Objectives: Antenatal Fetal Surveillance

- Review evidence to guide surveillance:
  - Patient selection
  - Technologies
  - Techniques
  - Timing
  - Location
  - Effectiveness
    - Goals?
    - Evidence is limited

- Who, What, When, Where, Why?

Antenatal Testing: Why?

Improve Perinatal Outcomes!
- Prevent Intrauterine Fetal Demise (IUFD)
- Identify at risk fetuses:
  - Intrauterine neurologic injury
- Timely intervention
  - Delivery
    - Induction of labor
    - Cesarean
- Balance potential benefits
- Inconveniences, Cost, Limitations


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6/10/10
IUFD - background

Far too common!
- Worldwide: 3.2 million/year
- US: 26,000/year
- Incidence - 6.4/1000
  - 20-27 weeks 3.3/1000
  - >28 weeks 3.2/1000
- “Late” IUFD
  - 23% decrease since 1990
- Healthy People 2010
  - 4.1/1000

IUFD: Decline in fetal status

- Predictable and sequential changes
  - Biophysical or Doppler examination
- Fetus with growth restriction
  - Loss of Fetal Heart Rate (FHR) reactivity
  - Abnormal blood flow in umbilical artery
    - Followed by MCA, DV
  - Abnormal biophysical parameters
    - Decreased breathing, body movements, tone
  - Blood flow is redirected from kidneys ➔ oligohydramnios
  - Hypoxemia/acidemia ➔ Fetal injury/death

IUFD – Associated conditions

- Maternal medical conditions
  - HTN, DM, Renal, Thyroid, Liver
  - Cholestasis, Connective tissue disorders
- Antiphospholipid AB, Thrombophilia, Alloimmunization
- Congenital anomaly or malformation
- Chromosomal (fetus or placenta)
- Fetomaternal hemorrhage
- Placental abnormalities (e.g. vasa previa, abruption)
- Umbilical cord (e.g. velamentous, prolapse, occlusion)
- Multifetal gestation (e.g. TTTS, TRAP)
- Abnormal serum markers (e.g. low PAPP-A)
- Infection
  - Maternal, placental, leading to preterm labor

Antenatal Testing: What?

- Fetal Movement Counting
- Contraction Stress Test (CST)
- Biophysical Profile (BPP)
- Non Stress Test (NST)
- Modified BPP (NST/AFI)
- Doppler interrogation
  - Umbilical artery (UA)
  - Ductus venosus (DV)
  - Middle cerebral artery (MCA)
  - Uterine artery
Fetal Movement Counting
- Regular movements ~20 weeks
  - Frequency unchanged
  - Quality change
- Kick counts in practice
  - 10 movements in 12 hours
  - 10 movements in 2 hours, focus on fetus
  - 4 movements in 1 hour, focus on fetus
- What is decreased fetal movement?
  - Overall maternal sense
    - Evaluation (history review, NST, ultrasound)

Contraction Stress Test (CST)
- Contractions decrease O₂ delivery
  - Hypoxic fetuses have late decelerations
    - Elucidates subtle compromise
    - May aid in predicting tolerance of labor
- CST
  - IV Oxytocin
  - Nipple stimulation
    - Faster
    - Hyperstimulation
  - 3 UCs, 40 sec in duration, in 10 minutes

Contraction Stress Test (CST)
- Negative CST
  - Rate of stillbirth in 7 days: 4/10,000
- Positive CST
  - 50% poor perinatal outcome
    - IUFD, CD for NRFHT, low Apgar scores
  - 30% tolerate labor without FHR changes
- Limitations
  - Contraindicated when unable to tolerate contractions (e.g. placenta previa)
  - Timing, Staff, Labor unit

CST – Management

<table>
<thead>
<tr>
<th>CST result</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactive-negative</td>
<td>Repeat, 7 days</td>
</tr>
</tbody>
</table>
| Nonreactive-negative| Repeat, 24 hours
  - Evaluation for nonreactivity
  - Fetus <28 weeks, normal variability,
    - repeat in 7 days |
| Reactive-equivocal   | Repeat, 24 hours |
| Nonreactive-equivocal| Repeat, 12-24 hours |
| Reactive-positive   | Gestational Age >37wks, trial of induction
  - Preterm: further evaluation |
| Nonreactive-positive| Term: delivery via cesarean
  - Preterm: further testing |
**Biophysical Profile (BPP)**

- Non Stress Test (NST) with ultrasound
- Acute & chronic fetal compromise
  - Amniotic fluid volume – chronic
    - Oligohydramnios - associated with acidemia
  - Others parameters – acute
- 5 Components tallied for score
  - Not all measures equal

**BPP Management**

<table>
<thead>
<tr>
<th>Score</th>
<th>Risk of Asphyxia</th>
<th>Management</th>
<th>Perinatal Mortality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/10</td>
<td>Nearly zero</td>
<td>Follow as clinical course dictates</td>
<td>&lt;1/1000</td>
</tr>
<tr>
<td>8/10 (AFI nil)</td>
<td>Chronic asphyxia likely</td>
<td>Normal urinary tract, no ROM, delivery after steroids</td>
<td>20-30</td>
</tr>
<tr>
<td>8/10 (Oligo)</td>
<td>Asphyxia not excluded</td>
<td>Repeat if 6/10, deliver at &gt;37 weeks if immature repeat within 24h if less than 6/10 delivery</td>
<td>50</td>
</tr>
<tr>
<td>6/10 (AFI nil)</td>
<td>Chronic Asphyxia likely</td>
<td>Delivery, continuous FHT</td>
<td>115</td>
</tr>
<tr>
<td>6/10 (Oligo)</td>
<td>Acute likely, if oligo, risk of acute and chronic increases</td>
<td>&gt;115 if oligo</td>
<td>&gt;50</td>
</tr>
<tr>
<td>4/10</td>
<td>Acute with chronic asphyxia likely</td>
<td>Delivery, typically via cesarean</td>
<td>220</td>
</tr>
<tr>
<td>2/10</td>
<td>Nearly certain</td>
<td>Deliver Immediately</td>
<td>550</td>
</tr>
</tbody>
</table>

* risk of fetal mortality (per 1000) within one week without any fetal intervention

**Non-Stress Test (NST)**

- Benefits: Less invasive, time consuming
- Procedure / Definition
  - Semi-Fowler’s with Lateral tilt
  - Baseline, variability, and accelerations
- Reactive NST
  - Normal Baseline (110-160 bpm)
  - Moderate Variability (5-25 bpm)
  - Accelerations (15 bpm x 15 sec)
    - 10 x 10 < 32 weeks
Non-Stress Test (NST)

- Factors that modulate accelerations
  - Sympathetic discharge
  - Fetal circadian rhythm - sleep
  - Maternal medication/illicit drug
- Decreased FHR reactivity
  - Smoking
  - Fetal non-REM sleep

NST - Interpretation

- Variables
  - Not infrequent (up to 50%)
  - Non-repetitive, <30 sec, otherwise reactive
    - No action needed
  - ≥ 3 variables: Increased C/S for FIOL
  - Deceleration > 60 sec
    - Associated with IUFD
    - Cesarean for non-reassuring FHT

NST - Interpretation

- Non-reactive NST
  - ≥ 40 minute – fetal compromise?
    - Consider Gestational Age
      - 24-28 weeks - 50% healthy
      - 28-32 weeks - 15% of healthy
    - Back-up test if abnormal
- Help
  - VAS – Safe and Effective
  - Glucose & manual stimulation
    - No difference

NST Performance

- Reactive NST
  - Normal FHR, but IUFD within 7 days
    - “False negative”
      - 3.1/1000; (1.9-5/1000)
- Nonreactive NST
  - “False positive”
    - 55% - Back-up testing is normal
  - “True positive”
    - 20% poor outcome
      - IUFD, late decelerations, low Apgar scores
Modified Biophysical Profile

- NST – short term assessment
- Amniotic fluid index (AFI)
  - Hypoxemia → renal perfusion → oligohydramnios
- False positive: (non-hypoxic at delivery) 60%
- False negative: (IUFD after normal test) 0.8/1000
- Intervention
  - Higher cesarean: 2 fold increase in RR
  - Iatrogenic PTB in ~1-2%

Comparison of Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>False Negative*</th>
<th>False Positive#</th>
</tr>
</thead>
<tbody>
<tr>
<td>NST</td>
<td>19-65</td>
<td>50-90%</td>
</tr>
<tr>
<td>Modified BPP</td>
<td>~8</td>
<td>60%</td>
</tr>
<tr>
<td>CST</td>
<td>4</td>
<td>35-65%</td>
</tr>
<tr>
<td>BPP</td>
<td>~8</td>
<td>40%</td>
</tr>
</tbody>
</table>

* risk of fetal mortality (per 10,000) <1 week after a negative test result
# fetal survival >1 week after a positive test result

Doppler Velocimetry

- Uteroplacental blood flow
- Fetal physiologic responses
- Best evidence
  - Adjunct
  - Primary surveillance
    - Early IUGR
- No benefit:
  - Low risk population
  - Primary surveillance

Doppler: Uterine artery

- Abnormal placentation
  - Inadequate trophoblast invasion and spiral artery remodeling
- Increased impedance in uterine artery
  - Notching at 22-24 weeks
    - Reduced flow to placental unit
    - Associated with future pre-eclampsia, IUGR, and death
**Doppler: Umbilical artery - IUGR**

- Associated destruction of villous vasculature
  - Increased systolic: diastolic ratio
  - Absent, or reversed diastolic flow
    - Fetal hypoxia, morbidity, & mortality
    - Cesarean, NICU admission, neurodev delay
- Early onset IUGR due to placental insufficiency
  - Decreased antepartum admission, induction
  - Trend toward ↓ mortality - OR 0.71 (95% CI, 0.5-1.01)

**Doppler: Middle cerebral artery**

- Compromised fetus
  - Decreased blood flow to periphery
  - Increased flow to brain
  - “brain sparing effect”
    - Decreased S/D ratio
  - Poor predictor of adverse outcomes

**Doppler: Ductus Venosus**

- Fetal veins
  - Cardiac function
- Regulates oxygenated blood in fetus
  - Resistant to changes except in severe IUGR
    - Earliest sign → increased shunting (prior to lag in AC)
      - Increased placental resistance → RV can’t compensate
        → LV increases work → spares the heart & brain
    - Late sign → excessive shunting followed by reversal of flow
      is associated with a ~40% risk of stillbirth

**Antenatal testing: Who & When?**

<table>
<thead>
<tr>
<th>Indication</th>
<th>Stillbirth (per 1000)</th>
<th>Odds Ratio</th>
<th>Gestational Age (wks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td>6.4</td>
<td>0.86</td>
<td>-</td>
</tr>
<tr>
<td>GDM A1</td>
<td>6-10</td>
<td>1.2-2.2</td>
<td>-</td>
</tr>
<tr>
<td>DM insulin</td>
<td>6-35</td>
<td>1.7-7</td>
<td>28-32</td>
</tr>
<tr>
<td>Chronic HTN</td>
<td>6-25</td>
<td>1.5-2.7</td>
<td>32</td>
</tr>
<tr>
<td>Pre-eclampsia</td>
<td>9-51</td>
<td>1.2-4</td>
<td>At Dx</td>
</tr>
<tr>
<td>Pre-e, Severe</td>
<td>12-29</td>
<td>1.8-4.4</td>
<td>At Dx</td>
</tr>
<tr>
<td>IUGR</td>
<td>10-47</td>
<td>7-11.8</td>
<td>At Dx</td>
</tr>
<tr>
<td>Twins</td>
<td>12</td>
<td>1-2.8</td>
<td>28-36</td>
</tr>
<tr>
<td>Triplets</td>
<td>34</td>
<td>2.8-3.7</td>
<td>28</td>
</tr>
</tbody>
</table>
### Antenatal testing: Who & When?

<table>
<thead>
<tr>
<th>Indication</th>
<th>Stillbirth (per 1000)</th>
<th>Odds Ratio</th>
<th>Gestational Age (wks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oligohydramnios</td>
<td>14</td>
<td>4.5</td>
<td>At Dx</td>
</tr>
<tr>
<td>Post term 41</td>
<td>1.6</td>
<td>1.5</td>
<td>40 ½</td>
</tr>
<tr>
<td>Post term 42</td>
<td>2-3.5</td>
<td>1.8-2.9</td>
<td>40 ½</td>
</tr>
<tr>
<td>h/o IUFD</td>
<td>9-20</td>
<td>1.4-3.2</td>
<td>32</td>
</tr>
<tr>
<td>Decreased FM</td>
<td>13</td>
<td>2.5-5.6</td>
<td>At Dx</td>
</tr>
<tr>
<td>SLE</td>
<td>40-150</td>
<td>6-20</td>
<td>32</td>
</tr>
<tr>
<td>Renal disease</td>
<td>15-200</td>
<td>2.2-30</td>
<td>28-32</td>
</tr>
<tr>
<td>Cholestasis</td>
<td>12-30</td>
<td>1.8-4.4</td>
<td>At Dx</td>
</tr>
<tr>
<td>ART</td>
<td>12</td>
<td>2.6</td>
<td>36</td>
</tr>
</tbody>
</table>

### Antenatal Testing: Benefits and Costs

- Limited data on benefits
  - Prevent IUFD?
- Costs
  - Testing, interpretation
  - Interventions
  - Iatrogenic prematurity
  - Anxiety
- Unclear if the costs and risks outweigh the gains

### Antenatal Testing: Conclusion

- Kick counts
  - May “capture” those at low risk
- Use evidence
  - Choose wisely who and when
  - NST/AFI ➔ back up CST/BPP
  - Doppler with IUGR: UA, DV
- Limit intervention if possible
  - Prematurity
- Further research