Management of Fetal Distress

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Conflicts of Interest

• I have no financial disclosures
Aims

• To provoke a thought based approach to the assessment of fetal wellbeing rather than a manual based approach
• To give an evidence based review of the technology and clinical strategies available to us in fetal assessment in labour
• To integrate historical knowledge with contemporary clinical practice
I have never had a problem – why change”
(The three dirty words – “In my experience”)

• Assume an Ob does 140 deliveries per year

• 1 permanent brachial plexus injury every 33 years
• 1 case of CP due to birth asphyxia every 48 years
• 1 case of CP due to uterine rupture every 403 years
“The process of birth is responsible for the pathology of cerebral palsy.”

W. Little, Trans Obstet Soc Lond, 1862
“... at most, only 3-10% of all CP can be explained on the basis of hypoxic (ischaemic) encephalopathy.”

_Nelson et al., Pediatrics, 1995_
## Risk factors for NE

<table>
<thead>
<tr>
<th>Factor</th>
<th>Adjusted Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal placental appearance</td>
<td>2.07</td>
</tr>
<tr>
<td>Emergency cesarean</td>
<td>2.17</td>
</tr>
<tr>
<td>Instrumental delivery</td>
<td>2.23</td>
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<tr>
<td>Family history of seizure</td>
<td>2.55</td>
</tr>
<tr>
<td>Family history of neurological disorders</td>
<td>2.73</td>
</tr>
<tr>
<td>Viral illness</td>
<td>2.97</td>
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<tr>
<td>Moderate/severe antepartum bleeding</td>
<td>3.57</td>
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<tr>
<td>Intrapartum fever</td>
<td>3.82</td>
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<tr>
<td>Occiput posterior presentation</td>
<td>4.29</td>
</tr>
<tr>
<td>IUGR 3rd-9th percentile</td>
<td>4.37</td>
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<tr>
<td>Infertility treatment</td>
<td>4.43</td>
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<tr>
<td>Acute intrapartum event</td>
<td>4.44</td>
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<tr>
<td>Severe preeclampsia</td>
<td>6.3</td>
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<tr>
<td>Maternal thyroid disease</td>
<td>9.7</td>
</tr>
<tr>
<td>IUGR &lt;3rd percentile</td>
<td>38.23</td>
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</tbody>
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Criteria to Define an Acute Intrapartum Hypoxic Event As Sufficient to Cause Cerebral Palsy

Essential criteria (must meet all four):

1. Evidence of metabolic acidosis in fetal umbilical cord arterial blood obtained at delivery (pH < 7 and base deficit 12 mmol/L)

2. Early onset of severe or moderate neonatal encephalopathy in infants born at 34 or more weeks of gestation

3. Cerebral palsy of spastic quadriplegic or dyskinetic type

4. Exclusion of other identifiable etiologies, such as trauma, coagulation disorders, infectious conditions, or genetic disorders
A Recent BWH Patient

• 20 yo G1P0 presenting in labor at 37+1
  ✦ 4/80/-1

• Medical / Surgical / Medication History
  ✦ Noncontributory

• This Pregnancy
  ✦ Late to prenatal care (28 weeks)
  ✦ Elevated GLT (144), normal GTT
  ✦ Presents in labour at 4 cms dilatation
Patient MW: 15:30

- Maternal vital signs: T 98.7, P 103, BP 117/71
- Still 4 cms cervical dilatation
- Oxytocin commenced
- Anesthesia called
  ✷ Epidural placed
- OB attending made aware
- Plan for Primary CS if FHT did not improve or worsened
19:45: Midwifery Shift Change

- Early labor
- EFW 8.5 lbs
- 6 / 100 / -1
- Tracing precludes fetal acidaemia
- Turn to left lateral position
- “Monitor Closely”
- Reviewed case with OB attending
23:00

- “150’s baseline, moderate variability, variety of decelerations: early, late, variables, +accelerations with scalp stimulation”
- 8 / 100 / 0, molding
- A/P
  - Moderate variability precludes acidaemia
  - Watch FHT closely
  - Re-evaluate in 1-2 hrs
23:20 Re-evaluated

- FSE applied
- OB Chief called
- “Prolonged deceleration due to tachysystole”
- Oxytocin decreased
- “Watch FHT closely, evaluate prn”
00:10

- $T=101.0$
- 8-9/100/0
- 160’s, minimal variability, late decelerations with every ctx
- “+accelerations with scalp stimulation”
- “slow progress with dysfunctional ctx pattern”
- Reevaluate in 1 hr, monitor CTG closely
- Chorioamnionitis & anbiotics
00:45-00:55

- Chief / Attending called in
- “Recommendation for Caesarean delivery explained to patient”
Delivery

- Emergent Primary CS
- In room: 01:10
- Induction Complete 01:15
- Knife to skin 01:16
Intra-Operative Findings

- The infant's head was found to be floating.
- A kiwi vacuum was placed to attempt to deliver the patient in the vertex presentation.
- The arm and shoulder emerged through the hysterotomy.
- The suction was released and the hand and shoulder were then repositioned inside the uterus.
- The infant was then found to be in a transverse position.
- The baby was delivered breech through the hysterotomy in an uncomplicated manner. Delivery 01:19
  - 7lb 5 oz
  - APGAR 4/8
  - Transferred to NICU
Can the CTG Predict a Neonatal pH < 7.12? (Umstad et al. 1994)

- 1200 intrapartum CTGs reviewed.
- PPV of late deceleration was 19%.
- Only 10% of fetuses with pH < 7.12 had late decelerations in labour.
- The combination of baseline tachycardia, reduced variability and late decelerations had a PPV for pH < 7.12 of 25%.
Day of Life 1

- Increased swelling of left leg noted
- X Ray: Single lateral view of the left leg shows a spiral fracture of the midshaft left femur with moderate posterior angulation of the distal fragment. There is moderate soft tissue swelling overlying the fracture.
- Impression: Spiral fracture of the left femur
- Orthopedics consulted: Pavlik harness
Pavlik Harness
What Are Our Tools and Strategies?
Resuscitative Measures

• Oxygen for intrauterine resuscitation: of unproved benefit and potentially harmful
  • Good biological plausibility
  • Data mixed and supportive data observational, non-randomized, and not exclusive to laboring women
  • At best improve fetal heart rate patterns but not fetal acid-base status (may lower pH)
Oxygen Supplementation

- Two Randomized Controlled trials
    - 86 randomized to room air or oxygen
    - Lower pH with oxygen – not statistically significant
    - 160 randomized to room air or oxygen
    - Lower pH with oxygen – not statistically significant

- Potentially harmful effects
  - Maternal hyperoxaemia may cause increased free radical activity in mother and baby
Scalp Stimulation

• Fetal heart response to scalp blood sampling
  ✦ 15 bpm for 15 seconds
  • 142 of 144 fetuses with a scalp pH > 7.28 responded to scalp puncture, < 7.28 none did

• The scalp stimulation test: a clinical alternative to fetal scalp sampling
  ✦ Digital pressure followed by an Allis clamp
  • 100 CTGs suspicious for asphyxia
  • 51 responded with an acceleration (pH > 7.19)
  • Of the remaining 49, 30 had a pH > 7.19 (61%)
Scalp Sampling

• A new method for examination of the child during labor. Introduction, technic, and principles.
  ✦ Initially introduced as a rest of fetal wellbeing in its own right
    • Before commercial introduction of CTG machines in 1968
  ✦ Then to ↓ the 60% false positive rate of those 40% sampled

• Fetal scalp blood sampling during labor: is it a useful diagnostic test or a historical test that no longer has a place in modern clinical obstetrics?
  ✦ Chandraharan E. BJOG 2014;1056-1062.
  ✦ In hypoxia, catecholamines result in peripheral vasoconstriction resulting in peripheral acidosis
Biological Plausibility of FSBS

- No RCTs of the use of this technique
- Meconium reduces PPV (bile acid effect)
- Amniotic fluid reduces accuracy (alkaline)
- More acidotic during a uterine contraction
- More acidotic if caput
- Peripheral acidosis may not predict central acid-base status
- Fetal acidosis is not a good predictor of outcome
Current Recommendations for FSBS

- No evidence that FSBS reduces incidence of operative vaginal delivery or Caesarean delivery or influences long term paediatric outcome

- ACOG Practice Bulletin No. 106

- Nice Clinical Guideline No.55 London
  - NICE; September 2007

- Currently not used in the USA
- Continues to be used in the UK
Fetal ECG ST Analysis

• When there is an abnormal trace fetal ECG ST changes can help discriminate true positives from false positives
• When there is a suspicious trace, the STAN system is initiated
• It will inform when a FSBS is indicated
• But we no longer use FSBS…
• Could be used for delivery indication without FSBS to decrease FPR of CTG
A Comparison of Scalp Stimulation with Scalp Blood Sampling

- Elimian A et al. Obstet Gynecol 1997;89:373-6
- 108 women with a CTG suggestive of acidosis
- In all 51 cases of a 15 x 15 response, pH >7.2
- 7 more if the definition included 10 x 10 bpm
- 21 of those cases without response had variability
  ✨ Only two had a pH < 7.2 compared to 13 of the 29 without
- 10% with variability had a pH < 7.2 (2SD from normal)
Apgars < 4

- 10 in the calendar year of 2013
- All are Category II tracings
- *Therefore un-predictive of fetal acid base status*
- All were followed for too long
- Often they deteriorated quickly, ending with a bradycardia prior to delivery
- *A false reassurance from normal variability is a common feature*
Apgars < 4

- The trace shows an increasing baseline, decelerations noted (both variable and late). Normal variability
- Variables throughout with occasional lates, rising baseline, always normal variability
- Occasional tachysystole with short bradycardias, early and late decelerations with a rising baseline, but always normal variability
- “Normal variability precludes asphyxia”
Why is Variability so Reassuring and Reliable?

• It is not

• Huter J, Hammacher K, Kubli F, Tripp R
  ✮ Geburtshife Frauenheilkd 1968;28:874-84
  ✮ Modification of the basal fetal heart rate and the fetal and maternal acid-base equilibrium by pethidine

• Nothing physiologically produced is entirely reliable

• It is convenient and an easy replacement for other techniques

• A need for a categorical system rather than a physiological understanding
Fetal Heart Trace Monitoring

- Would not get introduced in today’s world
  - Introduced clinically relatively soon after inception
  - Introduced without a large body of research
  - Introduced without premarket testing
  - Introduced without an instruction manual

- …so our specialty is now producing an instruction manual…
Since 1997 there have been several important consensus publications that have reshaped the fetal monitoring landscape:

• 1997 – First NICHD Consensus Statement

• 1999 – International Cerebral Palsy Task Force Consensus Statement

• 2003 – ACOG-AAP Cerebral Palsy Task Force Consensus Statement

• 2005 – ACOG/AWHONN endorsement

• 2006 – ACNM endorsement

• 2008 – Second NICHD consensus report

• 2009 – ACOG Practice Bulletin 106

• 2010 – ACOG Practice Bulletin 116
So...Yet Again...

• Category I
  ✴ Normal

• Category II
  ✴ Intermediate
    • In-between
    • Transitional
    • No man’s land

• Category III
  ✴ Abnormal
Category I
Normal

**Strongly predictive of normal acid-base balance**

- Baseline 110-160 bpm
- Moderate variability (6-25 bpm)
- No late or variable decelerations
- Early decelerations may be present or absent
- Accelerations may be present or absent
Category III
Abnormal
*Predictive of acidaemia at the time*

• Absent fetal heart rate variability and any of the following:
  ✦ Recurrent late decelerations
  ✦ Recurrent variable decelerations
  ✦ Bradycardia
  ✦ Sinusoidal pattern
Category II
Intermediate / Transitional

Not predictive of fetal acid base balance

- Not I and not III
  - Tachycardia, bradycardia without absent variability, minimal variability, absent variability without recurrent decelerations, marked variability, absence of accelerations after stimulation, recurrent variable decelerations with minimal or moderate variability, prolonged deceleration > 2 minutes but less than 10 minutes, recurrent late decelerations with moderate variability, variable decelerations with other characteristics such as slow return to baseline, and "overshoot"

- 80% of traces have regions of Category II
Accelerations reflect sympathetic activity, fetal movement, Spontaneous or response scalp stimulation. They are reassuring.

Remember the fetal heart does not obey Starling’s law – a chronotropic, rather than an inotropic, organ.
Abnormalities of the Fetal Heart Trace

• Early deceleration
  ✦ A vagal response
  ✦ A response to increased cranial pressure
  ✦ Increased pressure results in decreased blood flow which leads to a vagal response (immediate)
  ✦ Seals and diving mammals
  ✦ Ed Hon and rubber bands
Abnormalities of the Fetal Heart Trace

- The variable deceleration
  - Umbilical cord compression
  - Compression of the vein occurs first
    - Transient hypovolaemia may lead to a “healthy” reflex acceleration
  - Compression of the artery then occurs
    - Aortic / carotid baroreceptor response with vagal stimulation leads to the deceleration
    - Vagal, therefore immediate
  - Alleviation of the pressure
    - Can result in reflex acceleration, the classic “M” wave
Late decelerations

There are lates...

and there are lates...
Fetal oxygen consumption and mechanism of heart rate response during artificially produced late decelerations of fetal heart rate in sheep

- Pregnant ewes (26 studies on 6 sheep with aortic occlusion, 25 studies on 5 sheep after treatment with atropine, and 5 studies with atropine and propanolol [efficacy confirmed with acetylcholine and isoprotenerol])
  - Amniotic cavity catheter
  - Common umbilical artery blood flow transducer
  - Catheters in the umbilical vein and fetal distal aorta
  - Uterine artery flow transducer
  - Fogarty balloon tip catheter in the aorta distal to the renal arteries
• Lambs in late pregnancy
  ✦ Mean gestational age 125 days
  ✦ Mean fetal weight 2455 +/- 533 gms
• Heart rate, blood flows, blood pressures, pH, and oxygen content were measured
• Inflation of the Fogarty balloon in the maternal distal aorta led to uterine blood flow decreasing virtually to zero
• There was a delayed decrease in the fetal heart rate with no change in umbilical blood flow or fetal arterial pressure
• A laboratory recreation of utero-placental insufficiency
Portion of an actual recording of uterine blood flow (Ut. BF), maternal arterial blood pressure (MAP), fetal heart rate (FHR), fetal arterial pressure (FAP) and umbilical blood flow (Umb. BF). The 20-second period of aortic occlusion is evident from the decrease of uterine blood flow to zero.
Fig. 2. Fetal heart rate and O₂ consumption changes during and after maternal aortic occlusion. The value at time zero is the preocclusion control value in each study. See text for n values. Asterisks represent values significantly different from control (*p < 0.01; **p < 0.001).
Fig. 4. $O_2$ content of umbilical venous and umbilical arterial blood during and after maternal aortic occlusion (See legend for Fig. 2.)
Why is the Late Late?

- Chemoreceptors detect transient acidaemia
  - Transient acidaemia is physiological not pathological
- Hind quarter / brain sparing reflex
- Central hypertension
- Baroreceptor response
- Vagal response
- The above takes time (the chemoreceptor element)
- Delayed deceleration
Pharmacological Manipulation

- Tx with totally blocking doses of atropine
  ✦ The late deceleration is abolished
  ✦ It is replaced with a delayed acceleration (stress pressor response [adrenals noradrenaline etc.])

- Tx with totally blocking doses of propanolol
  ✦ The delayed acceleration is abolished

- Therefore the occurrence of a late deceleration is mediated by the vagal nerve in the presence of B adrenergic activity (parasympathetic & sympathetic activity)

- Remember the sheep are not pathologically acidaemic

- Late decelerations are not necessarily linked to pathological fetal hypoxia
Mechanisms of late decelerations of the fetal heart rate during hypoxia
Harris et al. Am J Obstet Gynecol 1982;144:491

• Same methodology as prior paper
• 23 aortic occlusions on 8 fetuses
• Hypoxic fetuses this time
• Late deceleration produced
• Not abrogated with atropine
• Mechanism?
  ✤ These lates are due to hypoxic myocardial depression
    • Hypoxic myocardial depression
Fig. 7. Mechanisms of late decelerations of the fetal heart rate (FHR, solid line) during normoxia and hypoxia illustrating the effect of these mechanisms on umbilical blood flow (UBF, broken line). AO, Aortic occlusion.
The Physiological Approach

• We have two types of deceleration (repetitive variables and lates), which although often physiological may be pathological (particularly lates)

• How do we discriminate?
  ✦ Scalp stimulation
  ✦ Fetal scalp sample?
  ✦ Variability

• The longer these decelerations persist, the more we have to be concerned, no matter what the variability
Variability

- Variability reflects the autonomic tone between the sympathetic and parasympathetic systems
- The literature is replete with blanket statements about it but no quantitative research
- According to the latest AJOG Clinical Opinion, intermediate variability is not predictive of fetal acid base status
Intrapartum management of category II fetal heart rate tracings: towards standardization of care

Steven L. Clark, MD; Michael P. Nageotte, MD; Thomas J. Garite, MD; Roger K. Freeman, MD; David A. Miller, MD; Kathleen R. Simpson, RN, PhD; Michael A. Belfort, MD, PhD; Gary A. Dildy, MD; Julian T. Parer, MD; Richard L. Berkowitz, MD; Mary D’Alton, MD; Dwight J. Rouse, MD; Larry C. Gilstrap, MD; Anthony M. Vintzileos, MD; J. Peter van Dorsten, MD; Frank H. Boehm, MD; Lisa A. Miller, CNM, JD; Gary D. V. Hankins, MD
FIGURE 1
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

No

Cesarean

Yes

Active Phase

Observe

No

Second Stage

Normal progress

No

Cesarean or OVD

Yes

Cesarean or OVD

Observe

No

Observe for 1 hour

Persistent pattern

Manage per algorithm

OVD, operative vaginal delivery.

*Participants have not been 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.

Normal Progress?

• Not defined
  ✦ 4 hours?
  ✦ 1 cm / hour?

• > 1 cm / hour to approximately 4 hours with no change is a grey area.

• Be aware progress should be adequate
• Be aware of mission creep
First Steps

- Maternal resuscitative measures
- Elimination of tachysystole
- 30 minutes for assessment – then a plan
- In mixed pictures manage according to the worse finding

- The case of the IUGR fetus with oligohydramnios
  - Variables from the oligo
  - Lates from the hypoxia
FIGURE 2
Tracing exhibits minimal to absent variability without decelerations, despite regular contractions

Medication effect has been excluded clinically as part of the initial period of intrauterine resuscitation attempts. While the fetus may have experienced prelabor central nervous system injury, absence of late decelerations excludes ongoing hypoxia in a neurologically intact fetus. However, since such fetuses may not tolerate labor without sudden deterioration and demise, cesarean delivery would be appropriate, per algorithm, if pattern persists for 1 hour.

FIGURE 3
Tracing exhibits minimal to absent variability and late decelerations occurring with >50% of contractions

Per algorithm, expedited delivery is indicated regardless of labor progress.

Late decelerations represent protective cardiovascular response to contraction-induced reductions in fetal oxygenation. Per algorithm, if labor is progressing normally in active phase or second stage, careful observation would be appropriate. If the fetus is remote from delivery, delivery would be appropriate.

FIGURE 5
Tracing exhibits moderate variability and acceleration, thus excluding clinically significant acidemia.

Significant variable decelerations seen here suggest umbilical cord compression during contraction, which could, over time, lead to significant acidemia. Per algorithm, if labor is progressing normally in active phase or second stage, careful observation would be appropriate. If the fetus is remote from delivery, delivery would be appropriate.

“The algorithms present represent a consensus of the best thoughts of 18 authors given their present scientific understanding. All authors are highly experienced clinicians with significant peer-reviewed research experience and publications in the area of fetal evaluation. They represent a broad geographic spectrum and experience in both the academic and private practice worlds and represent the disciplines of medicine, nursing, and midwifery.”

In other words, Level III Evidence
Conclusions

• The CTG is a screening, not a diagnostic test
• Should be used in clinical context
  ✦ Normal uncomplicated pregnancy
  ✦ IUGR
  ✦ Oligohydramnios
• Scalp sampling is falling from use
• The skill in contemporary practice is managing the Category 2 trace