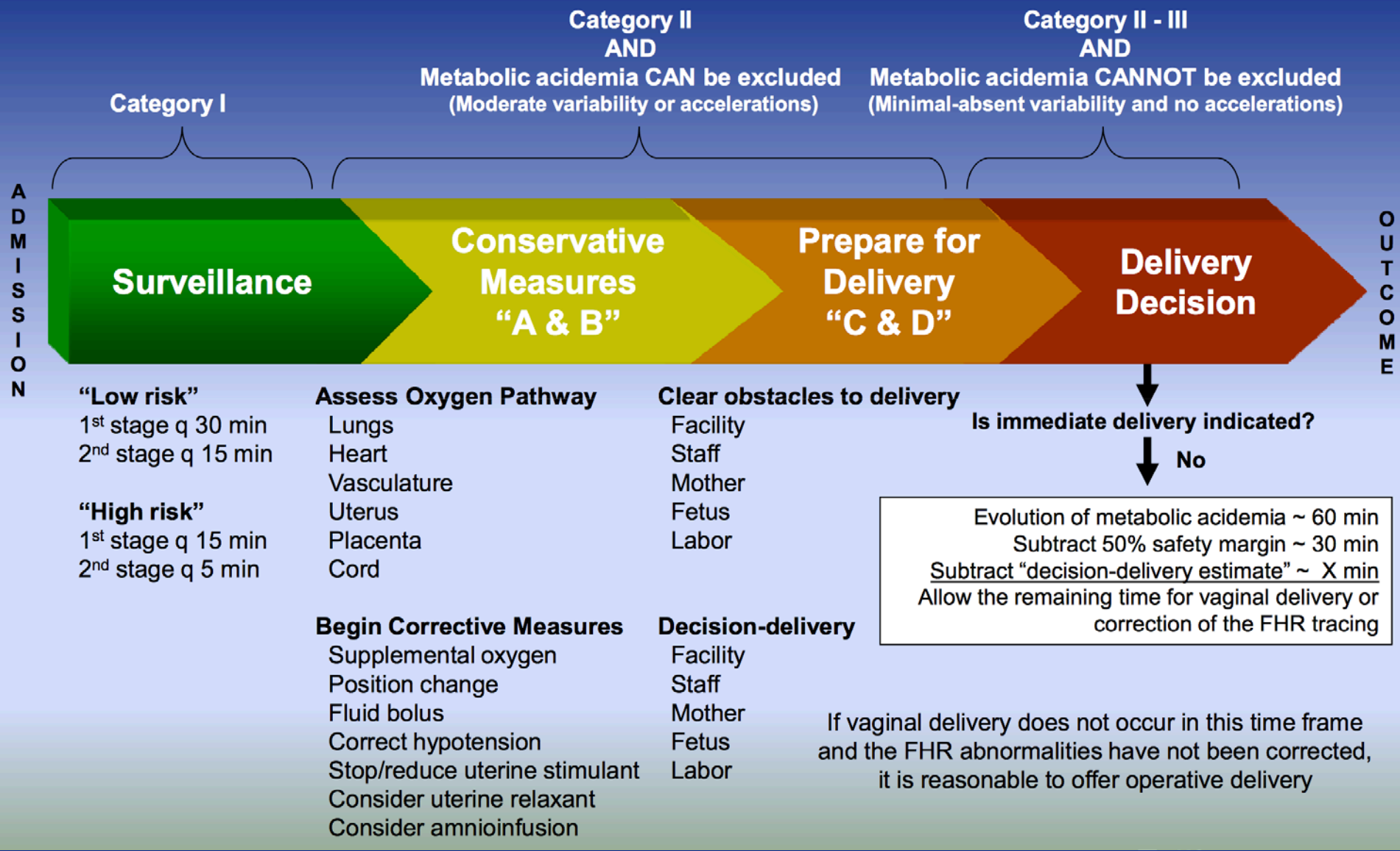


ACOG Algorithm



http://mail.ny.acog.org/website/EFMPoster.pdf

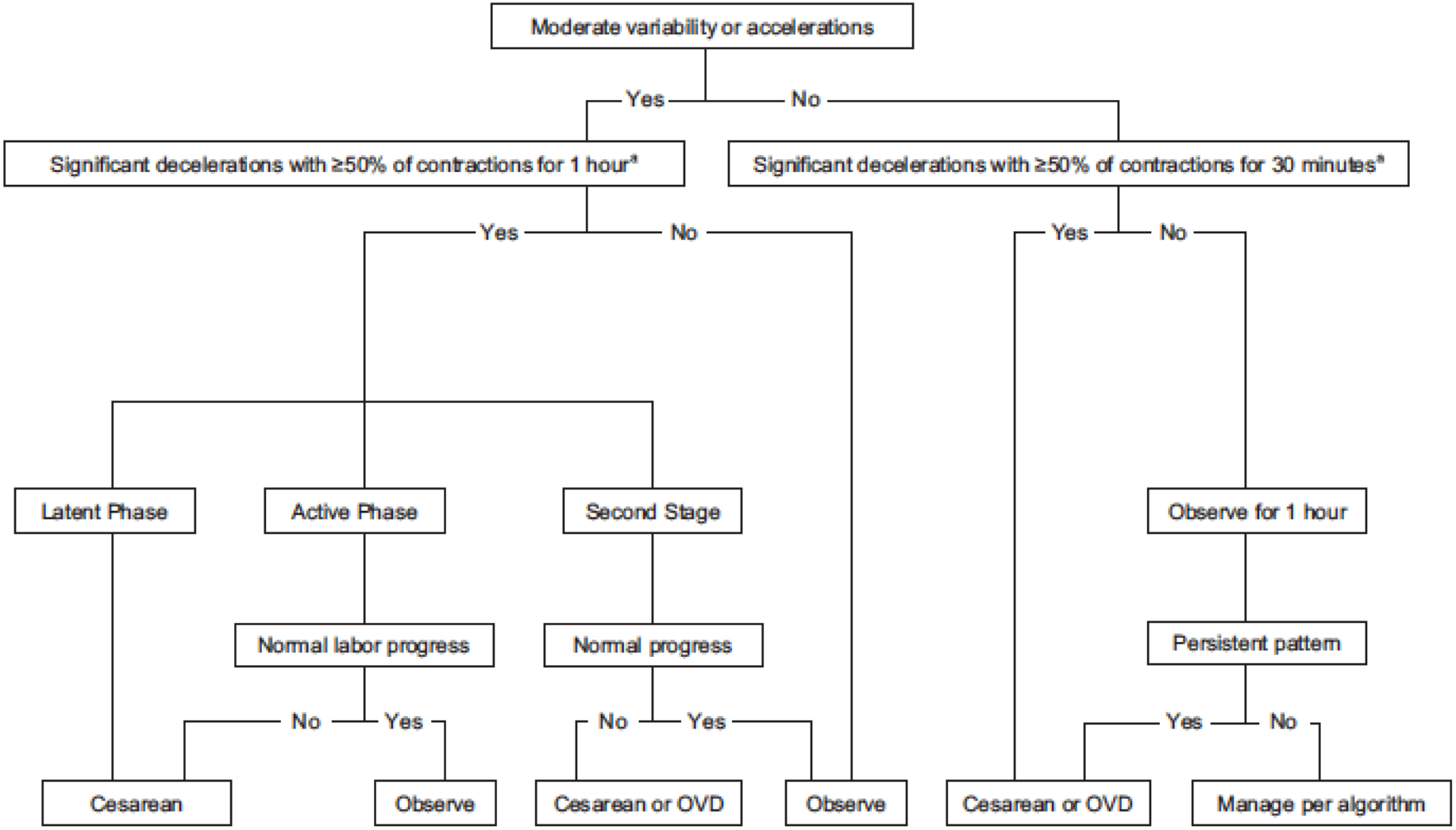
ACOG Algorithm



http://www.acog.org/About-ACOG/ACOG-Districts/District-II/Quick-Guide-and-Teaching-Modules

FIGURE 1

Algorithm for management of category II fetal heart rate tracings



OVD, operative vaginal delivery.

[a]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.

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

Clark SL et al Am J Obstet Gynecol 2013; 209(2):89-97.

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

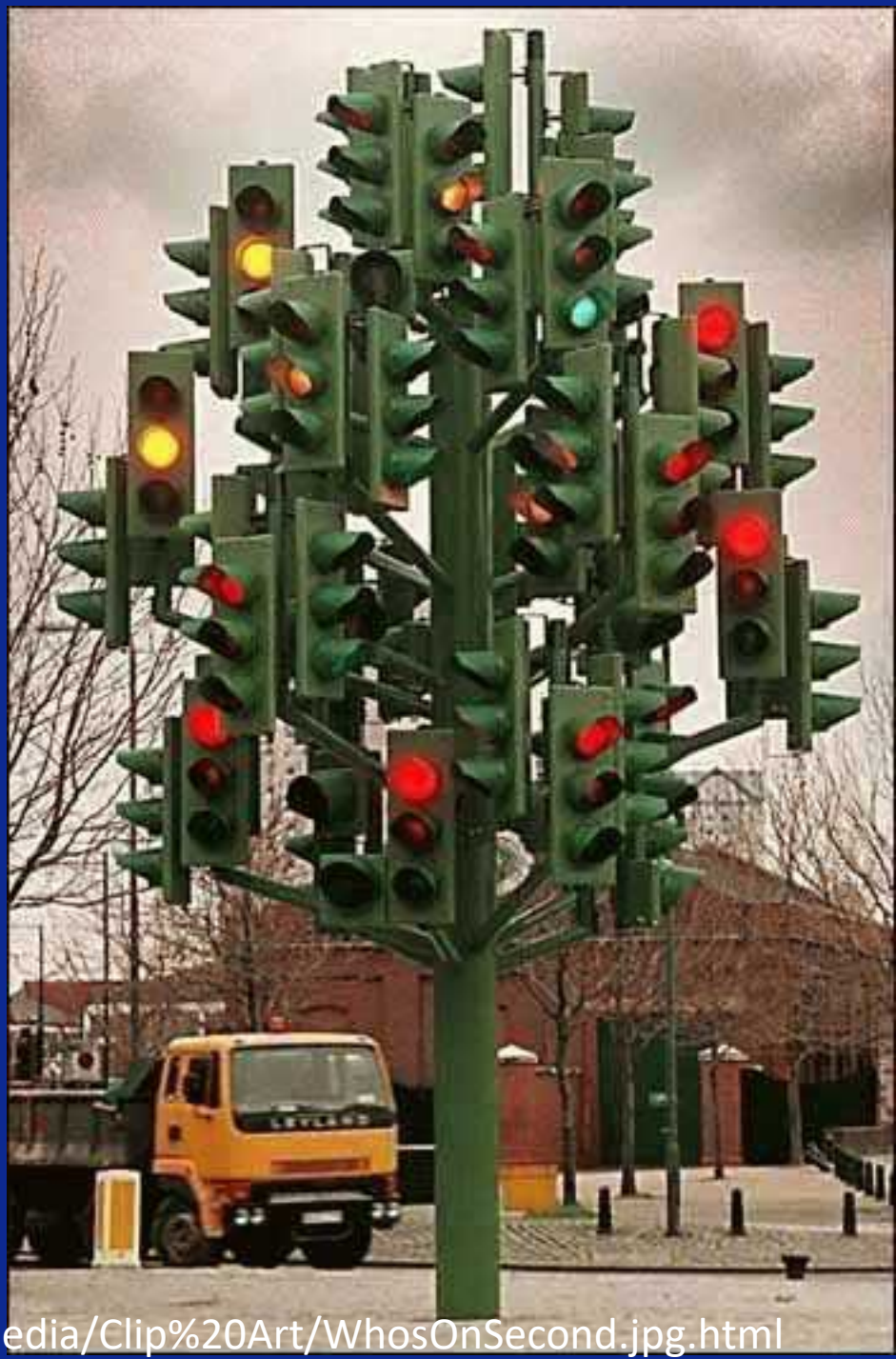
Summary General Approach

- 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???



http://s903.photobucket.com/user/drdoolittle/media/Clip%20Art/WhosOnSecond.jpg.html