Antepartum Fetal Evaluation
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Goal of Fetal Evaluation?

- Reduce the perinatal mortality rate (PMR), which ACOG defines as the death rate of fetuses and infants weighing 500 gram or more at delivery. Internationally, the perinatal mortality rate only includes fetuses and infants weighing 1,000 grams or more.
- Currently, the rate of stillbirth in the US is 6.2 per 1,000 live births, which has improved. The African American PMR is more than twice that of Caucasians.
- Testing identifies fetuses at risk for hypoxia or asphyxia secondary to suboptimal uteroplacental transfer of oxygen.
- Antenatal surveillance cannot often predict such events as placenta abruption or an umbilical cord accident.

What are the etiologies of perinatal death?

- 30% are cord and placental complications leading to asphyxia (IUGR, postdates).
- 30% are from maternal complications (Placental abruption, cHTN, gHTN, Preeclampsia, and GDM).
- 15% are from congenital malformations and chromosomal abnormalities.
- 5% are from infection.
- 20% are still unexplained.

How did antenatal fetal surveillance come about?

- Studies showed that 2/3 of antenatal deaths were associated with chronic processes that might have been detected with antepartum fetal surveillance and hence, changed management such as timing of delivery, deliver via c-section, initiate drug therapy like betamethasone, increase frequency of testing, placing on pelvic rest/modified bedrest, admit neonate to the NICU, and terminating the pregnancy.
- It could provide information not already known by the patient’s clinical status such as IUGR, Congenital abnormalities, and Oligohydramnios.
- Women 35 years of age or older had nearly a twofold greater risk for fetal death.
- It ultimately had the power to decrease perinatal morbidity and mortality.

Why does testing usually begin at 32 weeks?

- Fetal death resulting from uteroplacental insufficiency is uncommon prior to 32 weeks and would likely increase the false-positive rate and unnecessary interventions. Fetuses at 40 weeks or more are at much greater risk for intrauterine death than fetuses at 28-31 weeks, so testing is usually continued through this time.
- In pregnancies with multiple, worrisome high-risk conditions, testing can begin at the gestational age in which delivery might be considered. An example might be a chronically hypertensive pregnancy complicated by IUGR.

What must be taken into account when interpreting tests?

**Fetal State:** One must take into account the neurologic state of the fetus in the 3rd trimester, as there is variability, and may explain an abnormal test:
Near Term: Fetus spends 25% of its time in quiet non-REM sleep, whereby, their heart rate slows, may have infrequent breathing movements and startled movements. This may last approximately 20 minutes. The remainder of sleep which is usually in 40 minute increments is active sleep. During active, REM sleep, the fetus usually has regular breathing movements and intermittent abrupt movements.

Hypoxemia and blood pH: Although surveillance is associated with acidemia or hypoxemia, they do not reflect the severity or duration of acid-base disturbance.

Prematurity: Can be a common cause of low BPP scores.

Maternal medication exposure: Narcotics can be a factor which adversely affects BPP scores.

Fetal CNS Abnormalities: Often can be detected in the setting of an abnormal BPP.

What do false-positive and false-negative rates mean? What about negative and positive predictive values?

- **False-Positive Rate**: Incidence or percentage of interventions, performed based on an abnormal test, which was unnecessary, as follow up tests prove normal.
- **False-Negative Rate**: Incidence of infant mortality that occurs within one week of a reactive or “normal” test.
- **Negative predictive values**: If a test is negative, what is the likelihood, represented as a percentage, that there is truly no pathology present. Generally, quite high in most tests at 99.9%.
- **Positive predictive values**: If a test is positive, what is the likelihood that there is truly pathology present. Depends heavily on the prevalence rate of conditions. Generally, quite low in most tests at 50%.

What is the recommended frequency of antenatal testing?

- When a clinical condition that prompts testing persists, testing should be repeated.
- Currently, MFM does weekly NST’s and BPP’s for well controlled GDMA2, IUGR with good interval growth and normal doppler’s, and mild preeclampsia. They increase to twice weekly for poorly controlled diabetics, post-dates 41 weeks or higher, IUGR with poor growth and abnormal doppler’s, and moderate preeclampsia.

What techniques are available to evaluate the well-being of a fetus?

**Maternal Assessment of Fetal Activity:**

- Otherwise known as fetal “kick counts.”
- Can be used for routine antenatal surveillance in low risk pregnancies as well as high risk pregnancies.
- Usually, fetal activity is first perceived at 17-20 weeks and peaks at or before 38 weeks.
- Usually initiated at 28 weeks.
- Fetal movement increases from 9 pm to 1 am due to maternal hypoglycemia.
• Fetal movement is extremely sensitive to a decrease in fetal oxygenation, such that even a small decrease in PaO2 can lead to cessation of limb movements.
• If a mother has less than 10 movements OR weaker movements in a two hour period, the patient should be evaluated. This method has a 90% compliance rate and was developed by Moore and Picquadio.
• Once 10 movements are detected, kick counts can be discontinued.
• The average time for a woman to feel 10 movements is 20 minutes.
• Approximately 5% of women will report decreased fetal movement.
• Instituting this method has decreased the fetal mortality rate by 50-73%.

**Nonstress Test:**

• Patients should be placed in either the semi-Fowler position with their head elevated 30 degrees or in the lateral recumbent position (*Semi-Fowler is usually faster*).
• **Reactive** → 2 heart rate accelerations of 15 bpm above baseline lasting 15 seconds over a 20 minute period. 85% will be reactive.
• **Nonreactive** → 15% are nonreactive and most commonly due to quiet sleep. 80% of nonreactive NST’s will become reactive if the time is extended up to 40 minutes. The rate of mortality with a nonreactive NST is 30-40 per 1,000. A BPP should be performed for all nonreactive NST’s.
• **Bradycardia** → Defined as a fetal heart rate of 90 bpm or a heart rate drop of 40 bpm below the baseline which lasts 1 minute or longer. The etiology is usually cord compression, IUGR, and fetal malformations. A BPP should be performed to assess AFI and look for anomalies. Delivery may be indicated for term infants. When the fetus is preterm, steroids are usually given, and fetal heart rate is continuously monitored. Even for mild decels, a BPP should be performed. Bradycardia is direct result of chemoreceptor responses to hypoxemia which lead to a vagally-mediated reflex.
• Good measurement of current fetal health.
• Up to 65% of NSTs are normally non-reactive if performed less than 32 weeks, hence why 32 weeks is the usual gestational age at which NST’s are initiated.
• Variable decels can be seen in 50% of NSTs and should not be repetitive or last more than 30 seconds. Three in a 20 minute period should prompt further evaluation. This may include performing a BPP and continuously monitoring the fetus in a hospital setting.
• Decels which last for 1 minute or longer should prompt hospitalization and/or delivery.
• **False-Positive rate can be as high as 50-90%**.
• **False-negative rate is 1.9 infant deaths per 1000 live births.**

**Fetal Biophysical Profile:** The first component of the BPP to develop in utero will usually be the last abnormal parameter seen. BPP’s can be initiated as early as 28 weeks. Steroid administration has the ability to decrease the profile score and lead to false positives, hence unnecessary interventions. The affect usually only lasts for 48 hours. The risk of cerebral palsy is increased with low BPP scores.

• **Fetal Breathing Movements (FBM)** → Starts to occur regularly at 20-21 weeks. FBM is a direct reflection of CNS function and is usually the first parameter to go when the fetus is in distress. Cessation of fetal breathing movements has been shown to occur when the umbilical vein blood pH is 7.28 or less. Hypoglycemia, and fetuses exposed to nicotine and narcotics can have decreased fetal breathing movements. Breathing movements must be present at least once for a score of 2, for at least 30 seconds, over any 30 minute period. When FBM are absent and accompanied by late decels, the likelihood of fetal compromise is great.
• **Fetal Movement** ➔ Starts functioning at 9 weeks. Usually the second parameter to go when the fetal condition worsens and often reflects an umbilical vein blood pH of 7.16. The presence of 3 or more discrete body/limb movements over a 30 minute period imparts a score of 2.

• **Fetal Tone** ➔ Begins to function at 7.5-8.5 weeks. Last parameter to go when the fetal condition worsens. A score of 2 is given for 1 or more active extension with return to flexion of a fetal limb or trunk OR opening or closing of a hand.

• **AFI** ➔ A marker of the longer-term adequacy of placental function. It can also indicate redistribution of blood flow in response to hypoxemia. When this occurs, there is less renal perfusion and therefore, urine output. This manifests as oligohydramnios. AFI in the 2\(^{nd}\) and 3\(^{rd}\) trimester reflects fetal urine production. When this parameter is low, an NST is the only way to detect fetal heart rate decels. A score of 2 is given if there is at least 1 pocket of fluid measuring 2 or more cm in its largest vertical axis.
  
  ▪ Using the deepest vertical pocket as opposed to AFI reduces unnecessary interventions without an increase in adverse perinatal outcomes.

• **Fetal heart rate reactivity** ➔ The fetal heart rate becomes functional at the end of the 2\(^{nd}\) or early 3\(^{rd}\) trimester. Is often one of the first indications of fetal compromise. This is assessed with a NST, which is usually performed when at least one ultrasound parameter is abnormal. A Non-reactive NST is also correlated with FBM. A reactive NST imparts a score of 2.

• **False negative rate** is 0.6-0.8 in 1,000 live births.

• **False positive rate** can be greater than 40% with scores of 6, but 0% with score of zero.

• **When all ultrasound variables are normal**, an NST does not increase the accuracy of the test.

What do BPP scores mean for clinicians?

• **Score of 8/10** with normal AFI is considered normal.

• **Score of 6** is considered suspicious and should prompt hospital evaluation/delivery in full term patients and repeated in 24 hours for preterm patients.

• **Scores of 4** are associated with increased morbidity and mortality. Hospitalization and/or delivery is warranted if 32 weeks or greater.

• **Scores of less than 4** almost always result in delivery.

**Modified BPP:**

• Consists of AFI evaluation with a NST.

• If the NST is non-reactive OR the AFI is abnormal, the mBPP is abnormal. A full BPP should be performed in this case.

• Late, prolonged, or significant variable decels, particularly with borderline oligohydramnios (6-10 cm for preterm and 6-8 cm in full term), is considered abnormal.

• Any time there is oligohydramnios, the test is abnormal regardless of reactivity.

• The modified BPP has a false-negative rate comparable to a full BPP and is 0.8 per 1,000 live births.

• The modified BPP has a false-positive rate similar to an NST, but higher than a full BPP at 60%.

• **Study by Lagrew and Wing in 1996 suggested that weekly AFI measurements are reasonable prior to 41 weeks, provided the AFI is greater than 8 cm, which supports our protocol to perform twice weekly BPP’s for borderline oligohydramnios.**

• Beyond 41 weeks, AFI assessment should be performed twice weekly, which also supports our protocol.
Doppler Ultrasound:

- Noninvasive assessment of the fetal, maternal, and placental circulation.
- A normal Doppler is characterized by high-velocity diastolic flow.
- Systolic velocity/diastolic velocity = S/D ratio **Ratio > 3 is abnormal.**
- Resistance Index: S-D/S **Index >0.6 is abnormal.**
- Usually performed weekly to biweekly.
- When the diastolic flow is low, the ratio is elevated, which translates into an increased resistance, or vascular impedance in the umbilical artery.
- End-diastolic flow decreases when 60-70% of the placental vascular tree is compromised.
- Best performed when the fetus is quiet. The ultrasound probe should be placed on the mid-portion of the umbilical cord, where you will get the average velocity of the artery.
- Variations in fetal heart rate and episodes of fetal breathing affect the blood flow through the umbilical artery.
- Most helpful in pregnancies complicated by IUGR, where S/D ratios are often elevated in a severely growth restricted fetus. The diastolic flow may become absent or reversed.
- The higher the resistance of placental vessels, the decreased blood flow to the fetus.
- The Middle cerebral artery systolic velocity may be looked at as well, where IUGR fetuses redistribute systemic blood flow from the periphery to the brain. Also called “brain-sparing.” The aorta clamps down (increasing afterload) to increase flow to the brain. Increased velocity in the MCA can also indicate fetal anemia, as often seen in hemolytic disease of the newborn.
- Mortality with reversed flow can be as high as 36%, which may be higher if umbilical venous pulsations are seen.
- Umbilical venous pulsations reflect increased central venous pressure due to an increased afterload. The aorta clamps down to increase the blood flow to the brain. These pulsations may also be seen in fetuses with abnormal cardiac function and severe growth restriction. The inferior vena cava and the ductus venosus may be measured as well.
- The decision to deliver depends on fetal heart rate monitoring (NST) or results of a BPP.
- Although false negative rates have not been reported in large clinical studies, a small RCT of 214 pregnancies complicated by IUGR found no stillbirths in pregnancies where Doppler was the primary means of surveillance.

**How do abnormal doppler’s guide management?**

- **Elevated S/D Ratio** – Delivery should be considered at or beyond 37 weeks
- **Absent End-diastolic flow** – Delivery should be considered at or beyond 34 weeks s/p BMZ
- **Reversed End-diastolic flow** – Delivery should be considered at or beyond 32 weeks s/p BMZ
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